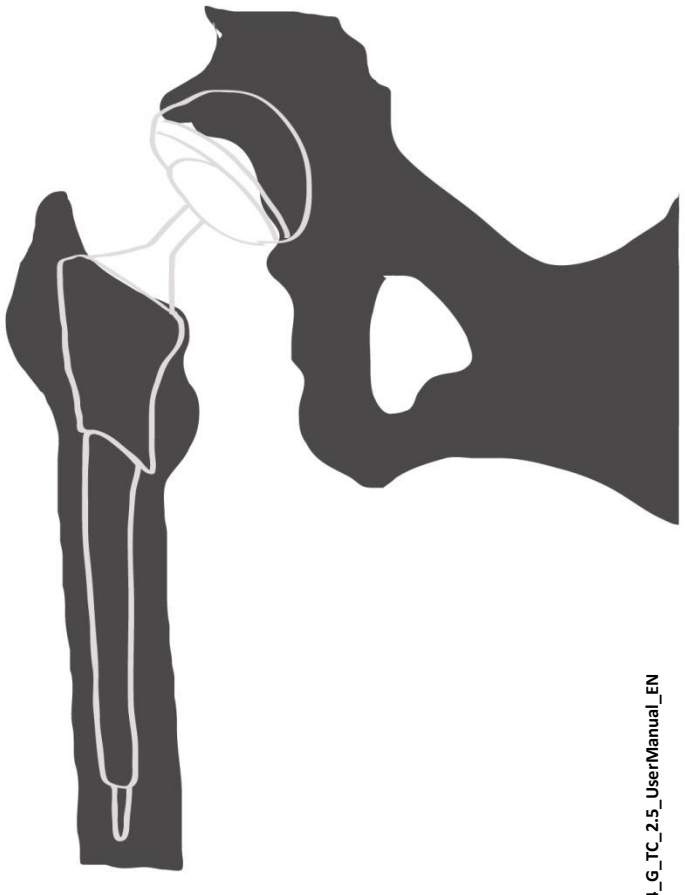
TraumaCad

Version 2.5

USER'S GUIDE



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SUPPORT AND CONTACT INFORMATION

If you need help using TraumaCad, please contact our technical support group. Technical support is available by live online chat, email and phone.

Visit www.traumacad.com and select Services Support for more details or to connect with a support representative online at www.traumacad.com/chat.html (during normal business hours).

During your support session, you may be asked to provide information about your copy of TraumaCad. The Help menu displays the software version and access to support contact information.

For a printed copy of the User's Guide contact Support by email to support@traumacad.com.

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If any serious incident occurs in relation to the device it should be reported to the manufacturer, and if within Europe, to the competent authority of the Member State in which the user and/or patient is established.

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SYMBOL GLOSSARY

Symbol	Standard Title	FDA Standard Recognition Number	Symbol Title	Symbol Reference Number	Explanatory Text
	ISO 15223-1	5-134	Unique Device Identifier	5.7.10	Indicates a carrier that contains unique device identifier information
	ISO 15223-1	5-134	Medical Device	5.7.7	Indicates that the product is a medical device
	ISO 15223-1	5-134	Manufacturer	5.1.1	Indicates the medical device manufacturer
	ISO 15223-1	5-134	Importer	5.1.8	Indicates the entity importing the medical device into the locale
	ISO 15223-1	5-134	Authorized representative in the European Community	5.1.2	Indicates the Authorized representative in the European Community
			Swiss Authorized Representative		Indicates the Authorized representative in Switzerland
	ISO 15223-1	5-134	Consult instructions for use	5.4.3	Indicates the need for the user to consult the instructions for use
RX only			Prescription Use only		Caution: USA federal law restricts this device to sale by or on the order of a licensed healthcare practitioner

Safety Symbols

The following symbols are used throughout the documentation. Please pay particular attention at specific points in a procedure when one of the following messages appears.

Warning! denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.

Notes provide pertinent information to help obtain optimum performance from the application.

Tips provide useful suggestions and information.

Important! Denotes important information to which you should adhere.

AUDIENCE

Intended Use: TraumaCad is indicated for assisting healthcare professionals in preoperative planning of orthopedic surgery. The device allows for overlaying of prosthesis templates on radiological images, and includes tools for performing measurements on the image and for positioning the template. Clinical judgments and experience are required to properly use the software.

Intended users: this product is intended for healthcare professionals who want to perform pre-operative surgical planning and evaluate medical images.

Intended patient population: patient group of adults and pediatrics.

Clinical benefits: the software helps healthcare professionals prepare in advance for orthopedic procedures, by evaluating the patient's anatomy, by considering potential outcomes, and by choosing the appropriate implants.

ABOUT THIS GUIDE

This guide is intended for surgeons who are performing pre-operative evaluation and planning for orthopedic procedures.

This guide contains the following chapters:

- **Getting Started with TraumaCad**, page 14, describes the purpose of TraumaCad, its system requirements, how to install it, how to launch it and provides a quick tour through its interface.
- **Handling Images**, page 34, describes how to use TraumaCad to load the required images, specify their anatomical orientation and calibrate the images.
- **Planning Your Surgery**, page 51, describes how to use TraumaCad for pre-operative evaluation and planning for a variety of orthopedic procedures.
- **Measuring the Anatomy**, page 70, describes how to use the various tools provided by TraumaCad to measure the anatomy represented in an image. It also describes how to take anatomical measurements, compare them to normative standards and simulate corrective procedures for limb alignment analysis.
- **Save Case:**, page 21, describes how to generate a report.
- **Appendix A - Installing TraumaCad**, page 172, describes how to install TraumaCad for standalone operation.
- **Appendix B - Standalone Usage**, page 176, describes several procedures that may be required in standalone mode.
- **Appendix C - Managing Implant Templates**, page 178, describes how to import and manage implant templates in the TraumaCad system.

GETTING STARTED WITH TRAUMACAD

WHAT IS TRAUMACAD?

TraumaCad allows surgeons to evaluate and manipulate digital images while performing various pre-operative surgical planning and evaluation of images.

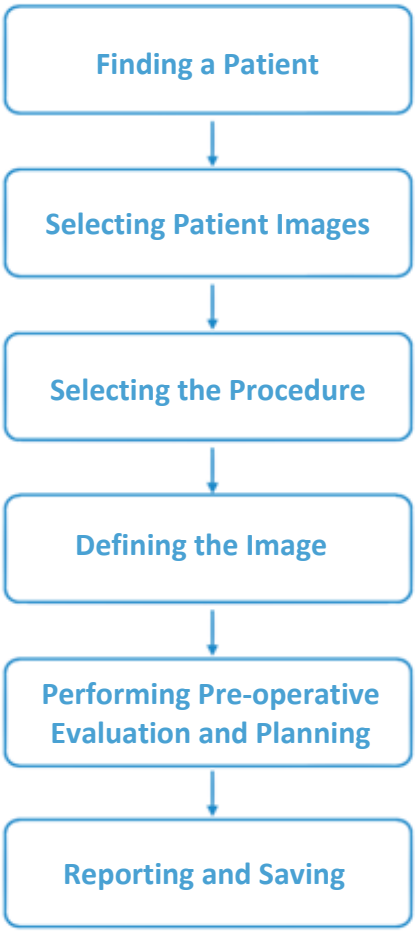
The program features full PACS integration and an extensive regularly updated library of digital templates from leading manufacturers.

TraumaCad provides easy-to-use solutions for various orthopedic subspecialties:

- **Hip**
- **Knee**
- **Upper Limb**
- **Foot and Ankle**
- **Pediatric**
- **Deformity**
- **Trauma**
- **Spine**
- **3D Suite**

TRAUMACAD WORKFLOW

The following provides a chronological overview of the process of using TraumaCad.



View the list of patients from your local cache, PACS or Quentry by clicking the applicable radio button at the top of the main view. See page 34 for details.

Select the image you want to evaluate by clicking its thumbnail. To select multiple images, click the images you want successively, one after another. See page 41 for details.

Select the relevant surgical or analysis procedure to be performed to determine the specific templates and measurement tools that can be used in the application. See page 51 for details.

Specifying the image orientation, view and side, and calibration are mandatory steps that must be performed for each image. See page 44 and page 44 respectively for details.

TraumaCad offers a large and easily accessible templates library together with a suite of orthopedic tools and wizards for measuring the actual anatomy in an image.

A full report is generated, and can be stored together with the manipulated images in the patient's PACS file, locally or uploaded to Quentry by saving the case. See page 22 for details.

Warning! Be sure to save the patient's case in order not to lose patient data.

CLIENT/SERVER, STANDALONE OR TRAUMACAD WEB

TraumaCad is installed and runs locally on your computer and interacts with a PACS system or Quentry. Three TraumaCad versions are available: client/server, standalone version and TraumaCad Web.

The TraumaCad client/server version consists of a server application that is set up by the administrator, and client applications that run on any computers.

The TraumaCad standalone version runs on a specific computer only and stores all its files, such as its configuration and implant templates.

TraumaCad Web is launched from Quentry, and is a cloud application that runs on any computer.

These three types of applications operate in a very similar manner and there are only slight differences in functionality, as described below.

Note: All TraumaCad versions can run through a Windows Mac virtual machine. TraumaCad Web runs automatically on a Mac through Citrix.

Important! Some procedures and sections in the guide are marked to indicate whether they apply to
standalone mode,
client/server mode or
TraumaCad Web mode.

TraumaCad Client/Server Functionality

Some features that are not available in the client/server version are performed by the administrator. Some of these administrator features apply to all the TraumaCad applications running in an organization, such as the library of implant templates, and some are user-specific according to the user that logs in to a client:

- There is no need to specify the connection properties between TraumaCad and PACS. Therefore, the **PACS Configuration** option is not applicable in the client version.
- The following are enabled/disabled for the clients by the administrator:
  - **Import Image**
  - **Import DICOM Folder**
  - **Query**
  - **Download Templates**
  - **Screen Capture**
  - **Save to Local Folder**

TraumaCad Web and Standalone Functionality

All the functionality described in this guide is available in the TraumaCad Web version and the standalone version.

Automatic Updates and Upgrades

For the client/server version, the application is upgraded in the server only and from there distributed automatically to the clients. Before the TraumaCad client starts, it automatically updates itself and then starts in a normal fashion.
Template updates for the client/server version are done automatically via the web.

For TraumaCad Web, the user's TraumaCad version automatically upgrades/updates to reflect any updates made to the application.

For the standalone version, if there is an update to the application, a message is presented to the user, offering the option to update the TraumaCad application. The user can select either Yes or No at that point. When selecting No, the user can perform updates later by selecting **Help ➔ Check for Update** in the menu bar.

SYSTEM REQUIREMENTS

Hardware and Software

TraumaCad is a Windows based product. For more information on supported operating systems and TraumaCad server and client prerequisites, click here.

Security Measures

IT security measures, including protection against unauthorized access, are taken to run the software as intended:

- Authentication and authorization processes, including session timeout mechanism.
- Audit logs of the key actions in the system.
- Master key based data encryption mechanisms.
- MS Security Patches are verified for compatibility with software on a regular basis.
- HTTPS SSL network security for client-server data transfers available. Specific ports are open for client server communication (note: additional customer certificate is required)

For additional information, contact Brainlab support.

Clinical Requirements

To perform accurate templating, the image should be calibrated. Image requirements may differ according to the image source:

- **Uncalibrated Images:** A calibration device must be placed prior to taking the image in order to secure accurate measurements and implant sizing.
- **DICOM Images with a Preset Calibration Attribute Acquired from the Modality**: Calibration can be approximated by oversize estimation, however, using a calibration device is recommended for better accuracy.

For more information on image calibration and calibration devices see page 44.

Combination with Other Devices

TraumaCad can be used in combination with Brainlab Quentry cloud service and various PACS systems.

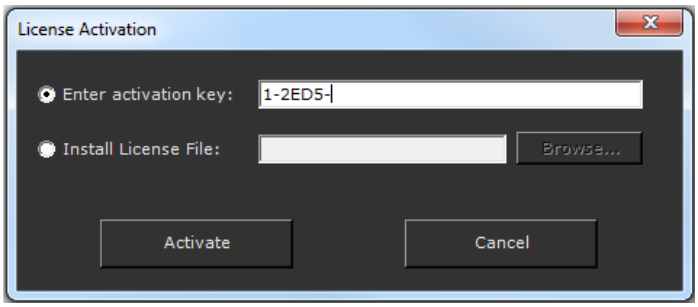
LAUNCHING TRAUMACAD

▶ **To launch TraumaCad:**

1. Double-click the TraumaCad icon that was installed on your desktop:

If this is not the first time that TraumaCad is launched on this computer, the main window is displayed, as shown on page 20.

For first time activation, enter the required activation information provided by Brainlab. For online activation using an activation key, you must be connected to the internet. Select the **Enter Activation Key** radio button, enter a valid activation key and click **Activate**.
For offline activation using a license file, you do not require connection to the internet. Select the **Install License File** radio button and click on the **Browse** button to select the License file. Then click **Activate**.

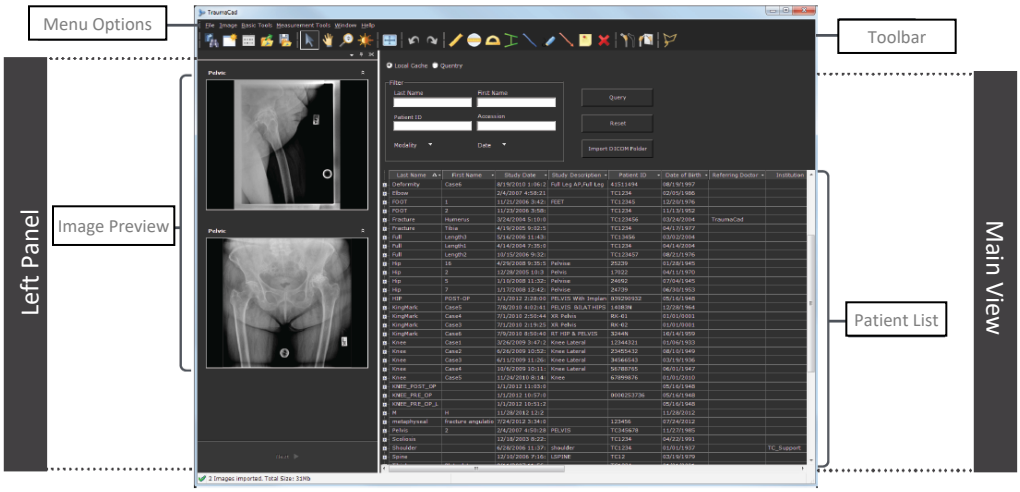


2. After entering a valid activation key or a license file, the **Activate** button becomes active. Enter information about yourself in the displayed window and click **OK**.

TraumaCad application is opened and you can get started planning.

QUICK TOUR OF THE TRAUMACAD INTERFACE

This section provides a brief overview of the features of the TraumaCad application, and describes its main window, menu bar and toolbar. The main window displays a list of patients and their images. It also serves as the main work area in which you can measure anatomy, select an appropriate implant or plan for an operation.



Note: After you select an image(s), the interface displays as shown on page 52, where you select the procedure to be performed.

This section describes the following:

- **Menu Bar**, page 21
- **Toolbar**, page 28
- **TraumaCad Right-click Menus**, page 29
- **Touch Screen Interface**, page 30

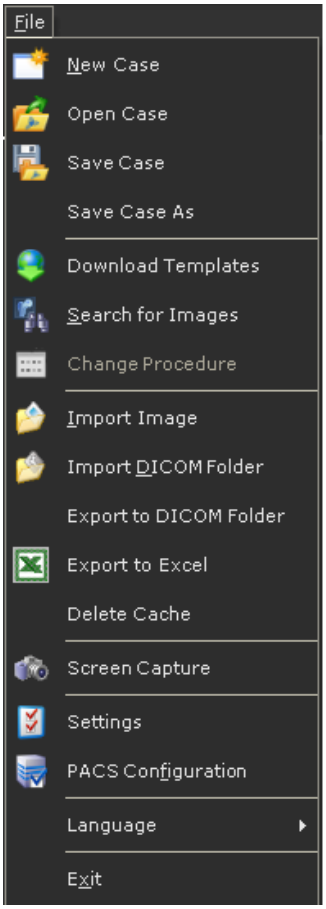
Note: Status Bar: Indicates the status of the application.

Tip: All TraumaCad options are accessible from both the toolbar and the menu bar.

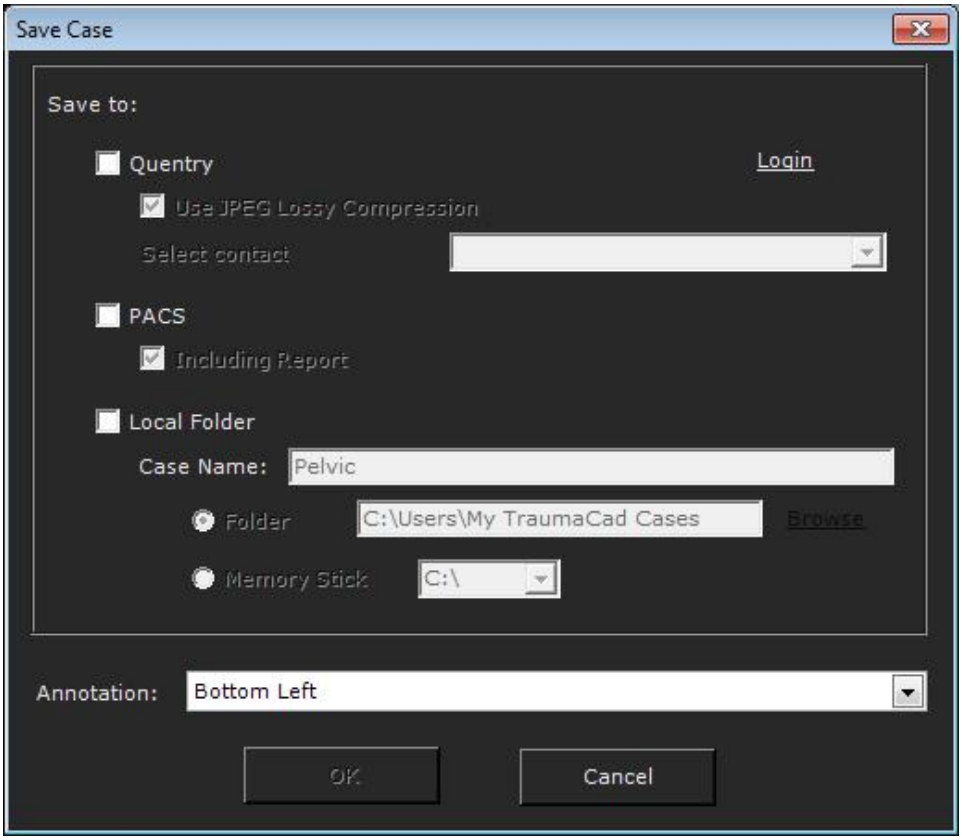
Menu Bar

The following describes the menu options available in the TraumaCad menu bar.

File Menu



- **New Case:** When you launch TraumaCad, a new case study is opened. Only one case can be open at a time. Opening a new case closes the current case and removes all the displayed images. Before starting a new case, make sure to save the current one.
- **Open Case:** Opens a local case that was stored on your computer in a folder called **My TraumaCad Cases** or on a memory stick. Locally stored cases have a file extension of **.tcc**. See page 40 for details.
- **Save Case:** Saving a case enables you to store all its images, templates, measurements and case information and later re-open it in TraumaCad. This option opens a window in which you can select to save this case by choosing any of the following options:

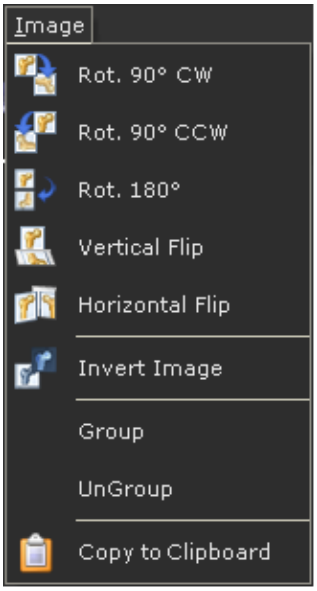


- **Quentry:** Uploads the case to Quentry. Use the **Login** option to log in to Quentry, if you are not already logged in.
  - **Use JPEG Lossy Compression:** When this option is selected, the DICOM files in the ***.tcc** file sent to Quentry are compressed using JPEG Lossy compression.
  - **Select contact:** You can choose which account to upload the files to:
    - Your own account
    - The account of a contact or Care Team that has given you permissions to upload
- **PACS:** Commit the case to PACS.
  - **Including Report:** When this option is selected, images are converted from HTML format to DICOM images for inclusion in reports. HTML cannot be committed to PACS.
- **Local Folder:** Saves the case locally in the My TraumaCad Cases folder or any other desired location, including memory stick. You can change the Case Default Location of the local folder using **File menu ➔ Settings ➔ Save Case**.
- **Annotation:** Selects the positioning and orientation of the text on the saved image.

- **Download Templates:** Downloads templates of implants from Brainlab Ltd.'s global repository to your computer.
- **Search for Images:** Searches for and adds an image while performing a procedure.
- **Change Procedure:** Changes the surgical or analysis procedure for a given patient after your initial procedure selection for this patient. See page 52.

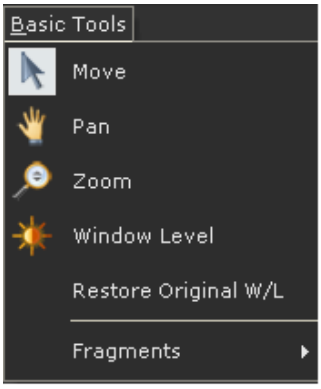
- **Import Image:** Imports a single image file. See page 36.
- **Import DICOM Folder:** Imports a folder of DICOM images to your local cache. See page 36.
- **Export to DICOM Folder:** Saves the DICOM image on the local PC as a DICOM folder.
- **Export to Excel:** Exports the measurements to an Excel sheet. This option is especially suited for research, as each measurement is added as a row in the Excel sheet file that you specify.
- **Delete Cache:** Clears the cache of images on your local computer.
- **Screen Capture:** Captures any image that is displayed on the screen into TraumaCad. See page 37.
- **Settings:** Defines settings for the TraumaCad application. See page 33.
- **PACS Configuration:** Configures the connection properties between TraumaCad and the PACS system. See page 177.
- **Language:** Chooses the language for displaying the TraumaCad interface.
- **Exit:** Closes the application.

Image Menu



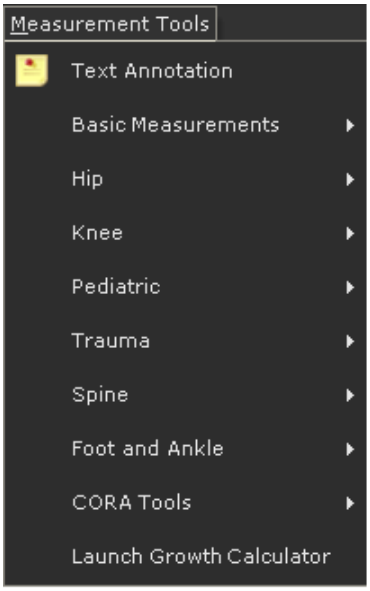
- **Rot. 90° CW (clockwise):** Rotates the image 90° clockwise.
- **Rot. 90° CCW (counter-clockwise):** Rotates the image 90° counter-clockwise.
- **Rot. 180°:** Rotates the image 180°.
- **Vertical Flip:** Flips the image vertically.
- **Horizontal Flip:** Flips the image horizontally.
- **Invert Image:** Reverses the areas of black/white on the image.
- **Group:** Groups multiple objects on the image to handle them together as a single object. See page 32 for details.
- **UnGroup:** Removes objects from a group.
- **Copy to Clipboard:** Copies the displayed image to the clipboard, including the implants, textual annotations and measurement tools that were added.

Basic Tools Menu



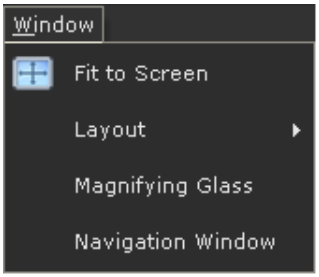
- **Move:** Moves an object in the image by dragging the mouse. Click this tool, click an object that was drawn on the image, hold down the mouse button and then move the mouse to move the object.
- **Pan:** Moves the image itself. Click this tool, click the image and hold down the mouse button. Then, move the mouse to move the image. You can also use the mouse wheel to pan the image by simply holding the wheel down and then moving the mouse to move the image.
- **Zoom:** Zooms in (enlarges) or zooms out (shrinks) the image view. Click this tool, click the image, hold down the mouse button and then drag the mouse up to zoom in or down to zoom out. You can also use the mouse wheel to zoom by rolling it upwards to zoom in and downwards to zoom out.
- **Window Level:** Enhances the visible distinction between contrasting tissue regions by manipulating the brightness and contrast. Position the cursor on the image, and click this tool. Then, click the image and drag the mouse left or right to change the contrast, and up or down to change the brightness.
- **Restore Original W/L:** Returns the image's contrast and brightness settings to their original values.
- **Fragments Submenu:** See pages 61 through 62 for more details.

Measurement Tools Menu



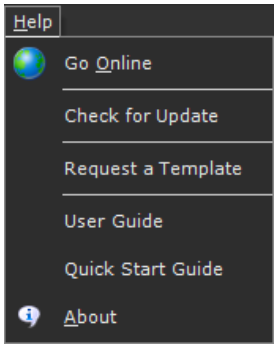
- **Text Annotation:** Adds a textual annotation to be shown on the image.
- **Basic Measurements Submenu:** See pages 70 through 74 for details.
- **Hip Submenu:** See page 75 for details.
- **Knee Submenu:** See page 89 for details.
- **Pediatric Submenu:** See page 100 for details.
- **Trauma Submenu:** See page 128 for details.
- **Spine Submenu:** See page 132 for details.
- **Foot and Ankle Submenu:** See page 149 for details.
- **CORA Tools Submenu:** See page 161 for details.
- **Launch Growth Calculator:** Opens the Growth Calculator. See page 162 for details.

Window Menu



- **Fit to Screen:** Returns to the original image size after zooming in.
- **Layout:** Specifies the layout of more than one image on the screen.
- **Magnifying Glass:** Displays an enlarged view of the area around the mouse cursor in a separate window. Magnification can be adjusted as needed.
- **Navigation Window:** Used to navigate on a zoomed in image. Drag the green box to select the specific area of the image to be displayed in the main area.

Help Menu



- **Go Online:** Displays Brainlab's website.
- **Check for Update:** Checks if there is an update available for the application.
- **Request a Template:** Accesses the Brainlab website to request a template.
- **User Guide:** Displays the online help of this User's Guide.
- **Quick Start Guide:** Opens a quick help guide to get started with the TraumaCad workflow
- **About:** Presents license and version information for TraumaCad.

Toolbar

The following provides a brief description of each of the tools in the TraumaCad toolbar.

Search for Images: Searches for patient images.

New Case: Opens a new case study.

Change Procedure: Changes the procedure selected for planning.

Open Case: Opens a saved case.

Save Case: Saves an open case.

Move: Move an object.

Pan: Pans around the image.

Zoom: Zooms in or out in the image.

Window Level: Enhances the visible distinction between contrasting tissue regions by manipulating the brightness and contrast.

Fit to Screen: Fits an image to the width of the screen.

Undo and Redo: Undoes and redoes the last action in TraumaCad.

Ruler: Measures a section of the image. See page 71 for details.

Circle: Measures the diameter of any round object. See page 71 for details.

Angle: Measures an angle. See page 71 for details.

Interline Angle: Measures the angle between two lines on an image. See page 71 for details.

Line: Draws a line on an image. See page 72 for details.

Free Hand Line: Enables you to draw a freehand line on the image. See page 72 for details.

Arrow Tool: Draws an arrow to indicate an area on the image for further attention. See page 72 for details.

Text Annotation: Adds a textual annotation to be shown on the image. See page 72 for details.

Delete Selected Object: Deletes a selected measurement tool or implant that you have added onto the image using.

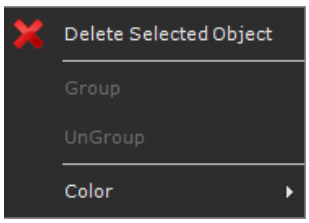
Copy implant: Duplicates a selected implant.

Flip Implant/Fragment: Flips the selected implant or fragment left or right.

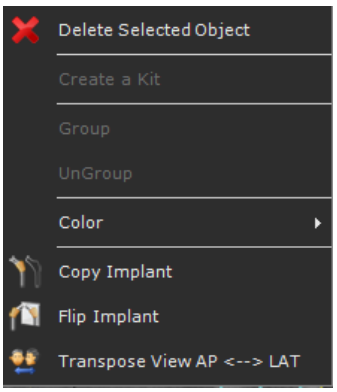
Define Fragment: Draws an outline around a fragment. See page 60 for details.

TraumaCad Right-click Menus

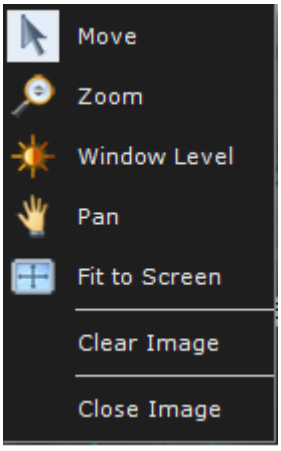
The right-click menus vary, depending on the type of object selected. The following figures show examples of the menus that display when selecting measurements, templates and images, respectively.



Measurements Right-click Menu



Templates Right-click Menu



Images Right-click menu

Note: The **Color** option is available on the templates and measurements right-click menus. This option enables you to change the color of the template/ measurement tool.

Touch Screen Interface

To enable TraumaCad touch mode, go to **File ➔ Settings ➔ Touch Mode**.

System Requirements

Touch screen is supported for Windows 7 and up.

Touch Screen Toolbar

The touch screen toolbar is similar to the TraumaCad toolbar with larger buttons to facilitate touch. For more information on each tool in the toolbar see Toolbar on page 28.

Touch Screen Functionality

- Use a 2 finger pinch to zoom in or zoom out on an image.
- Swipe right or left to pan an image.

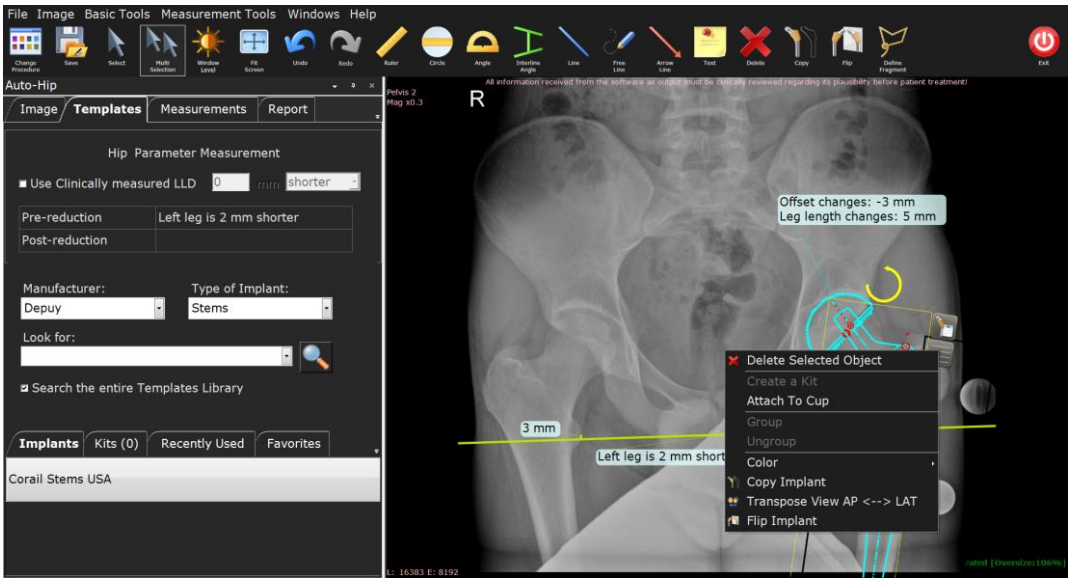
Swipe up or down to scroll templates, measurements lists or any other objects:

- A virtual keyboard opens automatically (partially hidden) on the far left side of the screen when typing text is available. Drag the keyboard onto the screen to type. If the keyboard is hidden, contact your system administrator.

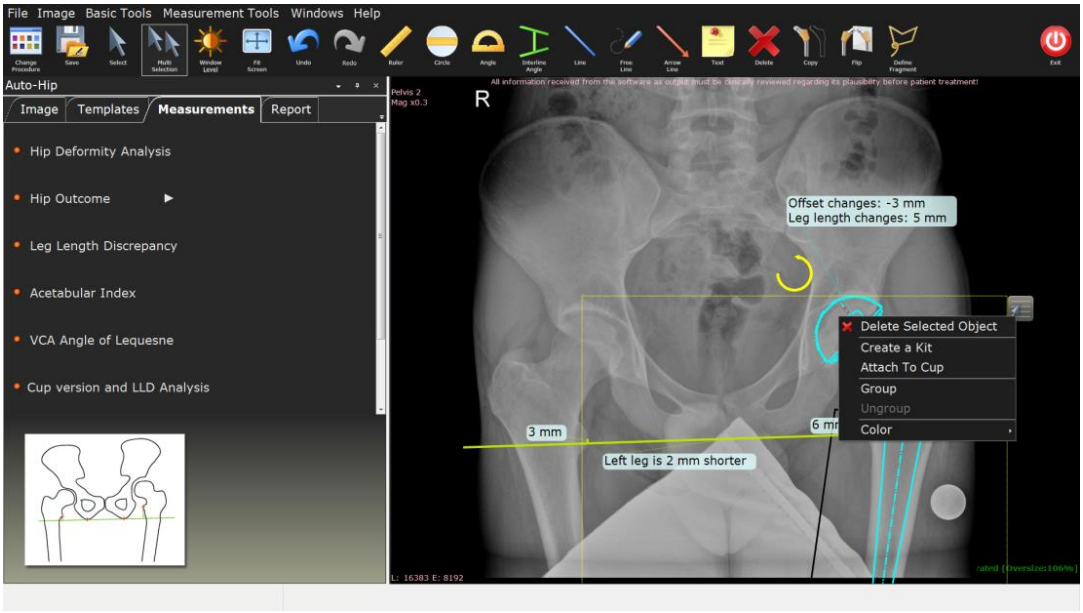
Note: It is not possible to work with mouse and keyboard when planning in Touch Mode.

Right-click Menus:

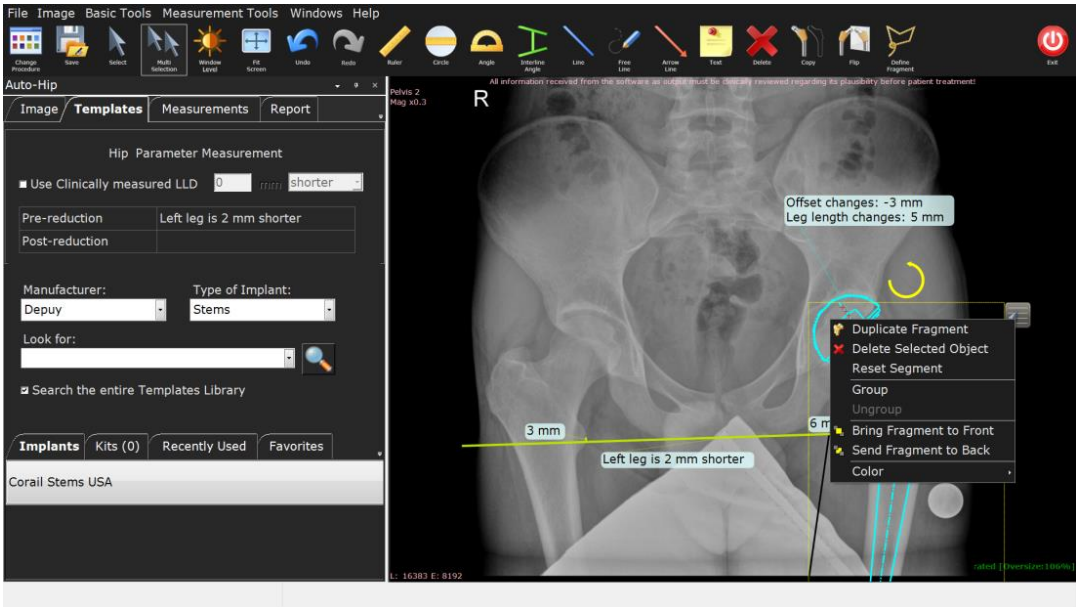
- The right-click menu appears as a button on the image. Touch the button to open the right-click menu.



- For multi-selection of objects, touch **Multi Selection** on the toolbar and then touch the right-click menu button. The multi-selection right-click menu appears.



- Right-click on a fragment for the following menu:



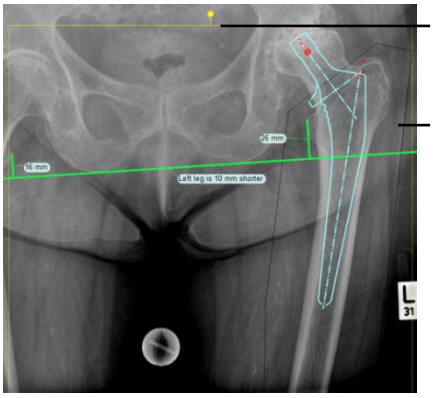
Grouping Objects

TraumaCad enables you to group various types of objects together into a group, including measurements, fragments and templates. Once grouped, the objects comprising the group can be moved and rotated as a single object.

TraumaCad also provides special options for grouping templates. See page 63 for more details.

▶ **To group TraumaCad objects:**

1. Using your mouse, hold down the mouse button and draw a selection box around the objects to be grouped. A yellow bounding box surrounds the objects you selected. Alternatively, you can select multiple objects while holding down the Shift key.

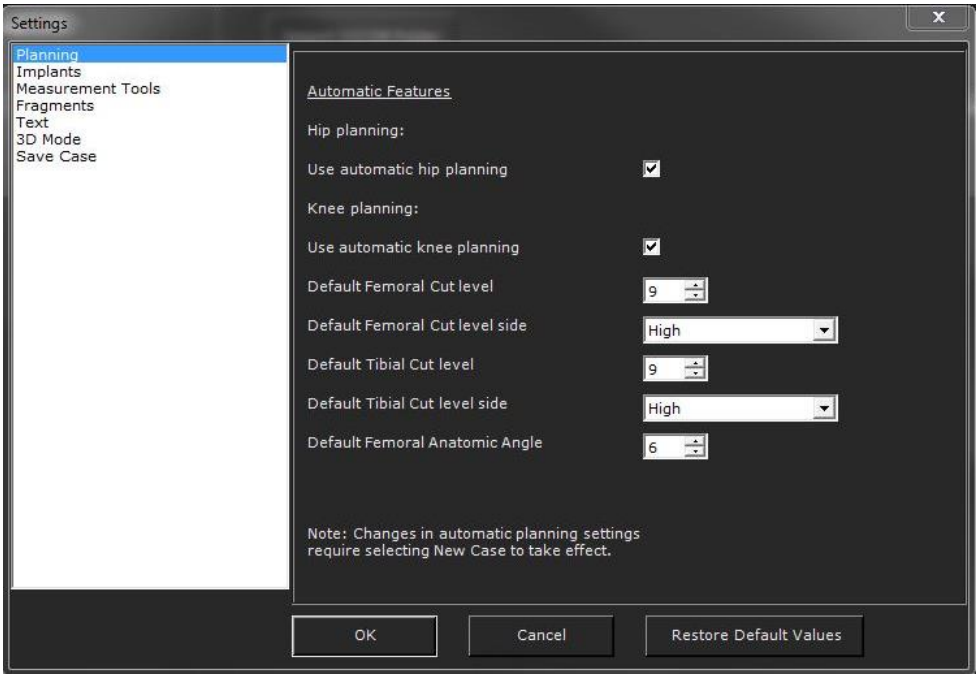


2. Right-click one of the objects within the bounding box and select **Group**. The objects are now grouped and can be moved and rotated as a single object. To rotate the group, click the handle at the top of the bounding box and pull in the direction in which you want to rotate the group.

   Grouped items remain grouped until you ungroup them by using the right-click menu or the *Image* menu.

TraumaCad Settings

The *Settings* window enables you to configure various settings used by the TraumaCad application. Select **File ➔ Settings** to open the *Settings* window:



This window contains the following branches:

- **Planning:** Defines automatic features defaults for hip and knee planning. Define the femoral and tibial cut level and side, as well as the femoral anatomic angle.
- **Implants:** Defines the colors and anchor size for implants. Enable a floating implant property window.
- **Measurement Tools:** Defines the colors, width and size of the anchors and lines of the measurement tools, and enables black and white mode.
- **Fragments:** Defines the colors and anchor size for fragments.
- **Text:** Defines the saved images text annotation, including fonts size and color as well as background color and opacity.
- **3D Mode:** Defines the colors, anchor sizes and lines for 3D tools.
- **Report:** Enables you to include a logo that is displayed on reports.
- **Save Case:** Specifies the default location for storing cases, which information to display, as well as where text annotations should be positioned on the planned images.

HANDLING IMAGES

TraumaCad supports DICOM and enables you to import (and export) any PACS file (X-ray, CT or MR) from a central PACS system, a CD or from a local workstation.

JPG, scanner or digital camera images can also be imported, and any image can be captured from the screen and used in TraumaCad.

The following options are provided for importing images:

- **Importing Images,** page 36
- **Capturing Images From the Screen,** page 37
- **Quentry Patient Folders,** page 37

FINDING THE PATIENT

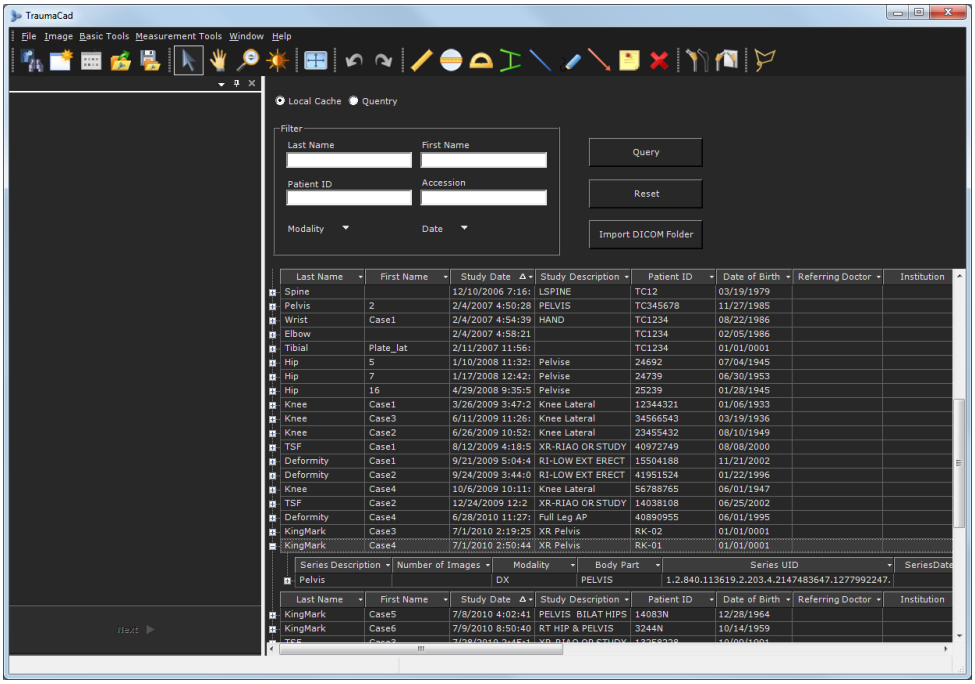
TraumaCad provides a variety of options for finding a specific patient of interest.

TraumaCad is transparently integrated with the PACS and enables full access to its patient images. If TraumaCad is integrated into your PACS, then all you need to do to access an image is to display it in the PACS, and then select the TraumaCad option.

> **Warning!** When importing an image from the PACS system, make sure that you import data from the correct patient, and use the correct image from the correct patient.

▶ **To find a patient:**

1. Perform any one of the following:
   - Enter/select all or some of the patient's information in the **Patient ID**, **Patient Name** and **Accession** fields. You can also enter part of the patient's ID or name.
   - From the **Modality** dropdown, select the modality type of the system. The default modalities selected for search are CR, DX/DR. Note that OT refers to TraumaCad cases that were stored in PACS. These cases include the original study and therefore the query results will also include CR image even if CR was not selected for the search.
   - From the **Date** dropdown, select **Today**, **Yesterday**, **Last 7 Days**, **Last 14 Days, Last 30 Days** or **All** option to see all the images within this date range.
2. Click **Query**.
3. Click **Reset** to clear the fields previously entered.

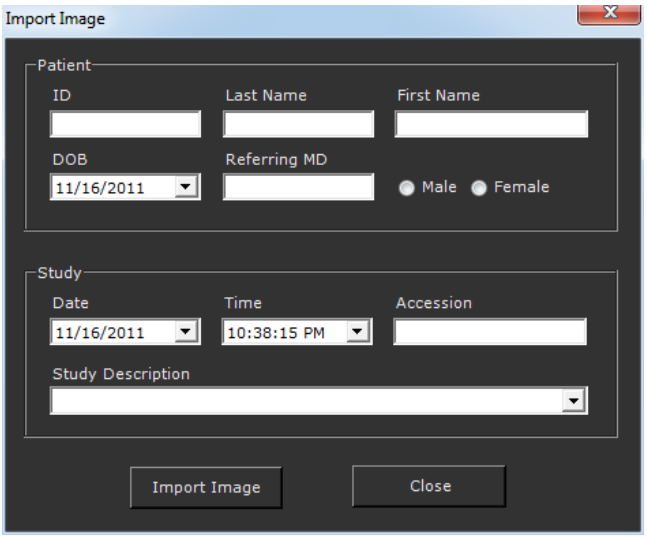


Typically, the search results list is sorted by Last Name, then First Name and then Study Date.

You can scroll down in this list or sort the listed patients by clicking the dropdown arrow for a column (at the top of the list), and then selecting the sort criterion to be used.

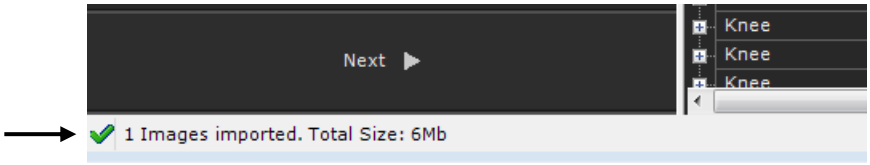
IMPORTING IMAGES

- **Import DICOM Folder:** Imports a folder of DICOM images to your local cache. To use this option, select the **Import DICOM Folder** option in the *File* menu. This action opens a window in which you select the folder containing the images to be imported.
- **Import Image:** Imports a single image file that is a JPG, PNG or BMP format. To use this option, select the **Import Image** option in the *File* menu. A window is displayed in which you can enter the patient and study information relevant for this image that will be stored with it. When completed click the **Import Image** button to browse for an image.



Warning! When importing an image or using an image from the local cache, make sure that you import data from the correct patient, and use the correct image from the correct patient.

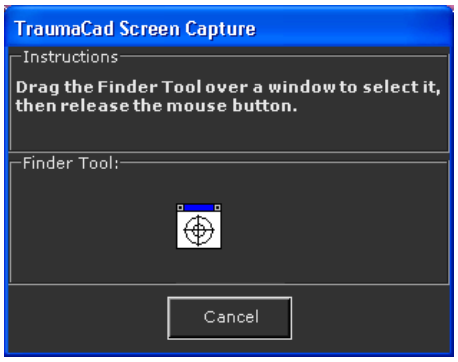
When importing an image, the progress of the import is displayed in the Status Bar, as shown below:



Note: Select **File** ➔ **Delete Cache** to clear the cache of images on your local computer.

CAPTURING IMAGES FROM THE SCREEN

Select the **Screen Capture** option in the *File* menu to capture any image that is displayed on the screen into TraumaCad. The following window is displayed:



Drag the **Finder Tool** over the image to be captured. It is then added to TraumaCad, and you can later commit it to PACS if you like.

QUENTRY PATIENT FOLDERS

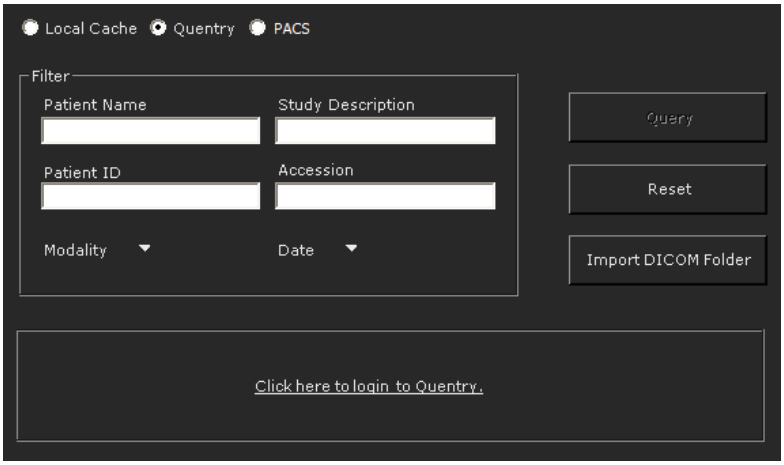
Quentry is a web-based environment where the medical staff can upload and store their patient folders in a highly secured location.

Doctors can manage patient folders including images, attachments and any other files into a private account and share them with their colleagues online.

Login to Quentry

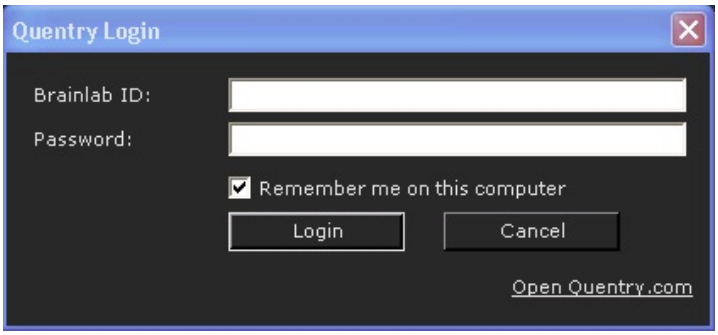
- **To login to Quentry:**

1. Select the **Quentry** radio button on the main screen to access the patient data that you saved in Quentry, as shown below:



2. Click the **Click here to login to Quentry** link.

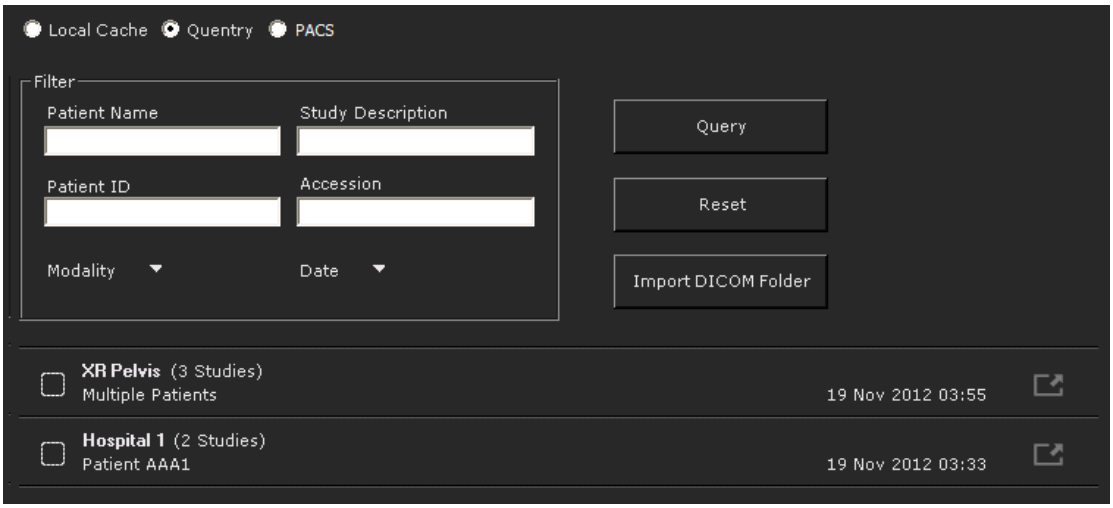
   The login window is displayed; fill in your Brainlab ID and password as provided to you by Brainlab's team.



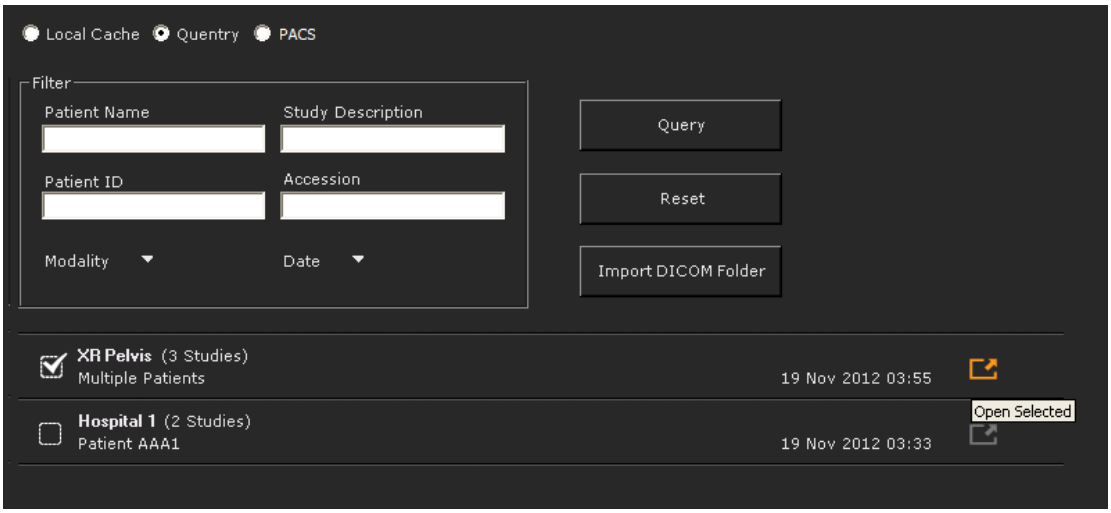
Selecting Patient Folders

▶ **To select patient folders:**

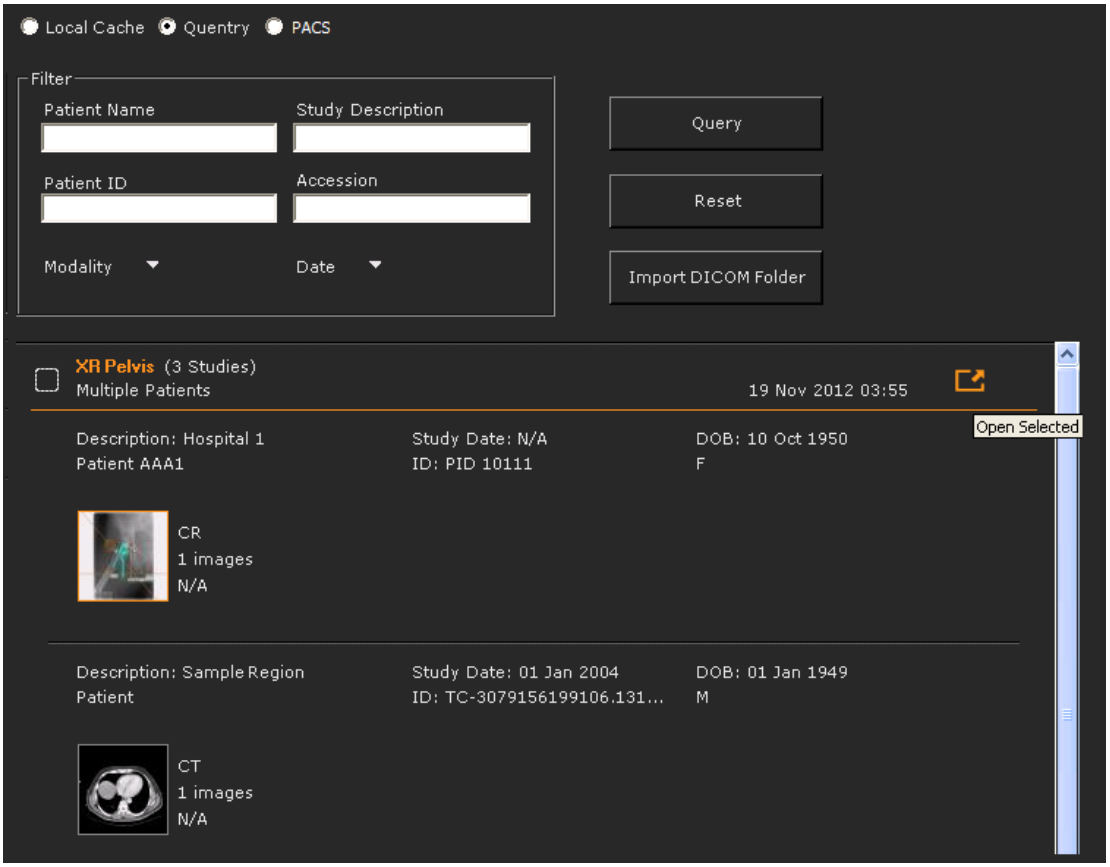
1. Select the **Quentry** radio button on the main screen to access the patient data that you uploaded to Quentry.



2. If there is more than one study, click the patient row to expand the studies and select the check box to open.

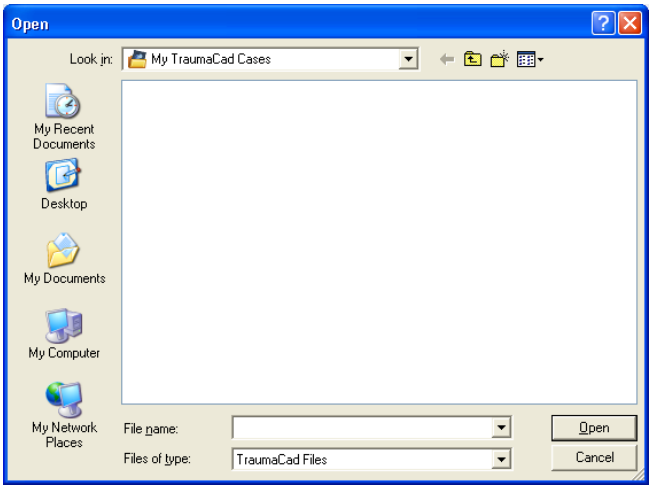


3. Click the **Open Selected** button on the right.

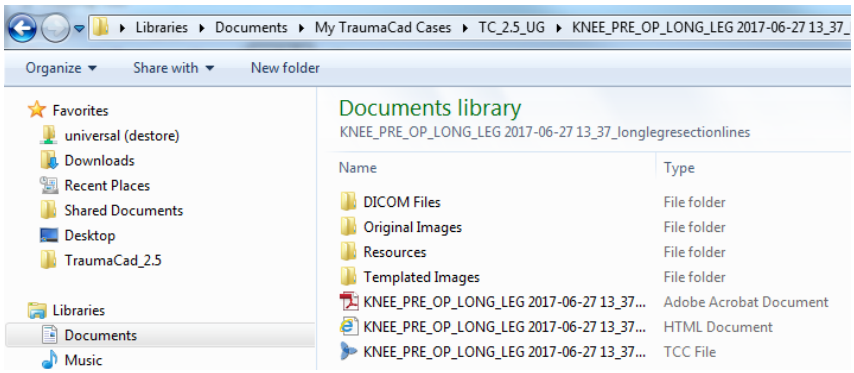


Local Cases

To open the cases that you saved locally on your computer or on a memory stick in a folder called **My TraumaCad Cases**, click **Open Case** on the toolbar. The following window opens in which you select the case to open.



The **My TraumaCad Cases** folder contains a sub-folder for each case that it contains:



The following describes the sub-folders provided for each case:

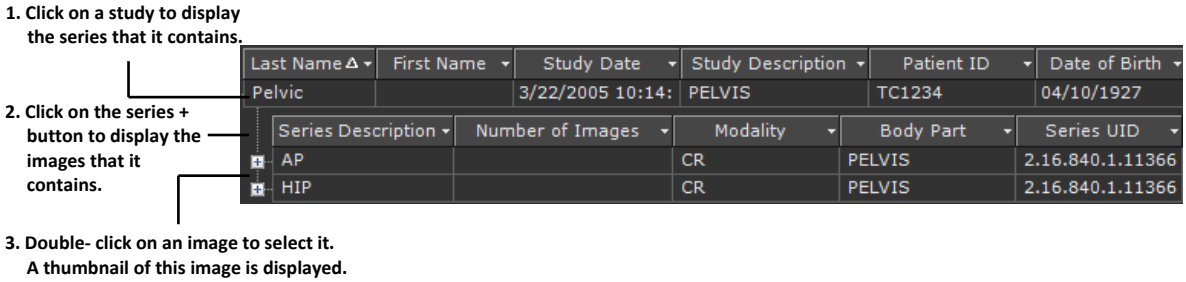
- **Original Images folder:** Contains the original images, in *.jpg format.
- **Templated Images folder:** Contains the templated images, in *.jpg format.
- **TraumaCad Case (tcc):** This file is the locally stored case with the file extension of *.tcc. The file is encrypted and can be read only by TraumaCad. This file type is associated in Windows with TraumaCad and automatically opens in the TraumaCad interface.
- **HTML Report:** A report is created automatically for each case. It provides a summary of the planning. For more details see Generating Reports. When saving a case to a local folder or Quentry, the report is also saved in a PDF format.

Note: Select **File** ➔ **Delete Cache** to clear the cache of images on your local computer.

SELECTING THE PATIENT'S IMAGES

Once you have found the patient in which you are interested, you can select the relevant images, an entire series or an entire study to be viewed. Double-click the relevant row, or click the plus sign ⊞ to drill down and see the series in a study and then again to see the images in a series. Double-click the study or the image to retrieve it from PACS and display it in the TraumaCad window.

The following diagram shows how to drill down and select a specific image in a series of a study.

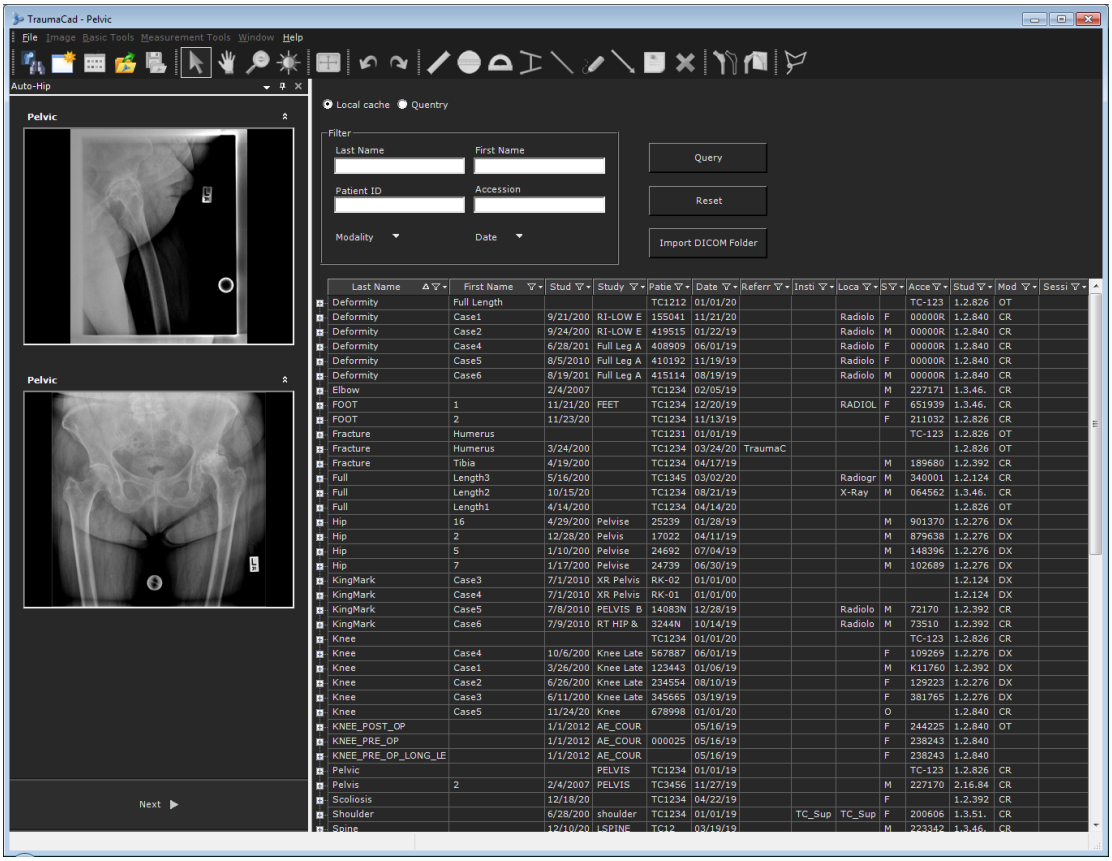


Note: Typically you select an entire study for a patient.

▶ **To select patient images:**

1. Double-click the study or the image to retrieve it from PACS and display it in the TraumaCad window.

   Once images are retrieved from the PACS or from any other location, they appear on the sidebar on the left panel.



2. Click on the images you want to work with to select them. The selected images are displayed in the main view.
3. After selecting the images, click **Next** at the bottom of the left panel to move to the procedure selection phase.

MULTIPLE VIEWS

Up to four images can be displayed simultaneously in the main work area. The active image has a red border. An unlimited number of image thumbnails can be displayed in the sidebar on the left of the window.

To make an image the active image, click the image in the main work area.

Double-click an image to select it for a single view. Double-click again to shift back to the multiple views.

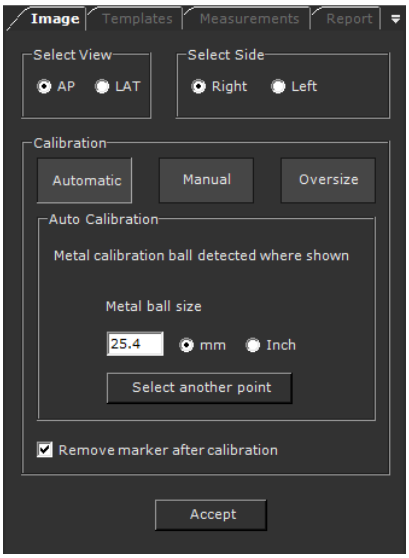
DEFINING AN IMAGE

Once the images are selected and the procedure is determined, TraumaCad working area is displayed. The **Image** tab is opened by default to define the image orientation and calibration. As these steps are mandatory for all selected images, all other tabs are disabled until all steps are completed:

- **Specifying Image Orientation and Body Side**, below
- **Calibrating the Image,** page 44

Specifying Image Orientation and Body Side

▶ **To specify image orientation and the patient's body side:**



1. Select the **AP** or **LAT** radio button to specify the applicable image view.
2. Select the **Right** or **Left** radio button to specify body side.
3. Calibrate the image, as described in Calibrating the Image on page 44.
4. Click **Accept**.
5. If there is more than one image, after the first one is defined the second one is automatically selected. Repeat steps **1** through **4** for that image.

Calibrating the Image

Direct linear measurements cannot be taken from plain X-rays because of the unknown magnification factor inherent in the X-ray-taking process.

There are two ways of determining the magnification factor:

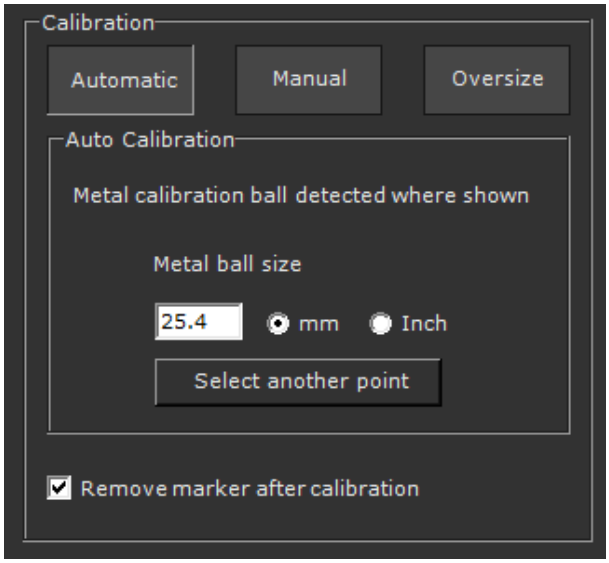
- To know the distance from the source of the X-rays to the object and the distance from the source to the X-ray plate.
- To include an object of known size or a radio opaque ruler in the plane of interest.

Warning! X-ray images can display with incorrect bone measurements due to the wrong angle of the bone during X-ray acquisition. Make sure to take X-rays with the bone at the correct angle.

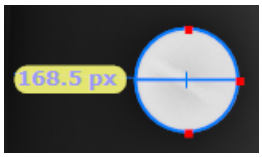
Automatically Calibrate an Image

▶ **To automatically calibrate an image:**

Automatic image calibration is performed in the Calibration area of the **Image** tab, as shown below:

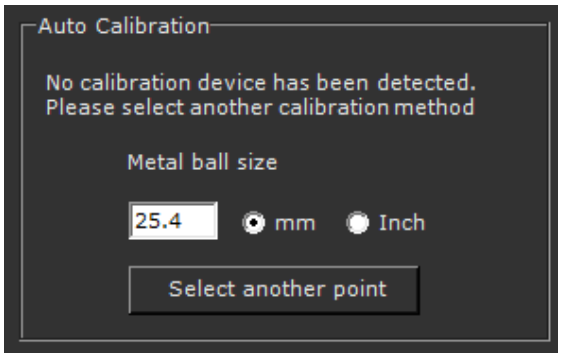


Automatic calibration attempts to find a marking device when opening the image. The marking device is then used to calibrate the image. Recommended devices are KingMark, and VoyantMark, for further details see page 48. This is the default calibration method.
When a metal ball marking device is detected the message "**Metal calibration ball detected where shown**" is displayed in the **Image** tab and a circle appears on the image, indicating where the marker was found. By default the ball size is 25.4 mm (1"). This size can be changed by setting a new size in the **Metal ball size** text box in the **Image** tab.
When a KingMark device is detected the message "**KingMark calibration device automatically detected**" is displayed in the **Image** tab.



If this is correct, click **Accept**.

When a marking device is not detected the message “No calibration device has been detected. Please select another calibration method” is displayed in the Image tab:



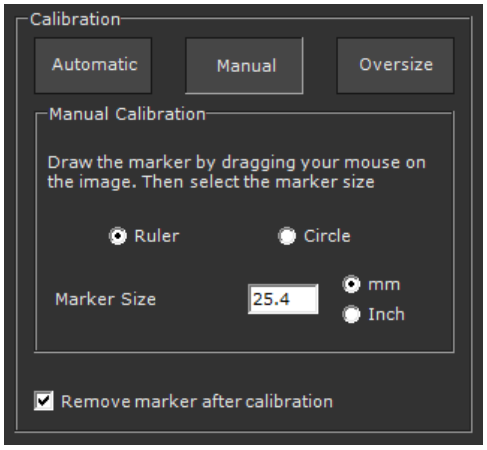
In this case, you must calibrate the image using the **Manual** or **Oversize** options, as described on pages 46 and 47, respectively.

For automatic calibration using a circle marker that appears in the image but has not been detected, you can click **Select another point** and then click inside the marker on the image to detect the entire spherical marker.

Manually Indicating the Marker in the Image

▶ **To manually indicate the position of the marker:**

1. Click **Manual**.
2. Select the calibration method you wish to use: Ruler or Circle.

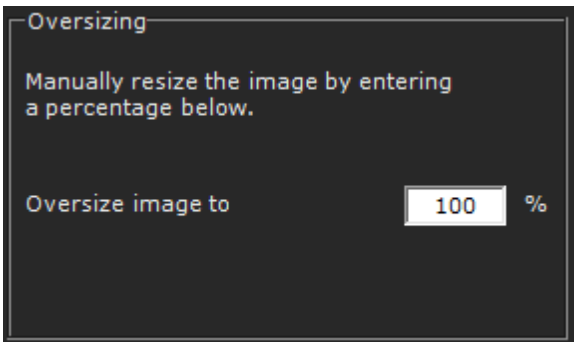


3. Draw the measurement on the image.
4. When the line/circle exactly covers the extent of the marker in the image, click **Accept**.

Using the Oversize Option

The **Oversize** option enables you to scale up an image from its original size.

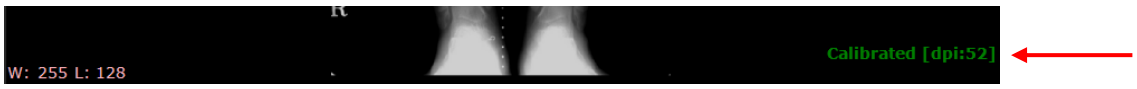
To resize an image, click the **Oversize** button and then enter the resizing percentage in the text box. It is possible to scale an image up or down from its original size. When ready, click **Accept**.



Note: If no calibration data is available in the DICOM image, for example, if the image is a jpeg, then the Oversize option cannot be used.

At the end of the calibration process, click **Accept** to accept the calibration. The calibration status of the image is indicated on the image, as shown below:

If there is no calibration data in the image when performing automatic or manual calibration, then the image indicates the DPI value as part of its calibration status, as shown below:

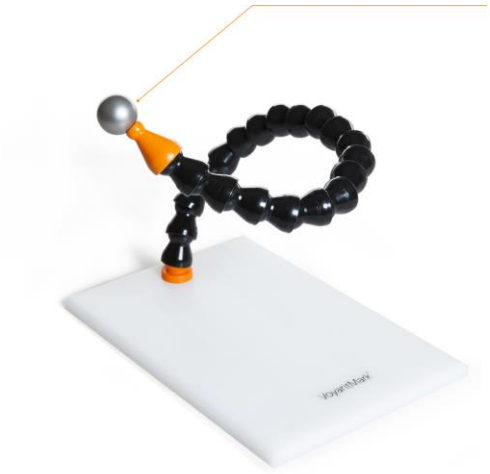


Note: If the Remove Marker after calibration option is checked in the Calibration section, then the measurements on the marker are removed after calibration and the marker appears as it was before calibration.

You can return to the **Image** tab at any time and recalibrate an image.

VoyantMark – Calibration Sphere

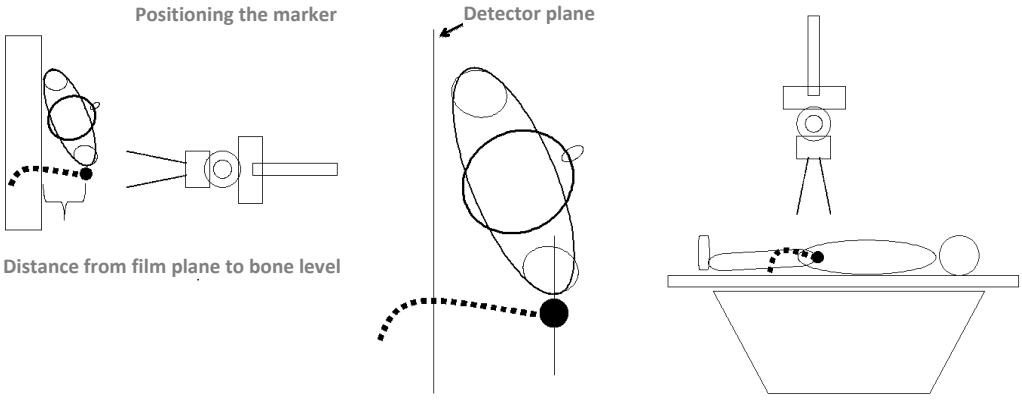
Brainlab's spherical metal X-ray marker scaling device is intended to provide a scale for plain X-rays. The scaling sphere should be placed at the bone height. The bone and sphere should then be the same distance from the X-ray plate and the X-ray source.



Ball-Marker
A 1-inch (25.4 mm) is the exact size from all angles and is positioned at the same plane as the bone of interest

When an X-ray image is scaled using a ruler or simple object, it is impossible to verify whether the scale was placed in the correct plane at the time of acquisition. The advantage of the sphere is that it is three-dimensional and its diameter is constant from any angle that the X-ray is taken.

Note: Measurements performed on uncalibrated images are in pixel units, while in calibrated images they are in millimeters.



Tip: To enable automatic calibration, you can use VoyantMark or KingMark. Contact your Brainlab sales representative if you need to obtain them.

KingMark

KingMark is a double marking device comprised of two separate markers—one is placed behind the pelvis and the other in front, as the patient lies supine. The anterior marker is a flexible strap that secures radio-opaque balls at regular intervals. The posterior marker is a radiolucent pad with steel rods embedded in a vertical row.

TraumaCad automatically detects the presence of KingMark in an X-ray, determines the magnification percentage and sizes the image accurately.

One of the five balls should align with the femoral head of the hip and the rods should run midline through the pelvis. If the markers are very off center and not positioned between the hips, the X-ray should be repeated.

Follow the tips below when working with the KingMark device:

- The positioning technique remains the same for all sizes of patients. Since KingMark is positioned midline, it always appears within the radiograph—even on very large patients.
- Flatten or remove bulky clothing that keeps the ballstrip from fitting snuggly to the patient.
- Attempt to have each ball in the ballstrip touch the patient—or be as close as possible to the skin. However, do not pull the strap and ballstrip so tight that it significantly compresses the patient's skin or adipose tissue.

PLANNING YOUR SURGERY

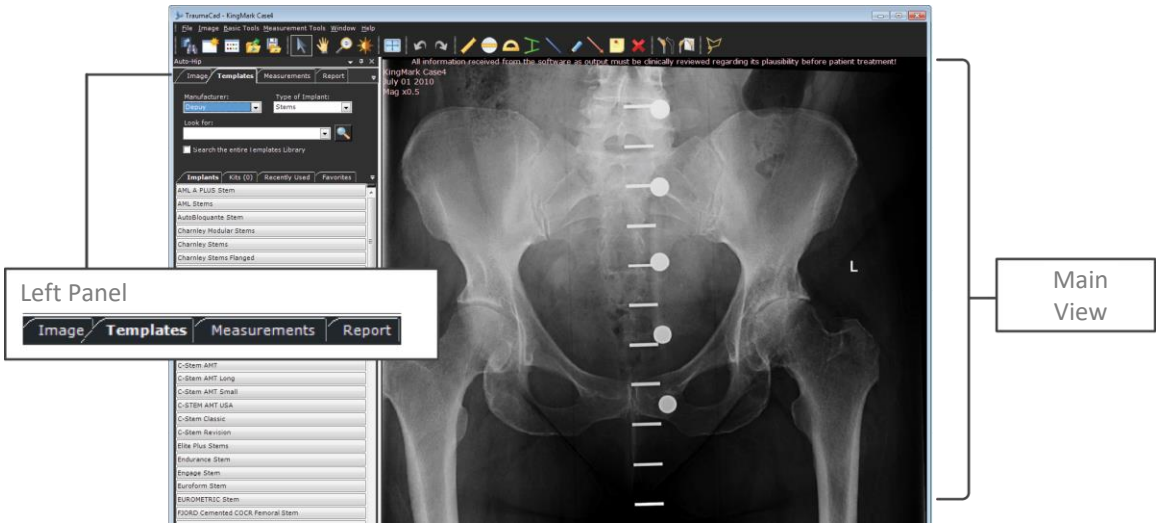
When planning your surgery first select the appropriate procedure. The relevant measurements and templates library are available according to the selected procedure.

Once images are selected and a procedure is determined, you are ready to start planning.

The TraumaCad planning window consists of a series of tabs on the left panel and the main area on the right that displays the image(s).

The following tabs are shown in the left panel:

- **Image:** Used to define image orientation and calibration. See page 44 for details.
- **Templates:** Apply templates to the image. See page 53 for more details.
- **Measurements:** Displays a variety of tools and wizards relevant to the selected procedure. For more information, see page 70.
- **Report:** Generates reports, previews planning and Save the Case. See page 170 for details.



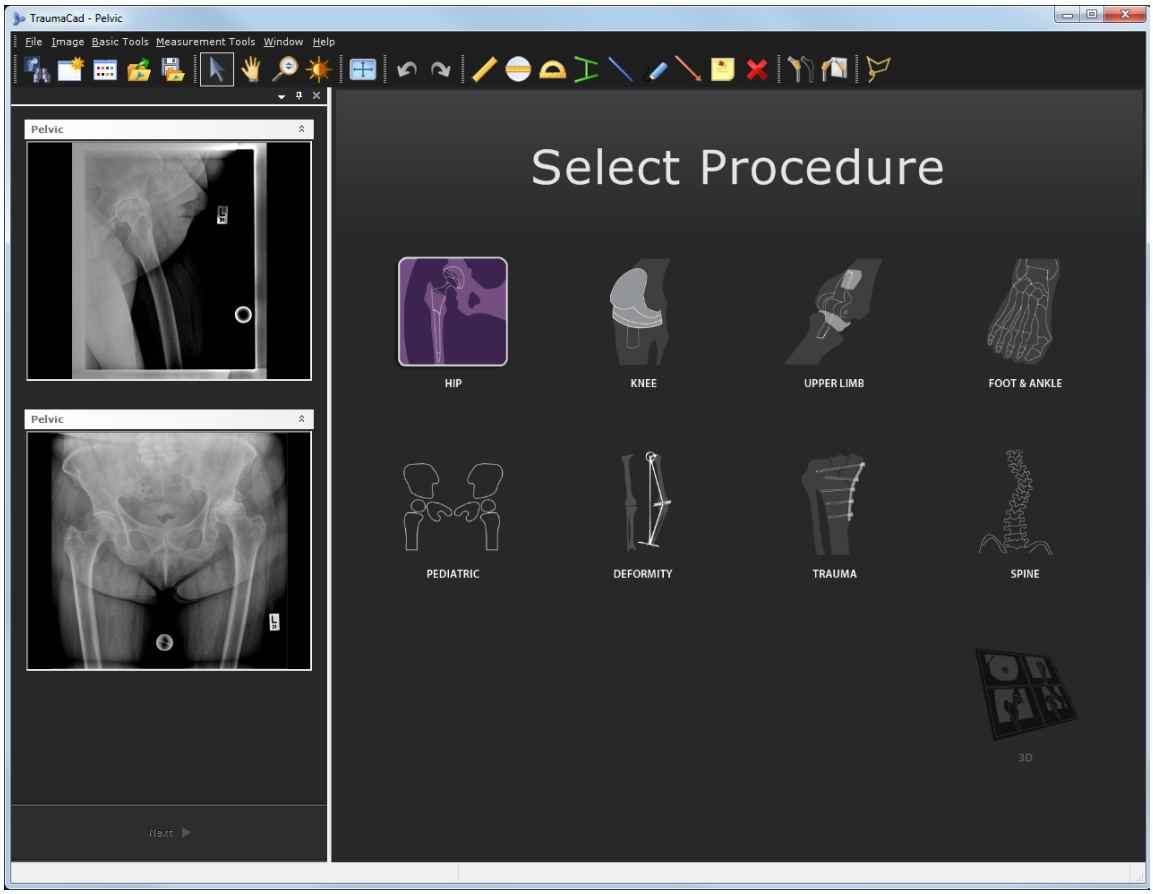
The following options are available for planning your surgery:

- **Procedures**, page 52
- **Templating**, page 53
- **Trauma Procedures**, page 59
- **3D Suite (Optional)**, page 67
- **Measuring the Anatomy**, page 70

PROCEDURES

The TraumaCad application is procedure-oriented. This means that you must select the relevant surgical or analysis procedure to be performed on the patient. Only the relevant templates and measurements for the procedure chosen are displayed.

Click the icon corresponding to the surgical or analysis procedure to be performed.



After you select a procedure, the patient's image is opened in the TraumaCad main window.

At any point you may change the procedure by selecting the **Change Procedure** icon from the toolbar. Note, that changing the procedure will result in clearing any measurements and planning that were made so far.

TEMPLATING

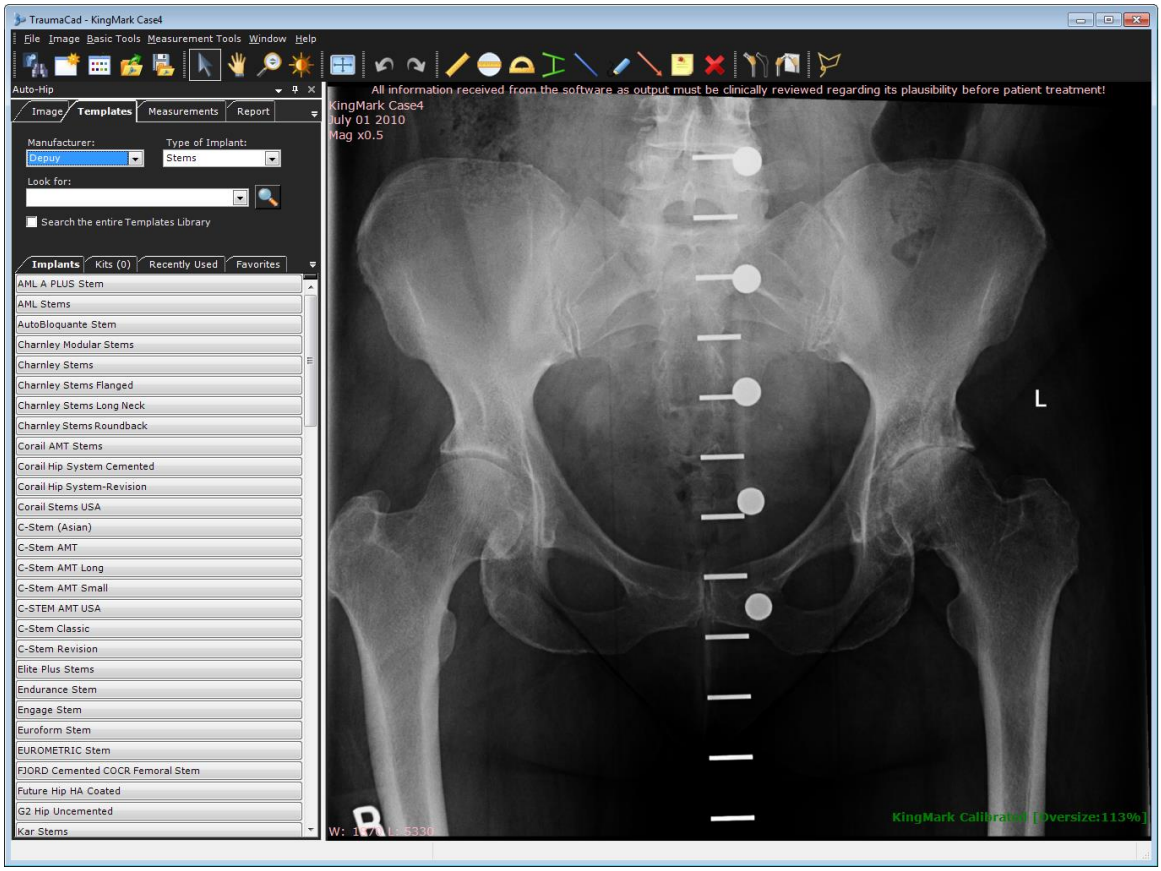
TraumaCad optimizes templating for complex reconstructions and osteotomies, as well as for standard primary replacements. TraumaCad offers a large and easily accessible template library. This library is constantly updated automatically through the server or manually in the standalone version.

Refer to the following sections for a description of the main steps of these procedures:

- **Selecting an Implant**, page 53
- **Positioning a Template**, page 55
- **Specifying Implant Properties**, page 56
- **Building a Kit and Favorites Lists**, page 57
- **Special Trauma Template Features**, page 63

Selecting an Implant

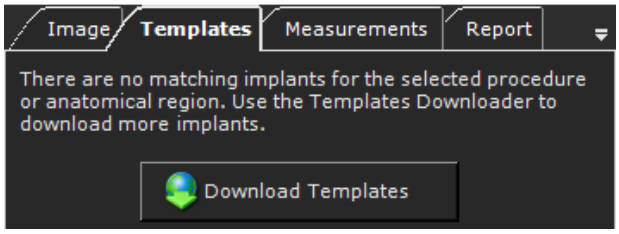
The templating process for each of the procedures (hip, knee, upper limb, pediatric, deformity, trauma, spine and foot and ankle) is similar. Of course, the implant library differs for different anatomical regions. A window such as the following is shown when you select templates:



The process of identifying the required implant is also referred to as *templating*. During this process, you select the appropriate implant from the available inventory, position it on the image on the appropriate anatomy and adjust the size and a variety of other properties.

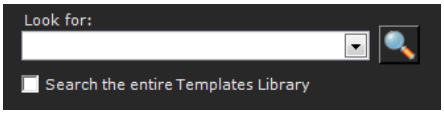
Four sub-tabs are displayed under the **Templates** tab, as follows:

- **Implants:** Displays a list of templates search results. See page 53 for details.
- **Kits:** Enables you to define your own kits of templates that you can add to an image together. See page 57 for details.
- **Recently Used:** Lists the last 20 templates used in this procedure.
- **Favorites:** Saves templates to a favorites list.

> **Note:** If the templates library is empty, the window contains a button, as shown below:
>
> 
>
>
> Click the **Download Templates** button to download the required template. For more information, see page 180.

▶ **To select the appropriate implant(s):**

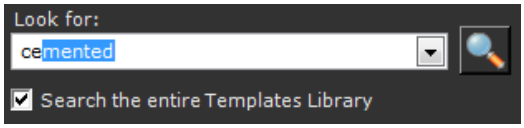
1. In the **Templates** tab, select the manufacturer of the implant from the **Manufacturer** field. Selecting a manufacturer determines the types of implants that are available for selection in the **Type of Implant** field.
2. Select the type of the implant in the **Type of Implant** field.
3. [Optional] You can search for a specific template using the **Look for** field.



Enter your search text in the **Look for** text box and click . This search function is procedure-specific, meaning the results are filtered according to the selected procedure. When you use this search option, you can leave the **Manufacturer** and **Type of Implant** fields blank. Otherwise, the search is filtered according to the fields (Manufacturer or Template Type).

To specify that the search is not procedure-specific, check the **Search the entire Templates Library** checkbox.

Click the **Look for** dropdown arrow to display a history of past searches.



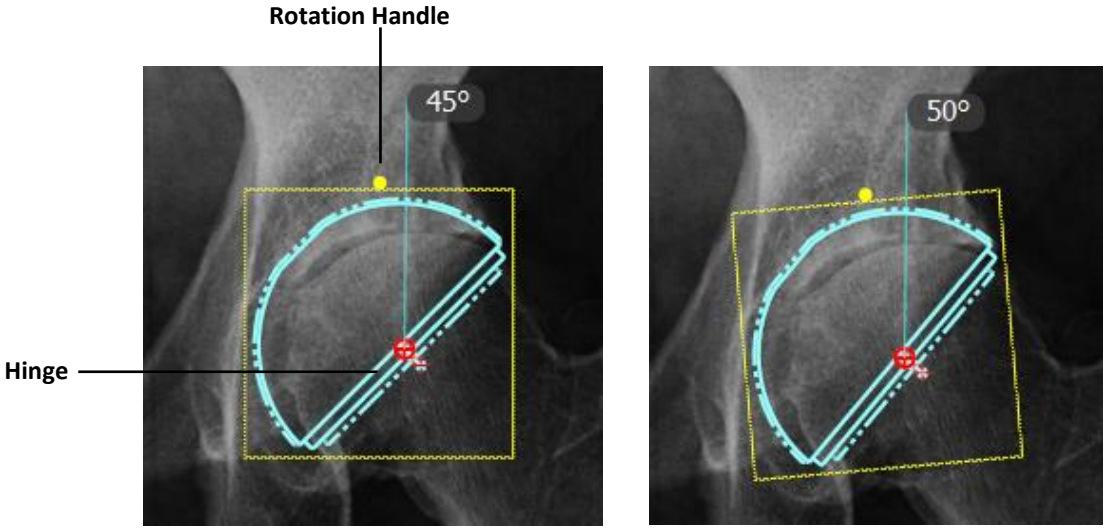
4. Select an implant from the **Implants** list. Double-click the implant's name or drag and drop it from the list onto the image.
5. To add another template to the image, click **Add Template** from the left panel and simply find the implant you want and place it on the image as described in Specifying Implant Properties on page 56.

Positioning a Template

You should position the implant on the image according to surgical considerations. A number of options are provided to facilitate implant positioning on the image.

- **To move an implant:**
  - Click the implant to drag and drop it to the required position. Alternatively, you can select the **Move** tool and then use the arrow keys to move the implant in small increments.

- **To rotate an implant:**
  - The selected implant is indicated by a yellow border with a rotation handle.



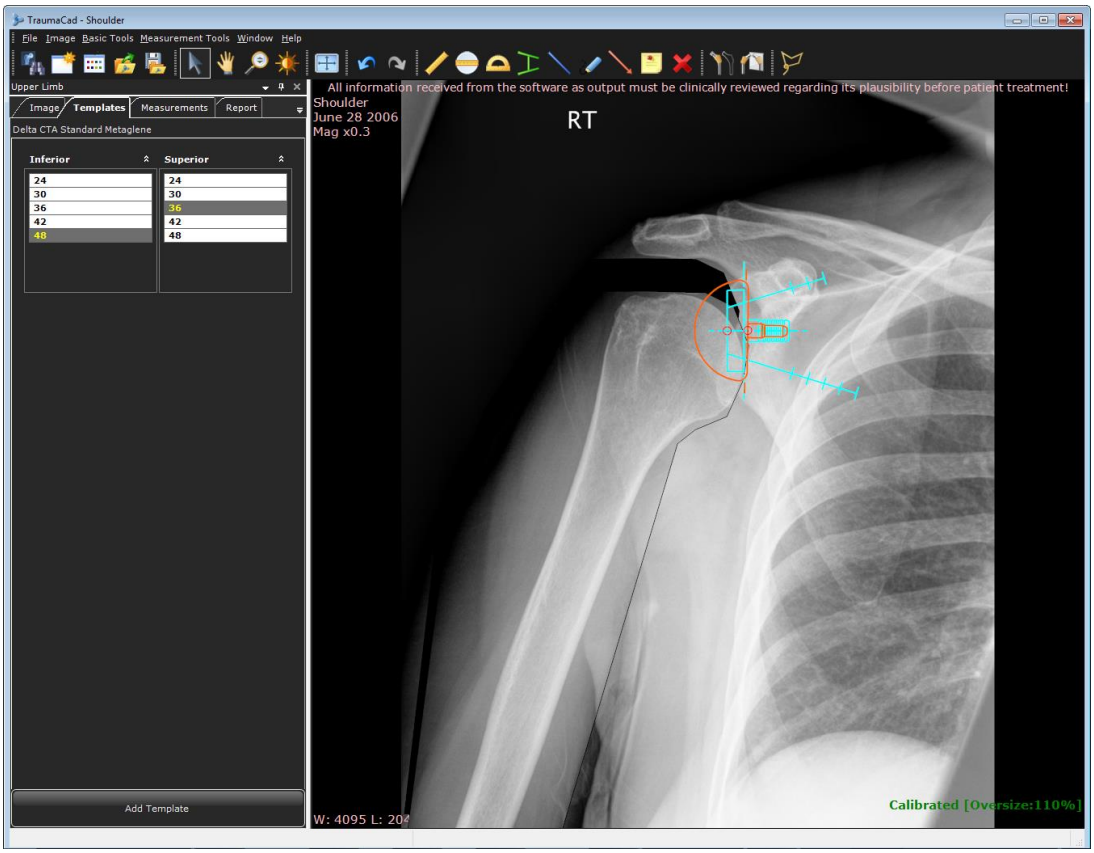
  - Click the rotation handle and move it left or right to the correct degree. Selected cups display the cup inclination angle.
  - You can also flip an implant using the **Flip Implant** tool, and change it from AP to LAT and vice versa by using the **Transpose View** tool from the implant right-click menu.

    The selected implant automatically appears in the new orientation.

Specifying Implant Properties

Once the template is selected, you can specify more properties of the implant, such as its size, offset and number of attachments.

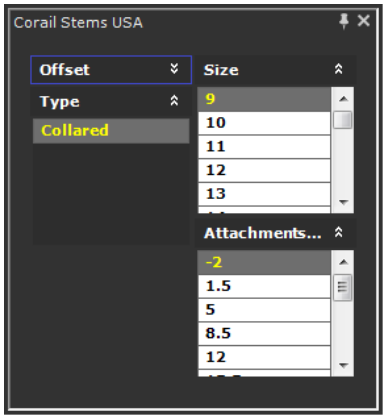
▶ **To specify implant properties:**



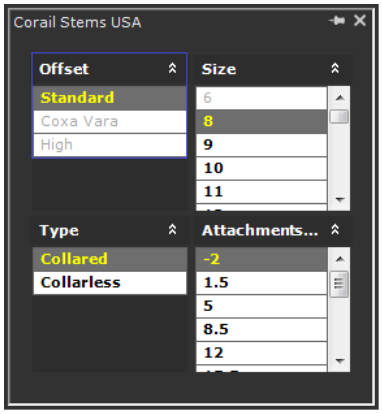
1. In the left panel, the implant properties can be adjusted. Specify the properties of the implant to suit the surgical procedure, for example:

   - The size of the implant in the **Size** field.
   - The length of the implant in the **Length** field.
   - The lateral offset of the femoral head in the **Offset** field.
   - The neck length of the implant attachments in the **Attachments** field.

   These properties and more differ according to the selected implant.
   You may find it useful to lock an implant's properties. Properties in TraumaCad are synchronized by default. This means that locking a property on a specific value automatically displays the values of other properties that match the locked value.
   To lock a property, double-click the property in the property list. Double-click the property value again to unlock this property. The figures below show examples when the **Offset** property is locked and unlocked.



Locked Properties



Unlocked Properties

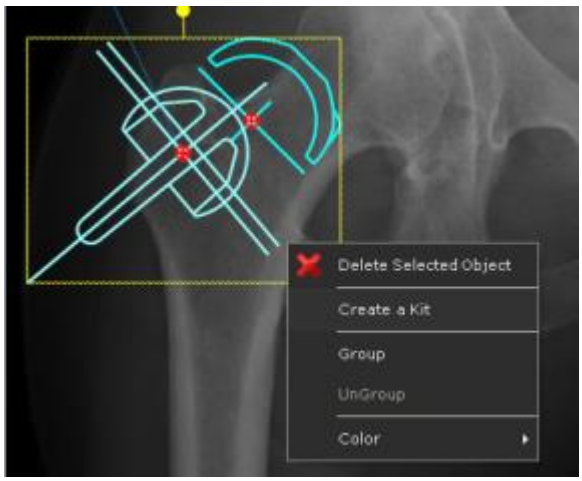
2. To delete an implant from the image, simply select it and press the **Delete** key or the **Delete Selected Object** tool.

Note: In **Settings** ➔ **Implants** you can choose to float the implant properties on the image.

Building a Kit and Favorites Lists

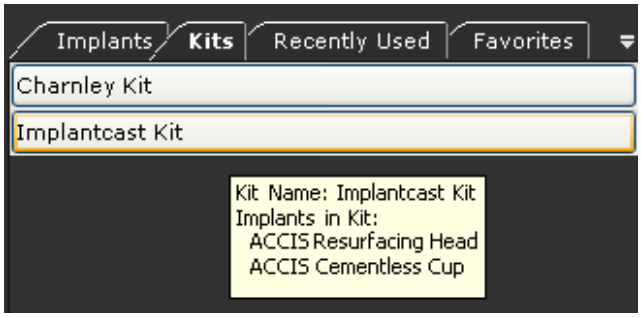
▶ **To build a kit:**

1. Add the preferred cup template and stem template to an image.
2. Drag the cursor around them to select them both.
3. Right-click this selection and select the **Create a Kit** option from the menu, as shown below:



The following window is displayed:

4. Enter a name and description for this kit and click **OK**. This new kit then appears in the **Kits** tab, as shown below:



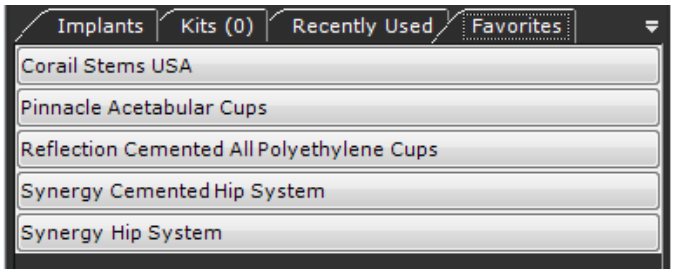
You can hover over this kit to display information about the templates that it comprises.

5. To add this kit to the image, simply double-click on it in the **Kits** tab. All the templates in the kit are then added to the image.

> **Tip:** To remove a template kit, select it on the image and use **Delete** function on the keyboard.
> To remove a kit from the kits list, select the kit on the image and press **Delete** on the keyboard.

▶ **To save an implant in the Favorites tab:**

- Select an implant from the implants list. While holding down the mouse button, drag and drop the implant onto the **Favorites** tab.



TRAUMA PROCEDURES

TraumaCad is designed to meet the needs of the trauma environment. TraumaCad enables you to define fracture or bone fragments, and to move, rotate and copy fragments on the image to reconstruct on the healthy side and accurately restore the anatomy on images prior to templating.

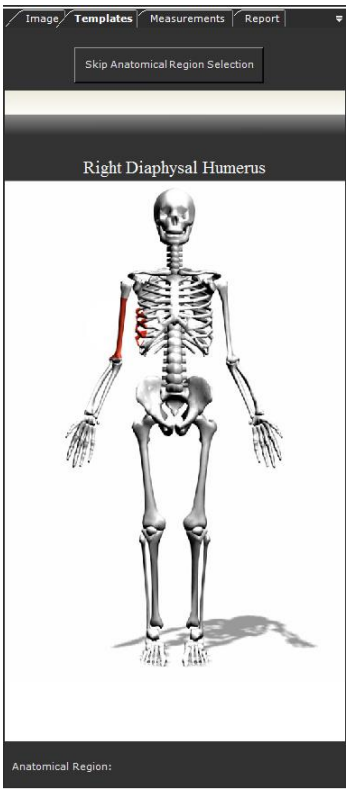
- **Specifying the Anatomical Region** (for a trauma procedure), page 59.
- **Working with Bone Fragments**, page 60. You may try different options for reducing the fragments and then select the optimal one.
- **Special Trauma Template Features**, page 63. Some TraumaCad trauma templates have special features not available with other templates, such as the ability to bend plate templates at marked points and determine screw type properties.

Specifying the Anatomical Region

For some procedures, you specify the anatomical region for the procedure. This option does not appear for all procedures.

▶ **To specify an anatomical region of the body:**

1. Move the mouse over each relevant area of the body on the skeletal image on the left. As you do so, it is highlighted in red. This action filters out templates that do not apply for this region.



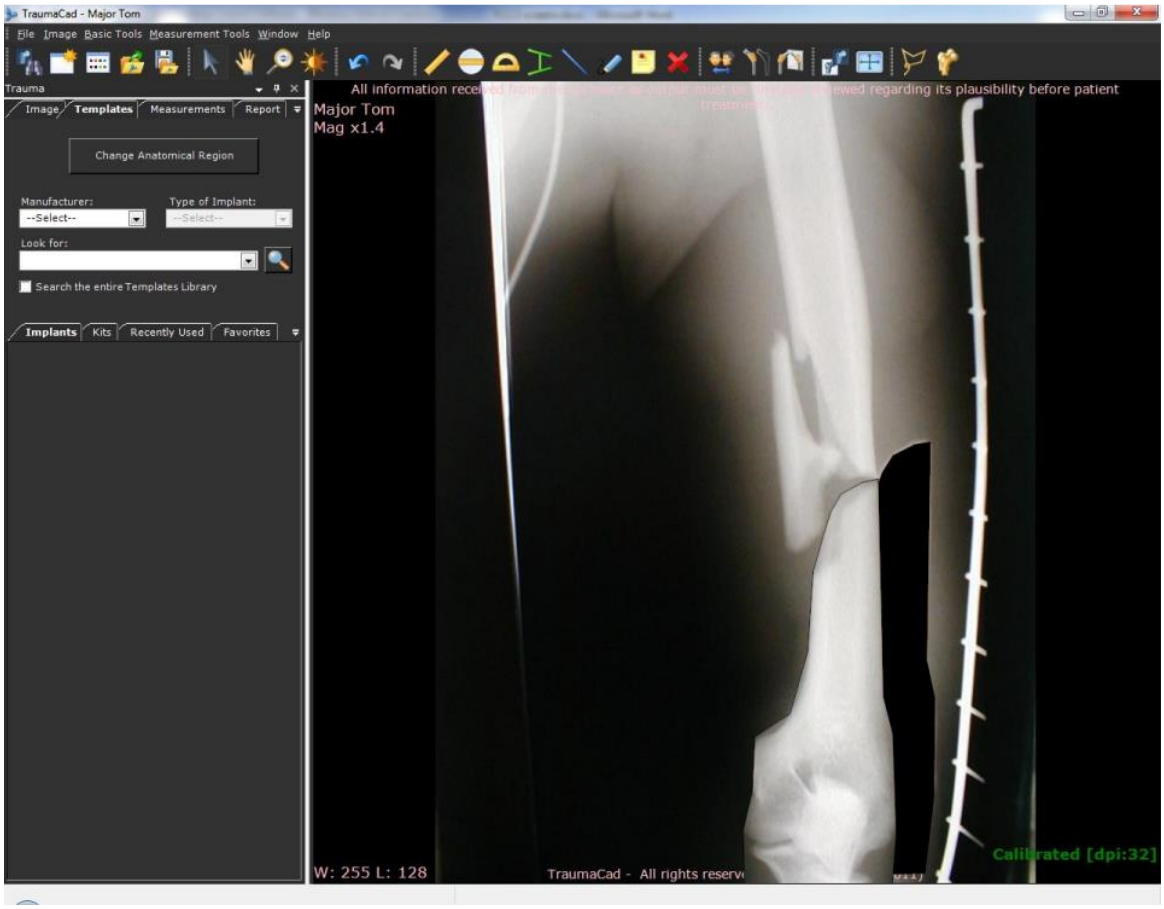
2. Click the relevant part of the body to access the **Templates**, **Measurement Tools** and **Report** tabs.

Note: Click the **Skip Anatomical Region Selection** button to disable template filtering.

Working with Bone Fragments

You can define fragments when planning a bone reduction procedure or an osteotomy. Several tools and menu options are provided to define and affect the bone fragments in the image: **Define Fragment**, **Lasso Tool** (select **Menu Bar** ➔ **Basic Tools** ➔ **Fragments** ➔ **Define Fragment**) and **Duplicate Fragment** (access from the right-click menu).

Multiple osteotomies can be done for the same procedure.



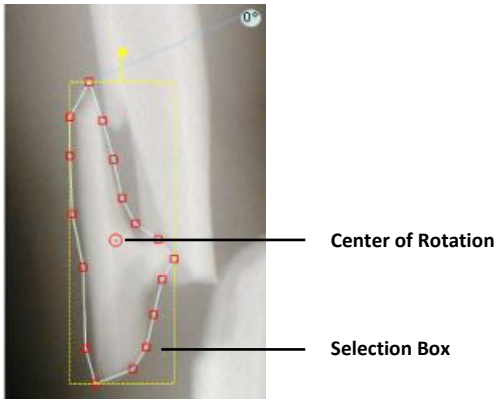
Warning! During reduction, it is imperative to verify the actual part of the bone against the reduction before performing the operation. This is may be due to the limitation of presenting the anatomy in 2D. It is imperative to evaluate additional X-ray views and consider the possible in-vivo differences.

Defining Fragments

▶ **To define fragments:**

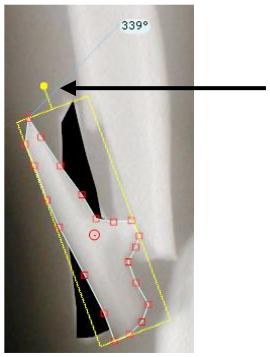
1. Select the **Define Fragment** tool in the toolbar or select **Basic Tools** ➔ **Fragments** ➔ **Define Fragment** in the menu bar. Make a series of clicks along the outline of the fragment to be moved.

2. Close the outline drawing of the fragment by double-clicking. You now have a closed shape that you can drag to a new position:



You can now reposition or adjust the selection of the fragment as required using any of the following options:

- You can rotate a fragment by using its yellow rotation handle.



- The red dot in the center of the fragment that you have traced is its center of rotation. Click the handle and move it to rotate the fragment. You can also drag this dot to a new position and then rotate the fragment.
- You can flip the fragment using the **Flip Implant/Fragment** tool.
- You can duplicate this fragment by right-clicking on the fragment and selecting the **Duplicate Fragment** tool.
- To delete the fragment, use the **Delete** tool. This option only removes the fragment itself.
- If you also want to remove the blank space where the fragment was (its original location), right-click on it and then click select **Delete** again.
- Return the fragment to its original location and orientation by right-clicking the fragment and selecting **Reset Segment**.

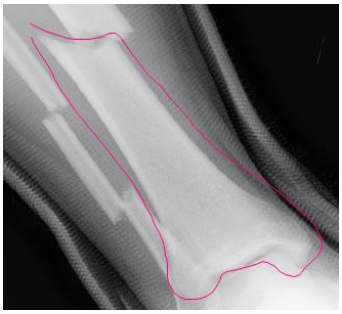
- To send the fragment forward or backward on the image, right-click on the fragment and select **Bring Fragment to Front** or **Send Fragment to Back**.

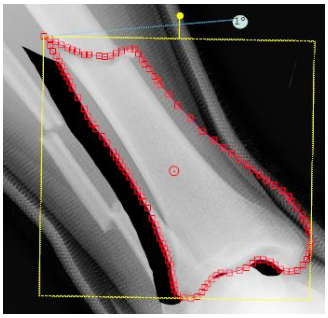
Lasso Fragments

Lassoing fragments means to simply draw a line around the area of the image that contains the fragments to be moved.

▶ **To lasso fragments:**

1. Select **Basic Tools** ➔ **Fragments** ➔ **Lasso Tool** in the menu bar.
2. Click and hold down the mouse button and drag the mouse around the area to be moved. A line is drawn as you move the mouse. You must complete the outline to create the fragment.





After the fracture is reduced, you can add implants for fixation as described previously.

Special Trauma Template Features

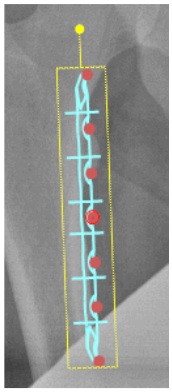
Some TraumaCad trauma templates have special features, including:

- **Plate Bending**, page 63
- **Grouping Templates**, page 63
- **Handling Screws in Locking Compression Plates**, page 65

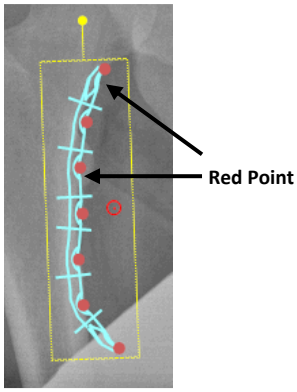
Plate Bending

Some plates used in trauma procedures can be bent to better conform to the curvature of the bone. Such plates display a series of red points on the template on the image. The plate can be bent at each of these points, as needed.

For example, the figures below show examples of such a plate before and after bending:



Before Bending



After Bending

▶ **To bend a plate template:**

- Click a red point on the plate template on the image, and while holding down the mouse button, move to bend the plate to the required position. Repeat for other points on the plate, as needed.

Grouping Templates

Some templates are grouped by default. For such, the group items are surrounded by a yellow box, which indicates the boundaries of the group.

In the example below the grouped template contains both a plate and screws. For a grouped template, you can manipulate the properties of each element within the group individually. The figures show the same template before and after resizing the plate.

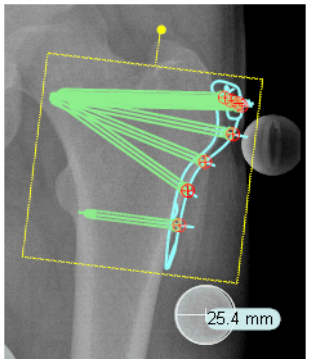


Plate Before Resizing

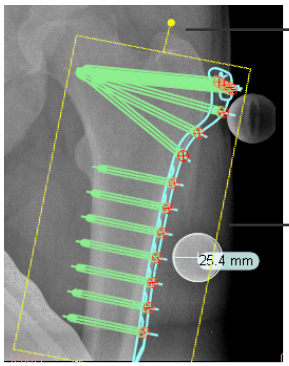
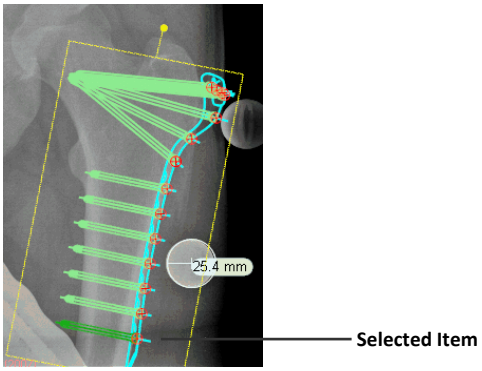


Plate After Resizing

You can select any item within a grouped template. The selected item is highlighted in dark green. You can only change the size of an item when it is highlighted.



▶ **To create a template group:**

1. Add two or more templates to an image, as well as image fragmentation.
2. Click one of the templates to select it, and while holding down the Shift key, click another template to select it. You can add an unlimited number of items to a group.
3. Right-click one of the templates you selected and select **Group**. The templates are now grouped. Grouped items remain grouped until you physically ungroup them.

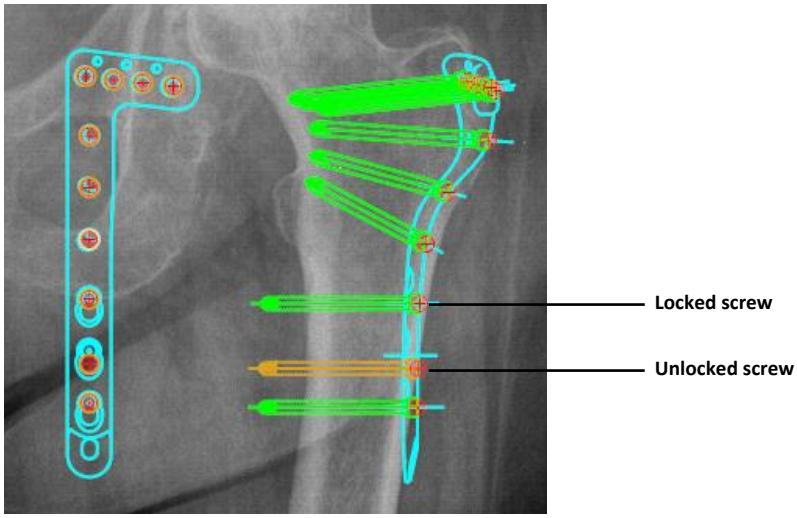
Note: Templates grouped in this fashion are only grouped in this image, and not within the TraumaCad template library.

Handling Screws in Locking Compression Plates

Locking Compression Plates (LCPs) can use two different types of screws, as follows:

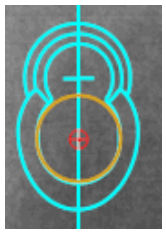
- **Locked screws:** Screws used in *locked* position are set at an angle to the template and this angle cannot be changed. Screws of this type have a threaded head. For such screws, it is important that the hole in the plate into which they are inserted be exactly the size of the screw.
- **Unlocked screws:** A screw used in *unlocked* position can be rotated (axial movement), which means that you can change its angle on the image, but its connection point remains constant.

  In LCP plates, the smaller holes in the plate are for locked screws and the larger holes are for unlocked screws.



Locked and unlocked screws appear differently on the image, as follows:

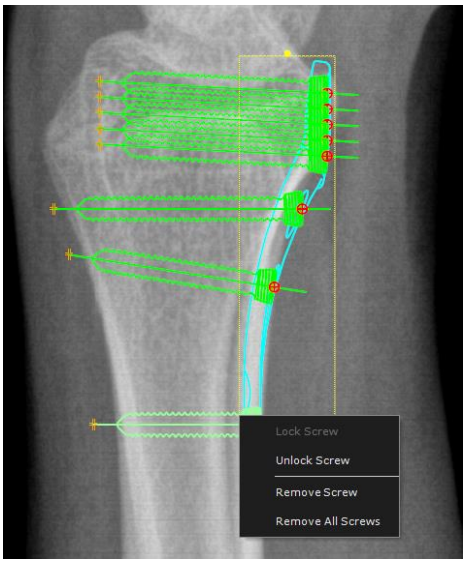
Locked screw



Unlocked screw

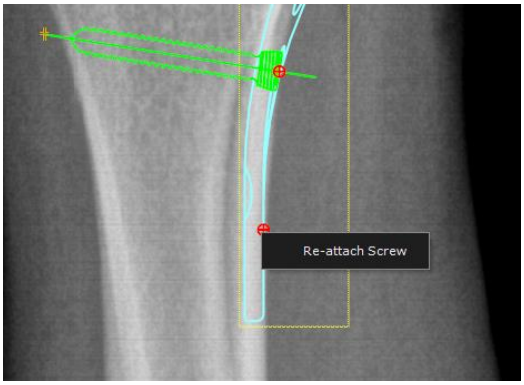
In LCP templates, several options are available for handling the screws within the template. You can:

- Lock a screw
- Unlock a screw
- Remove a screw
- Remove all screws



To use one of these options, simply right-click a screw in the template and select the relevant option in the right-click menu.

If you remove a screw from a template, you can re-attach it by right-clicking the hole where the screw should be affixed and selecting **Re-attach Screw** in the right-click menu.



3D SUITE (OPTIONAL)

The TraumaCad 3D module enables you to view images, such as CTs and MRIs, in three dimensions using Multi-Planar Reconstruction (MPR) or Maximum Intensity Projection (MIP). The images are shown in Axial, Coronal, Sagittal and Oblique views. In addition, the user can add three-dimensional templates to the image in order to do pre-operative planning.

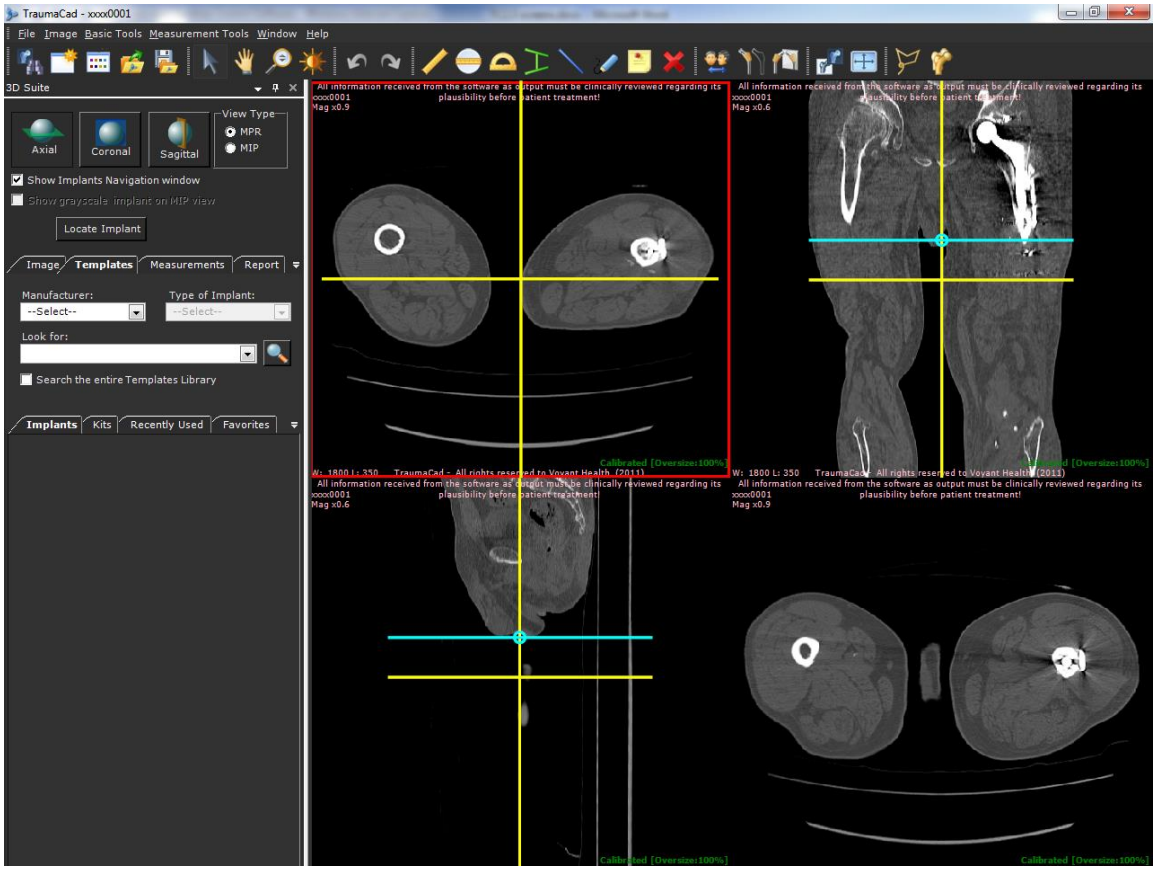
Note: The 3D suite is an optional add-on that can be purchased separately. Contact Brainlab Sales for more information.

Opening a 3D Image

To enable the 3D procedure, select a study with 6 or more images.

Select the 3D procedure in the *Procedure Selection* window.

Choose **Left** or **Right** laterality and then click the **Accept** to open the series in the main view.



Navigating on MPR Images

The series opened is shown initially with Axial, Coronal and Sagittal views. The yellow lines on the images represent the localizer lines, which help show the location of the image in relation to the other views.

To change the location of each slice, scroll in the active window using the mouse wheel or click and drag with the mouse button on the yellow localizer lines.

Note: Only series in Axial orientation can be displayed in 3D mode.

The lower-right view initially shows the Axial image. This view can be changed to either Coronal or Sagittal view using the respective button, or to any required Oblique view using the aqua localizer lines.

To change the orientation of this view, click the red holding points and rotate the aqua localizer line to the preferred Oblique view.

Note: The orientation chosen to be shown in the lower-right view has its aqua localizer lines shown in the two orthogonal views.

Changing the View Type to MIP

To change the bottom-right image to an MIP view, select the **MIP** radio button.

The MIP view can be shown in Axial, Coronal or Sagittal orientations only.

Adding a 3D Template

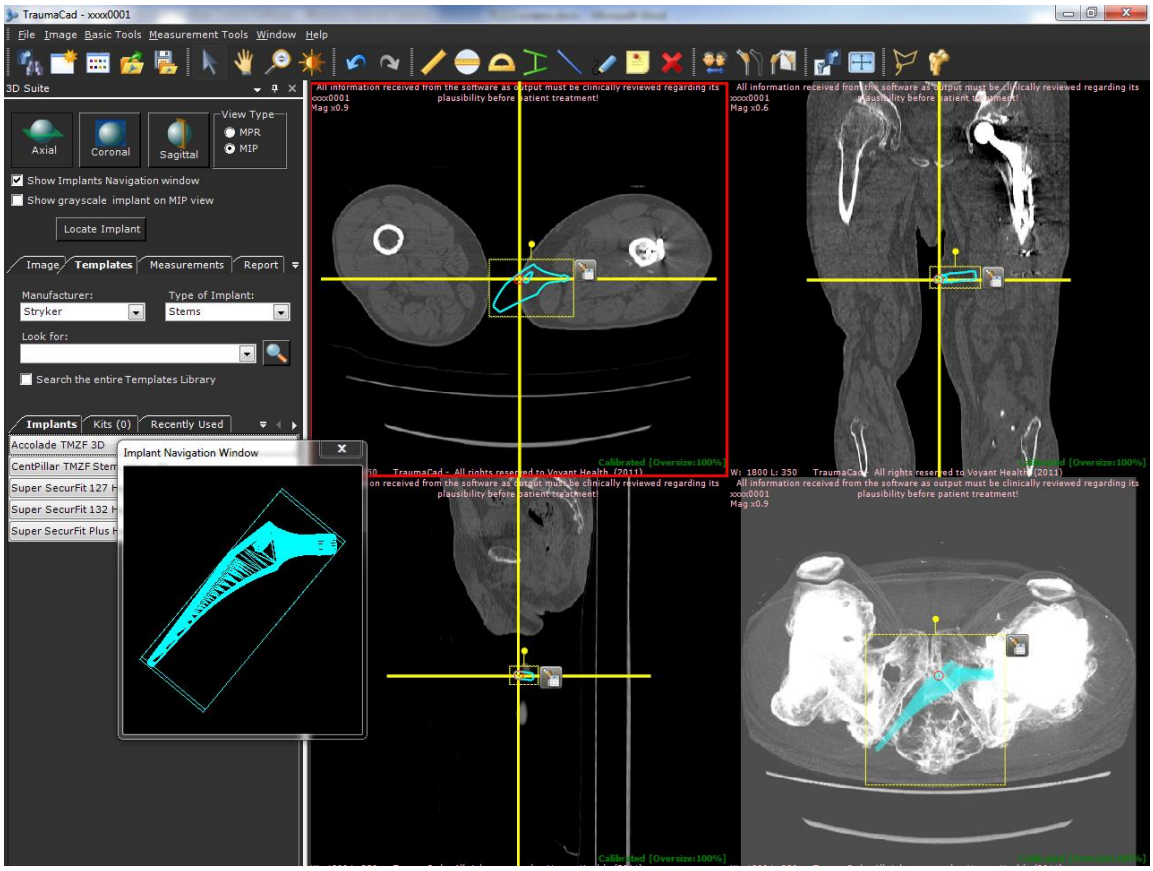
The procedure for adding a 3D template to the image is identical to that for adding a 2D template. For more information, see page 53.

For MPR views, the outline of the template is shown according to the slice location and orientation. For MIP views, the template is shown as a complete projection of the implant. Templates appear by default in color, but can be changed to grayscale.

The following button appears, as shown in the previous image:

- **Locate Implant:** Scrolls all the views to the template location, meaning that this template is shown in all the views.

The implant is also shown in a separate navigation window, in order to allow easier orientation and rotation of the implant.



Note: Moving or rotating the implant on one of the views affects its position and orientation on all other views.

Using the Implant Navigation Window

The *Implant Navigation* window shows the implant according to the orientation of the currently active view. To change the orientation, click and drag with the mouse button in the *Implant Navigation* window. The changes are reflected in the main views.

When several 3D templates are placed on the images, the last selected template is shown in the *Implant Navigation* window.

This window is resizable and can be enlarged by dragging the corner using the mouse.

MEASURING THE ANATOMY

TraumaCad offers a variety of measurement tools and wizards to measure the anatomy per the selected procedure. Most of TraumaCad's measurement tools can be accessed from both the *Measurement Tools* menu and from the **Measurements** tab. The most frequently used tools can also be accessed from the toolbar and by right-clicking on the image.

All tools are described in the sections that follow, and are organized by TraumaCad procedure.

TraumaCad offers some automatic features for THR and TKR planning, where the application attempts to automatically detect the anatomical regions in the image, evaluate measurements, position templates, and create fragmentations for image manipulation such as hip reduction and knee alignment.

In case the image is not automatically detected, you can always continue planning manually.

Note: To obtain quantitative measurements, the image must first be calibrated, as described in the Automatically Calibrate an Image section on page 44.

Note: The accuracy of the Angle tool is ± 0.75°, the accuracy of the Ruler tool is ± 0.24mm and Circle measurement tool is ± 0.18mm.
Accuracy is also affected by the calibration of the image. Depending on the calibration method chosen, the accuracy of the measurement tools can vary.

USING TOOLS

To use measurement tools select the tool from the left panel. The tool appears on the image. Use the red markers to adjust the tool.

BASIC TOOLS

TraumaCad includes several basic tools that can be used to supplement procedure-specific tools:

- **Ruler Tool**, page 71
- **Circle Tool**, page 71
- **Angle Tool**, page 71
- **Interline Angle Tool**, page 71
- **Line Tool**, page 72
- **Free Hand Line Tool**, page 72
- **Arrow Line** Tool, page 72
- **Text Annotations**, page 72

Ruler Tool

The **Ruler** tool measures selected portions of an image either in pixels (for uncalibrated images) or millimeters (for calibrated images).

▶ **To use the Ruler Tool:**

1. After loading an image, click the **Ruler** on the toolbar.
2. Left-click, hold the mouse button on the image where you want to start measuring and drag the mouse without releasing the mouse button until the end of the section to be measured.
3. Release the mouse. The measurement appears in pixels or millimeters.
4. Click and drag any of the red dots on the ends of the line to adjust its size.

Circle Tool

Use the **Circle** tool to measure the diameter of objects in the image.

▶ **To use the Circle tool:**

1. Click **Circle** in the toolbar.
2. Click the image in the work area. The **Circle** tool appears on the image.
3. Left-click and hold the mouse button inside the circle and drag it to the preferred position.
4. Click and drag any of the red dots to adjust the size of the circle. The diameter measurement (if calibrated in millimeters) is displayed.

Angle Tool

Use the **Angle** tool to measure the angle between two rays.

▶ **To use the Angle tool:**

1. Click **Angle** in the toolbar.
2. Click the image in the work area. The **Angle** tool is displayed.
3. Drag the anchors of the tool to the section to be measured. The measurement appears in degrees next to the angle.

Interline Angle Tool

Use the **Interline Angle** tool to measure the angle between two lines.

▶ **To use the Interline Angle tool:**

1. Click **Interline Angle** in the toolbar.
2. Click on the image in the work area. The **Interline Angle** tool appears on the image.
3. Left-click and hold the mouse button and drag each line to the required position. Use the red dots as needed to adjust the lines.

   The angle between the two lines is displayed next to the tool.

Line Tool

Use the **Line** tool to draw a simple line on the image.

▶ **To use the Line tool:**

1. Click **Line** in the toolbar.
2. Hold the mouse button and draw a line on the image, without releasing the button. A line is drawn on the image.

Free Hand Line Tool

Use the **Free Hand Line** tool to draw a freehand line on the image. No measurements are associated with this line.

▶ **To use the Free Hand Line tool:**

1. Click **Free Hand Line** in the toolbar.
2. Click the image and hold down the mouse button while you draw a free-hand line on the image in any shape, without releasing the button. A line is drawn on the image.

Arrow Line Tool

Use the **Arrow** line tool to indicate an area on the image for further attention.

▶ **To draw an arrow line on the image:**

1. Click **Arrow** line in the toolbar.
2. Drag the mouse on the image towards the area you are indicating.

   An arrow is drawn on the image.

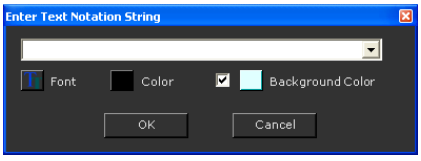
Text Annotations Tool

Use the **Text Annotations** tool to add free text to the basic measurements. When text is added to the image, a line shows the connection between the text and the part of the image to which it applies. You can drag this text away if it is obstructing the view.

▶ **To add text annotations to an image:**

1. Click **Text Annotations** in the toolbar.
2. Click the image or click a measurement in the image.

   The following window is displayed:



3. Enter your text in the text box.
4. Optionally, change the text color, font or background color.

Note: You can change the default font settings by clicking **File** ➔ **Settings** ➔ **Text** and specifying the required setting.

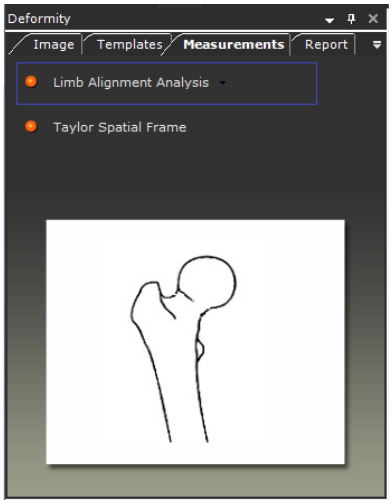
5. Click **OK** to save your settings.

USING WIZARDS

Wizards guide you through the process of identifying and marking each of the anatomical reference points required for the analysis and marking them on the image.

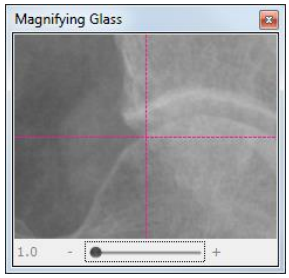
▶ **To use the wizards:**

1. Select the Tool from the Measurements menu > **Measurements** tab.



2. Use the wizard to mark anatomical landmarks on the image for the selected analysis.

   The **Magnifying Glass** tool is opened to help fine tune and to ensure that your markers are located in the correct, exact position.



Note: To cancel your last action and return to the previous step in a wizard, click the **Undo** button in the toolbar.

3. Select the **Report** tab to generate a report. See Generating Reports on page 170.

   For an example wizard, see Limb Alignment Analysis on page 103.

Note: Click **Back to Measurements List** to exit the wizard and return to the list of measurement tools. This button is available in all measurement tool wizards.

HIP MEASUREMENTS TOOLS

The following hip measurements can be made using TraumaCad hip tools:

- **Auto-Hip**, page 75
- **Hip Deformity Analysis**, page 78
- **Pre-operative Hip Outcome**, page 80
- **Post-operative Hip Outcome**, page 81
- **Hip Navigation Planning**, page 82
- **Leg Length Discrepancy Tool**, page 84
- **Acetabular Index**, page 85
- **VCA Angle of Lequesne**, page 85
- **Cup Version and LLD Analysis**, page 86
- **Center of Rotation**, page 87
- **Stem Version**, page 88

Auto-Hip

Digital preplanning for hip replacement surgery is a common orthopedic surgery procedure used to estimate implant size, determine the post-operative geometrical relationship between the femur and the acetabulum, the resulting leg length and offset change, and predict any geometrical mismatch and difficulty pre-operatively.

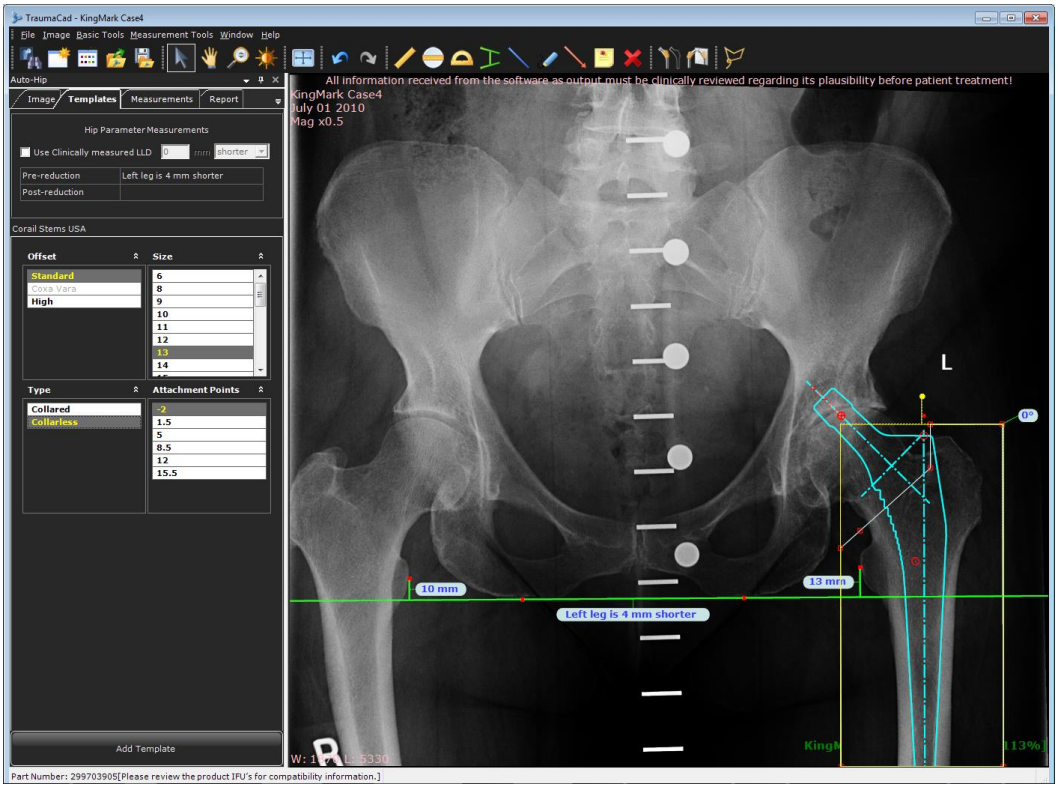
The Auto-hip procedure is a software module for the automatic marking of specific points within an anterior-posterior pelvis X-ray image. The Auto-hip procedure is used for pre-operative procedures only and will not work on post-operative images where there is an implant in place.

A set of anatomic landmarks on a pelvic AP X-ray are defined in a way that determines the size of the femoral stem and its expected stable position in the femoral canal. Points of interest are the femur midline and diameter of its channel, greater trochanters tips, lesser trochanters tips and bottom tangent line to the visible ischial tuberoses curves.

▶ **To use the Auto-Hip tool:**

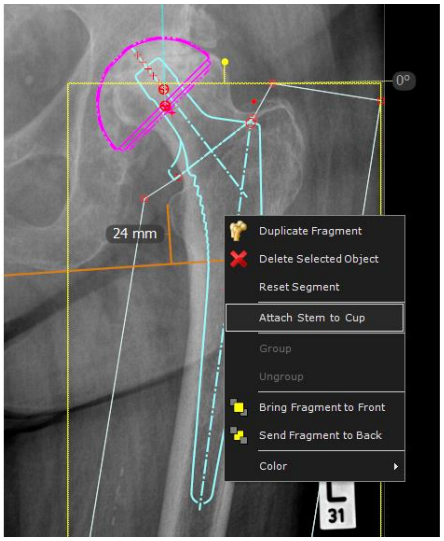
1. In the **Image** tab, specify the image view, side and calibration. For details see page 44.
2. In the **Templates** tab, select the relevant templates, which are displayed in the **Implants** tab. It is recommended to start the planning with the stem component.
3. Drag and drop or double-click a template in the **Implants** tab to add it to the image.

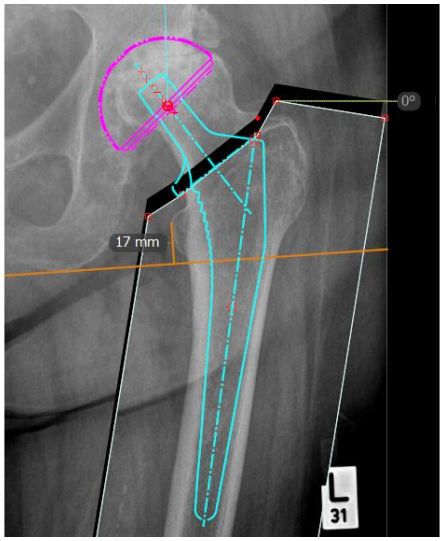
   The application automatically detects the anatomical regions in the image. A Leg Length Discrepancy tool is added to the image, and the selected stem is positioned in the femoral channel according to the selected side (right or left). This feature also automatically defines a fragment according to the suggested femur head osteotomy line.



Even though the tool automatically selects and places the stem, it is recommended to fine-tune its position, rotation and adjust the size in the *Implant Properties* window. Also the LLD tool can be fine-tuned by dragging the red anchors and by dragging the fragment.

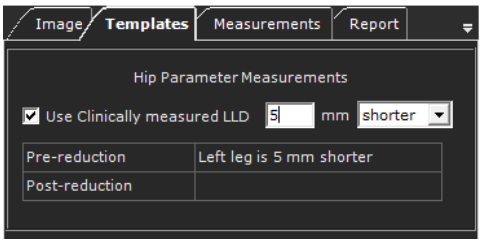
4. Select a cup template. The cup is automatically positioned in the area of the acetabulum.
5. Right-click the cup, stem or the fragment, and select **Attach Stem to Cup**. This action assists in visualizing the hip reduction. The stem and fragment are then automatically attached to the cup so that the attachment point of the stem is positioned on top of the attachment point of the cup. When the cup and stem are positioned automatically, the fragment moves accordingly, as shown below:





Note: To detach the stem from the cup, select the **Detach Stem from Cup** in the Right-click menu.

A default attachment point is automatically selected. If required, you can select a different attachment point in the *Implant Properties* window on the image.
The **Offset changes** and **Leg length changes** appear automatically on the image. The pre-reduction and post-reduction measurements appear at the top of the **Templates** tab. The difference between leg lengths can be measured automatically using the LLD tool or manually by checking the **Use Clinically Measured LLD** checkbox and entering the value.

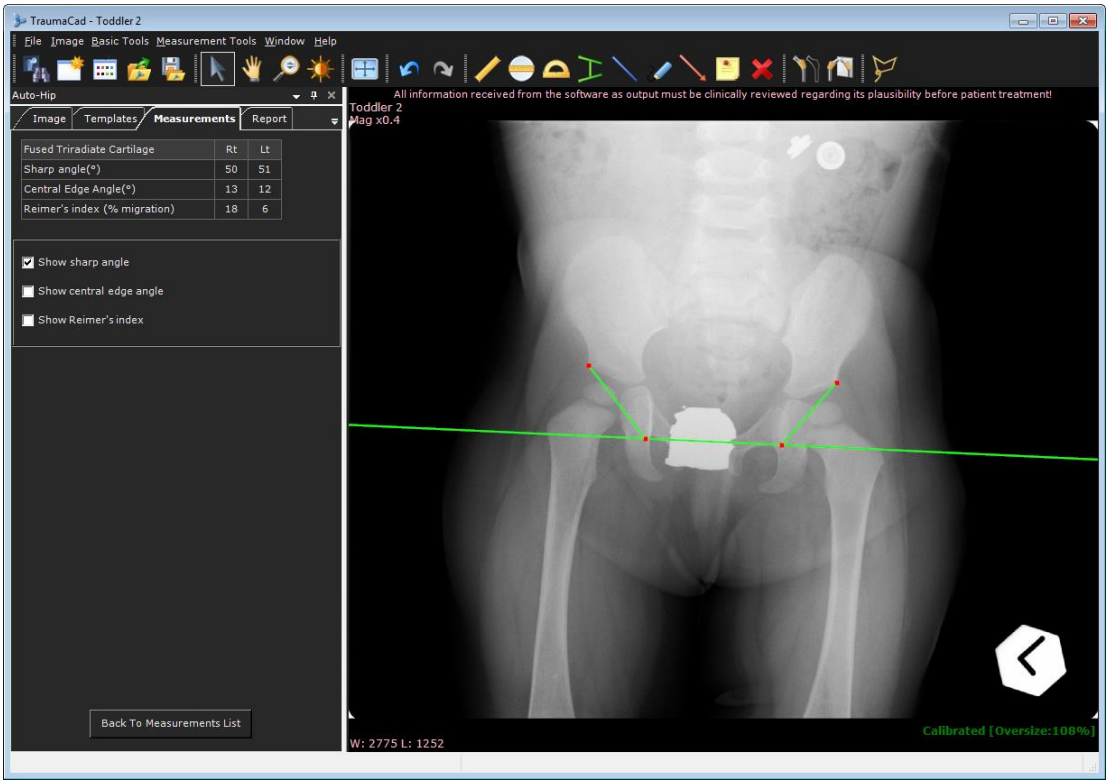


Note: If you wish to plan Hip Replacement manually, in **Settings** ➔ **Planning** unselect **Use automatic hip planning**. TraumaCad remembers your preferences and saves the planning mode you have selected for the next time you choose the Hip procedure.

Hip Deformity Analysis

▶ **To use the Hip Deformity Analysis wizard:**

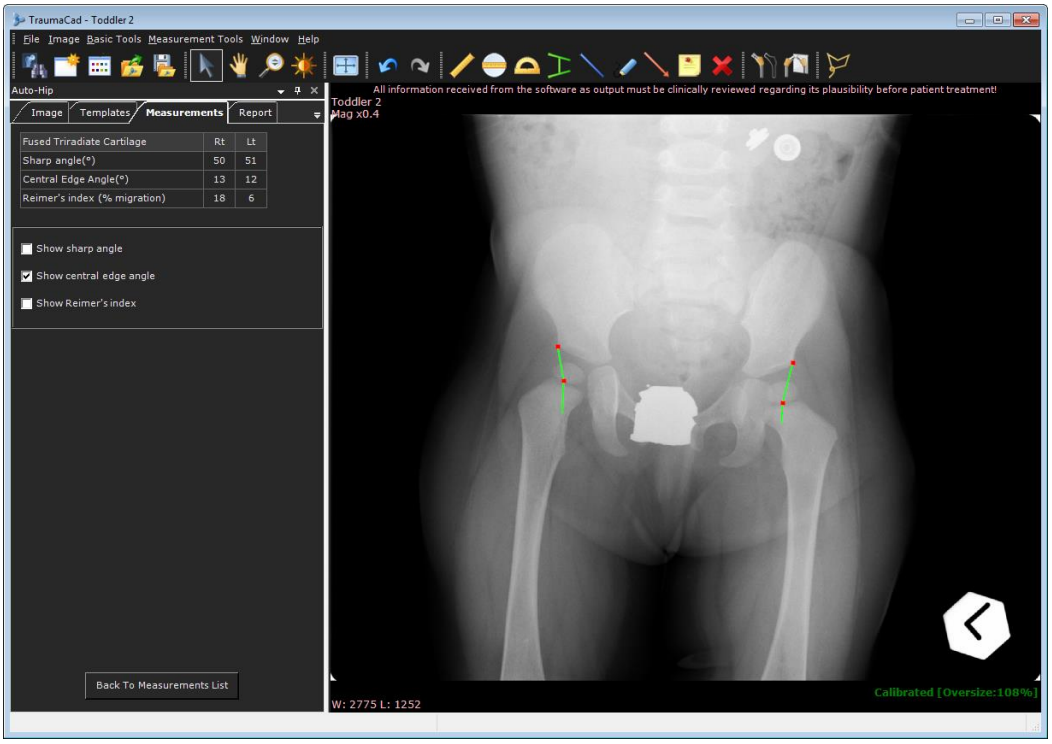
1. Use the wizard to mark the 10 relevant points on the image.
2. Enter the last (tenth) measurement. The window now appears as shown below:



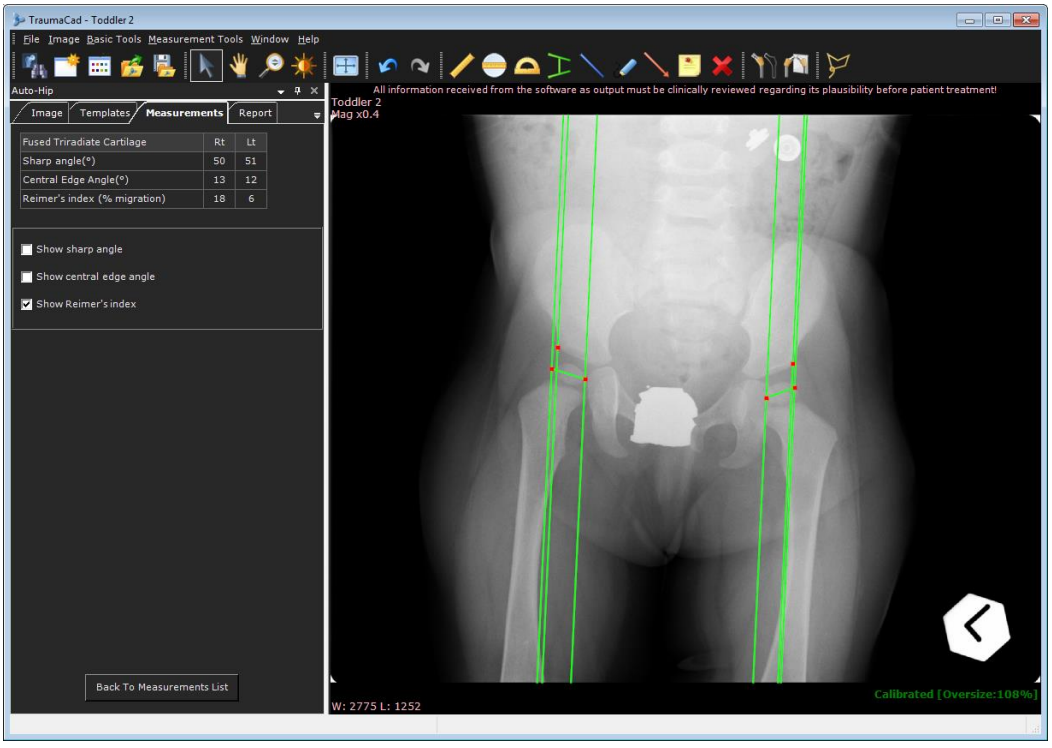
Once you have entered the 10 measurements the calculated measurements are displayed in a table at the top of the **Measurements** tab.

3. Click the associated checkbox to display the following calculated measurements:

- **Sharp Angle:** Measured from a pelvic horizontal at the teardrop's height to the superolateral acetabular margin (the lateral rim). This measures the inclination of the acetabulum after fusion of the triradiate cartilage.
- **Central Edge Angle:** Measured from a line that passes through the femoral head center, which is perpendicular to the pelvic horizontal line, to a line that passes from the center of the femoral head to the lateral rim. This measures the acetabular dysplasia. Select the **Show central edge angle** checkbox to display this measurement.



- **Reimer's Index (the hip migration percentage)**: Vertical lines are drawn through the edges of the femoral head and the lateral rim of the acetabulum. The index is calculated by dividing the uncovered part of the head by the entire width of the head. This measures the acetabular coverage of the femoral head. Select the **Show Reimer's index** checkbox to display this measurement.



Pre-operative Hip Outcome

The pre-operative and post-operative Hip Outcome define geometric anatomical measurements to determine the center of rotation and anatomical relationship before and after implant positioning.

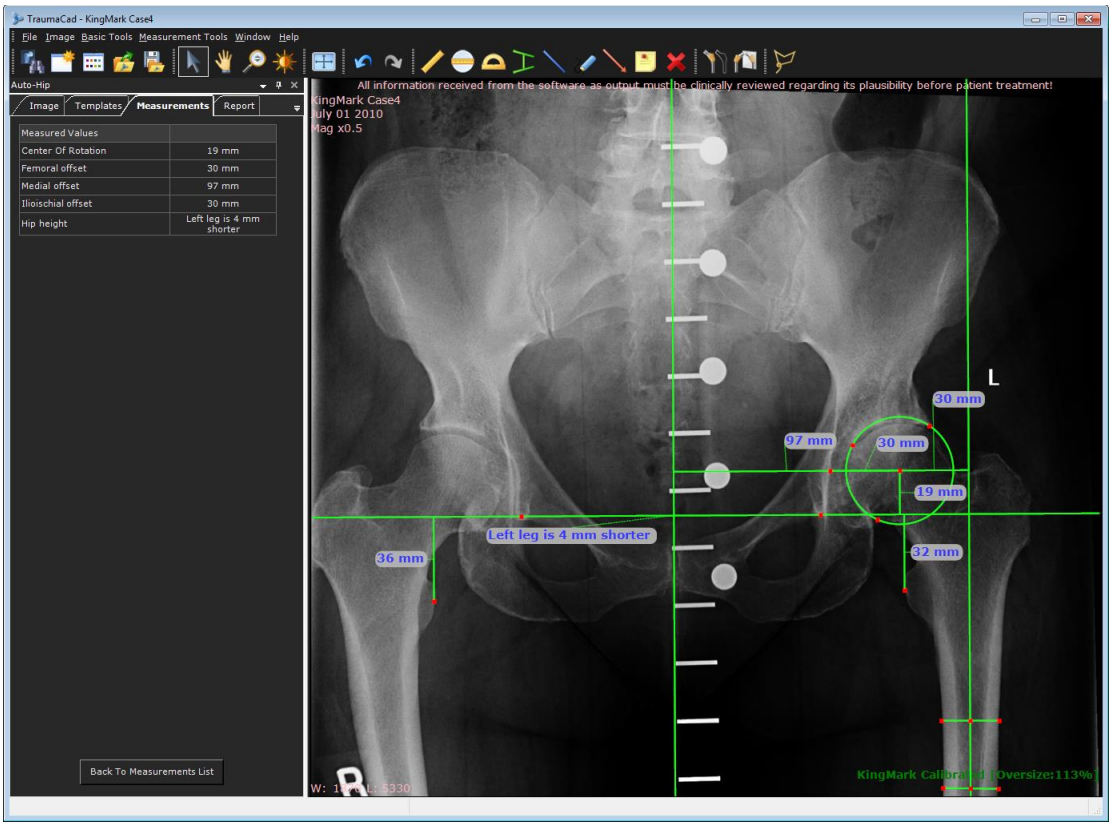
The tools provide the option for post-op evaluation and compare the pre-operative status, desired planning and operative results.

The following measurements are taken:

- Center of Rotation
- Femoral Offset
- Medial Offset
- Ilioschial Offset
- Hip Height

▶ **To use the pre-operative Hip Outcome:**

1. Select **Pre Op** in the **Hip Outcome** sub-menu.
2. Follow the 13 steps in the wizard to mark points on the image. You can drag points to move them to a new position.

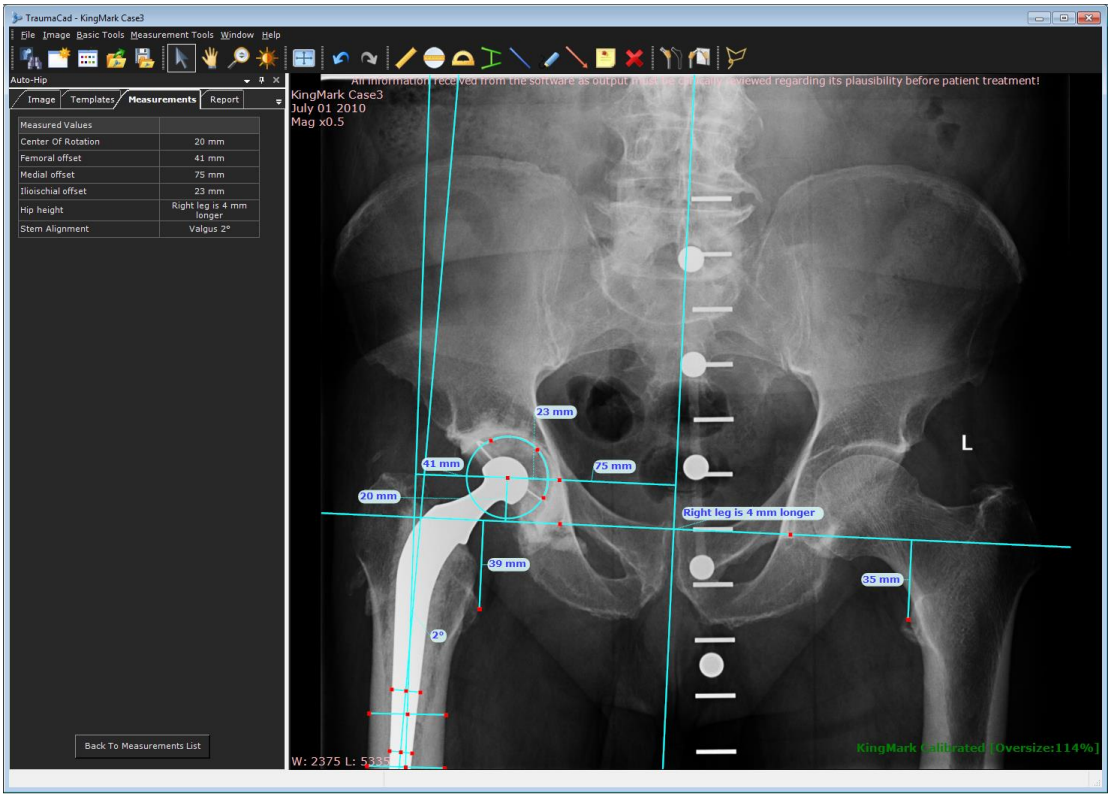


When the measurements are displayed it is recommended to zoom in and fine-tune lines according to the patient's anatomy.

Post-operative Hip Outcome

▶ **To use the post-operative Hip Outcome:**

1. Select the **Post Op** in the **Hip Outcome** sub-menu.
2. Follow the 17 steps in the wizard to mark points on the image. You can drag points to move them to a new position.



Hip Navigation Planning

The Hip Navigation Planning tool is designed for navigated Total Hip Replacement cases, offering surgeons to adjust the cup orientation to the functional reference plane using a 2D AP x-ray image.

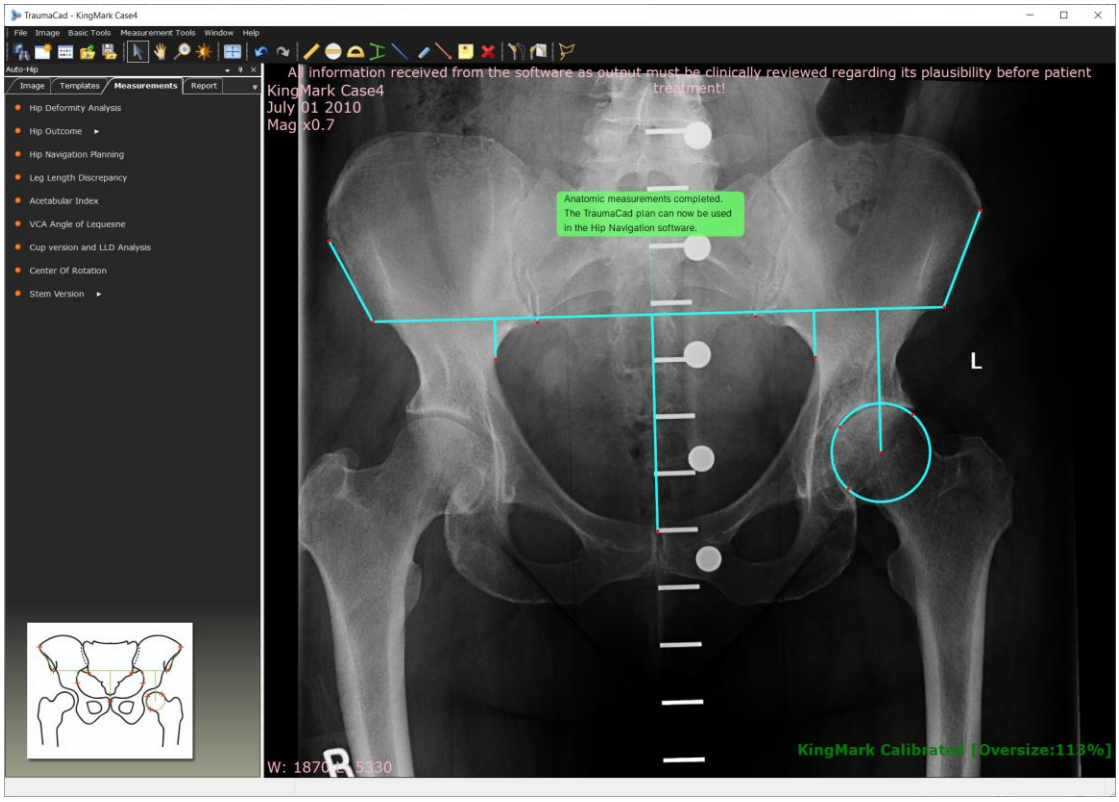
The navigation tool in combination with the Hip Navigation software, calculates the individual patient pelvic tilt. For this purpose, the TraumaCad plan has to be exported and loaded into the Hip Navigation system.

The following measurements are taken:

- Most lateral point of the left & right iliac crest
- Left & right anterior superior iliac spine (ASIS)
- Left & right posterior inferior iliac spine (PIIS)
- Left & right most lateral point of the pelvic inlet
- Most cranial point of the pubic symphysis
- Three points on the femoral head circumference

▶ **How to use the Hip Navigation Planning tool:**

1. Select the **Hip Navigation Planning** in the **Measurements** tab.
2. Follow the 12 steps in the wizard to mark points on the image. You can drag points to move them to a new position. Make sure that all landmarks are clearly visible.



Note: For a correct calculation of the pelvic tilt, the image has to be a true AP pelvic image. The pelvis must not be rotated around its longitudinal (i.e. cranial-caudal) axis in the X-ray.
If the measurement tool detects a large pelvic rotation in the X-ray, the user is informed that the TraumaCad plan cannot be used for pelvic tilt adjustment in the Hip navigation software.

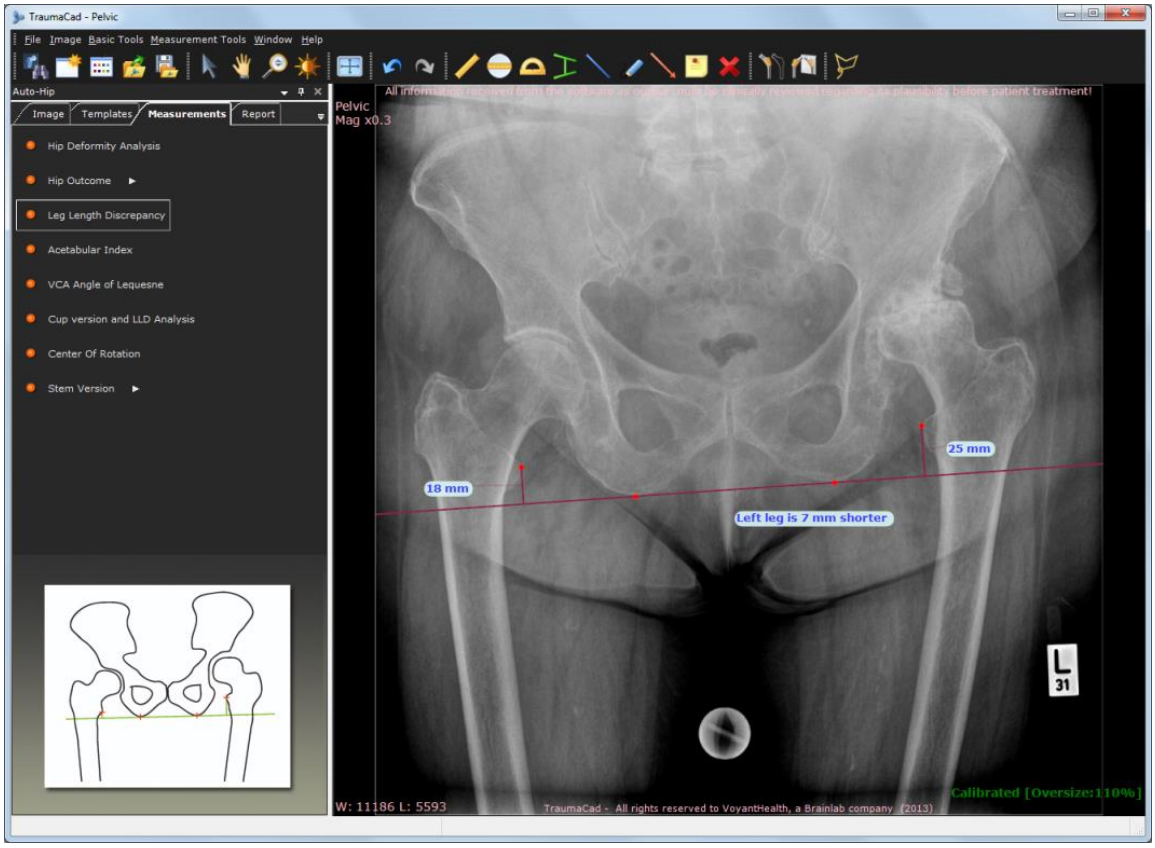
Note: The Navigation Planning tool can only be used on x-ray images with the KingMark calibration device in a supine patient position. A notification will appear if no KingMark calibration device is detected.

Leg Length Discrepancy Tool

The **Leg Length Discrepancy** measurement tool enables you to measure leg length discrepancy.

A tangent line is drawn by choosing two points at the most inferior points on the ischial tuberosities. From this reference line, two vertical lines should be drawn toward identical anatomical landmarks on each proximal femur (the center of the lesser trochanter, top of the greater trochanter and so on).

The text below the horizontal line indicates the discrepancy between the right and left side and the distance between the two points. If there is no discrepancy, the number 0 is shown.



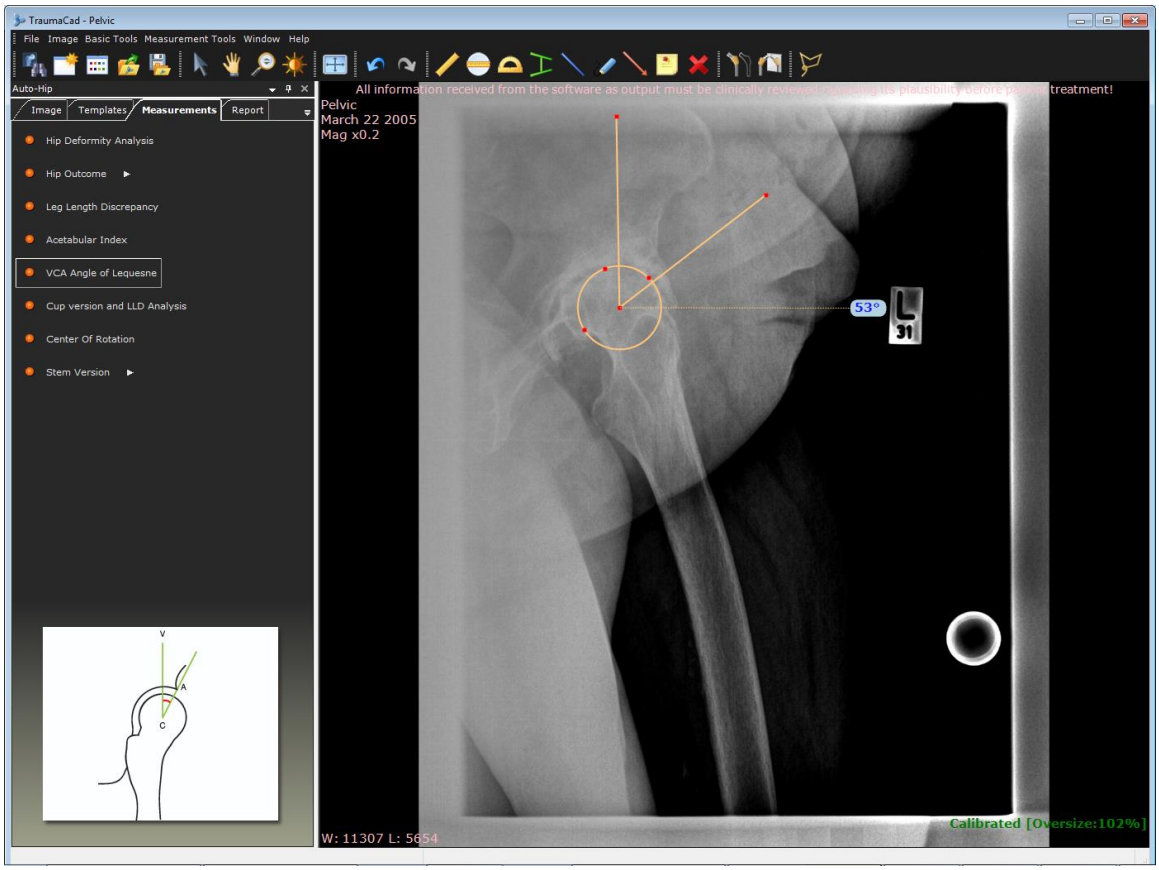
Acetabular Index

A wizard opens to guide you through the usage of the tool, as described on page 103.

VCA Angle of Lequesne

The anterior center-edge (VCA) angle quantifies the anterior coverage of the femoral head. Angles less than 20° are considered abnormal.

The VCA angle is calculated from a false-profile radiological view of the pelvis. The patient stands at an angle of 65° oblique to the X-ray beam, with the foot on the affected side parallel to the X-ray cassette. A vertical line through the center of the femoral head subtends the VCA angle by connecting with a second line through the center of the hip and the foremost aspect of the acetabulum.



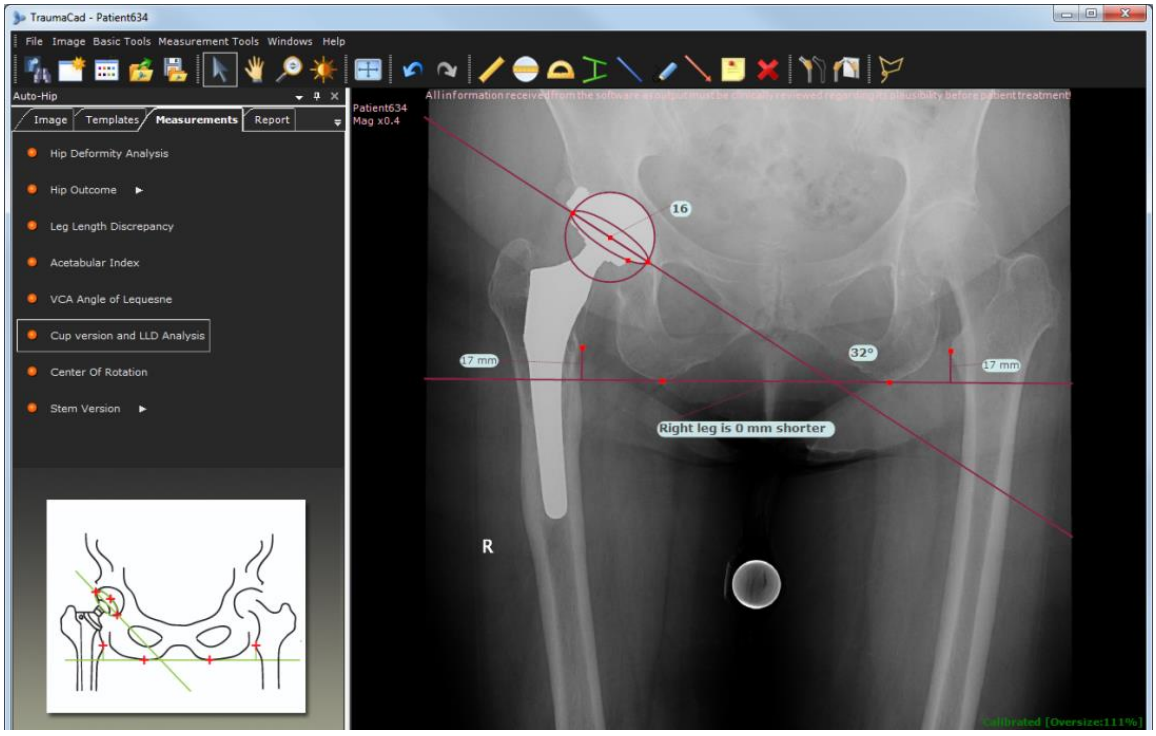
Cup Version and LLD Analysis

When the acetabular component of a total hip replacement is viewed at an angle, it projects as an ellipse. This projection can be mathematically proven to follow the general formula of an ellipse, and translated to ante/retroversion.

A horizontal reference line is drawn on the pelvis (between the ischial tuberosities, teardrops and so on) and three red markers are placed on the edge of the cup. The projection of the ellipse is then translated into ante/retroversion of the cup.

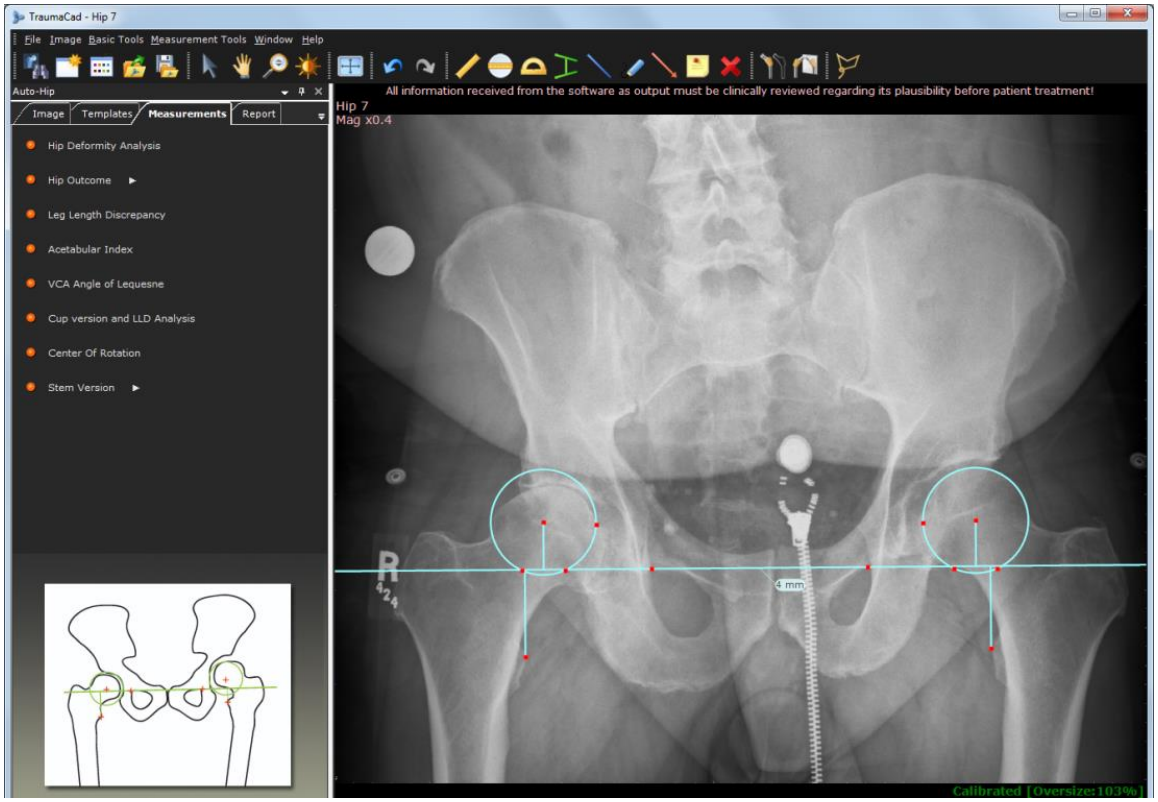
Warning! The image has to be a true AP pelvic image. Otherwise, the measured ante/retroversion will be miscalculated.

A Leg Length Discrepancy (LLD) tool is also added to the image. For more information see Leg Length Discrepancy Tool on page 84.



Center of Rotation

The **Center of Rotation** measurement tool helps you to find the approximate center of rotation of the injured acetabulum by locating the center of rotation of the contralateral hip. A horizontal line is placed on the pelvis between two teardrops. You then adjust a circle on the acetabulum of the healthy hip and the tool places a matching circle on the injured hip.



After the Center of Rotation Tool has been placed on the image and adjusted to the correct location, you can browse to the **Templates** tab and select the Cup templates. If you double-click a Cup template, it is automatically placed in the correct location with the correct size on the image.

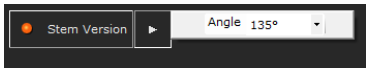
Stem Version

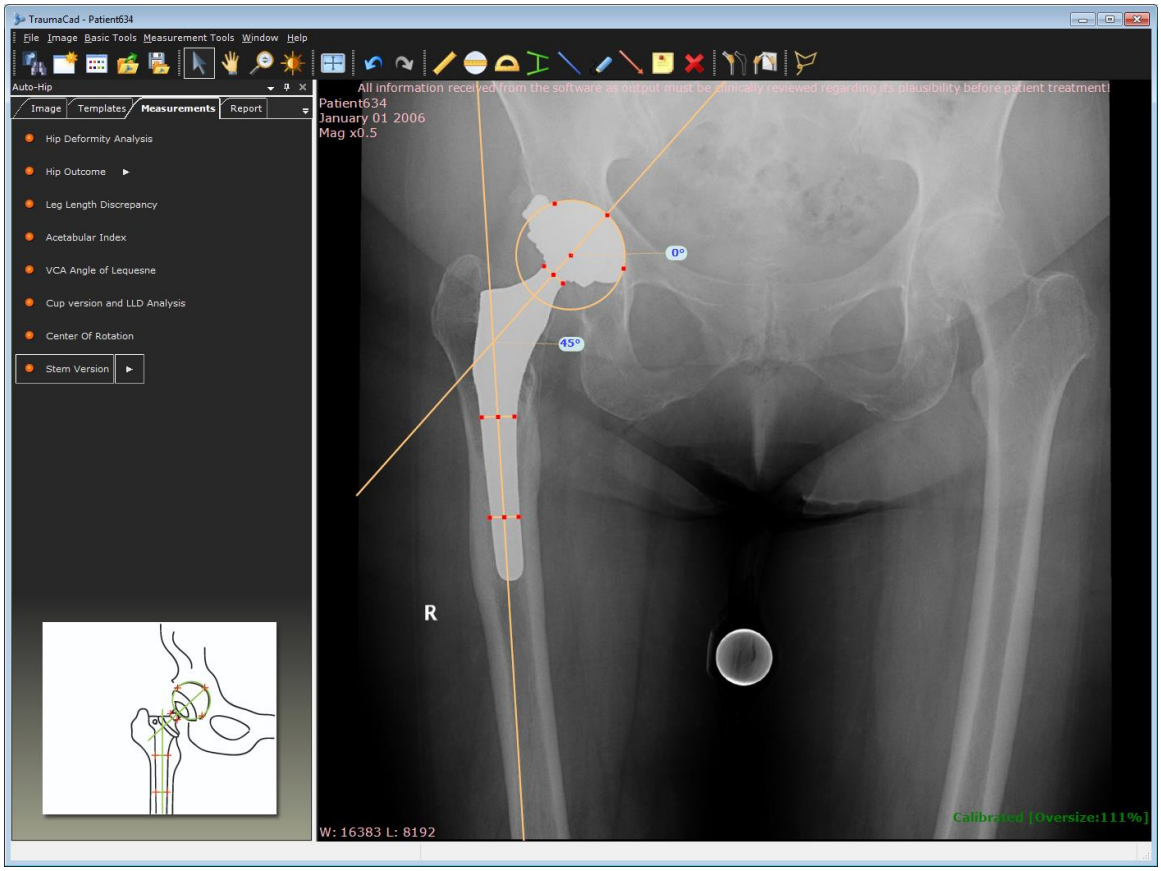
When the femoral component of a total hip replacement is ante/retroverted, the projected neck-shaft angle changes accordingly. The new projected neck-shaft angle can be mathematically translated to ante/retroversion of the stem.

First, define the neck shaft angle of the selected stem from the dropdown list. Then, a center-line finder is placed on the femoral stem, two red markers are placed on the femoral neck and three red markers are placed on the edges of the implanted head. The projection of the neck-shaft angle is then translated into the ante/retroversion of the stem.

Warning! The image must be a true AP pelvic one with neutral rotation of the hip joint. Otherwise, the measured ante/retroversion will be miscalculated.

The Stem Angle defines how much the stem is rotated compared to the AP plane of the image. In order to calculate the rotation of the stem, you need to know the angle between the axis of the stem and the axis of its connection to the cup. The default angle is 135°. To change the angle, click to open the angles values.





KNEE MEASUREMENTS

The following knee measurements can be made using TraumaCad measurements tools:

- **Auto-Knee**, page 90
- **Knee Resection Tools**, page 91
- **AP Resection Lines**, page 91
- **Long Leg Resection Line**, page 93
- **Limb Alignment Analysis**, page 94
- **Center Line Finder**, page 96
- **Simple Line**, page 97
- **High Tibial Osteotomy**, page 98
- **Joint Line**, page 99

Auto-Knee

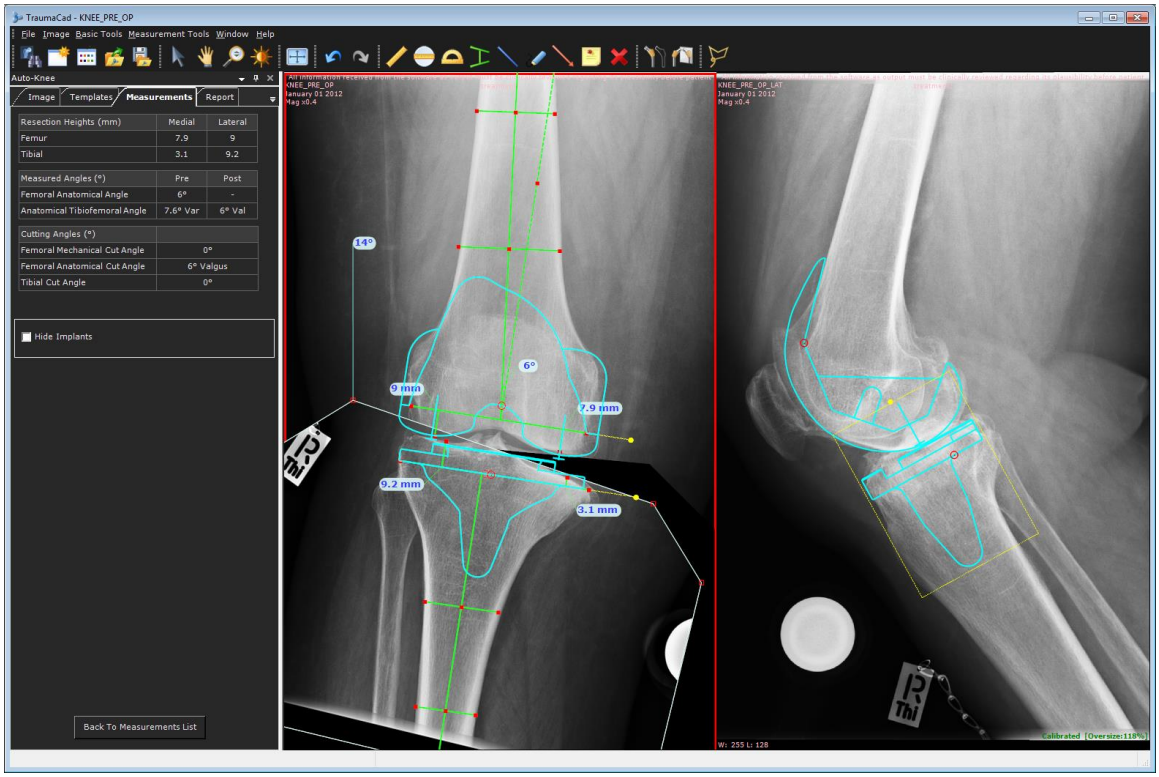
Auto-Knee functionality provides a quick method to perform Total Knee Replacement planning for AP and LAT images.

With this functionality, the application attempts to automatically detect the anatomical regions in the image, a resection line is added to the AP image, and implant sizing and position is determined both for AP and LAT images. This feature also automatically creates fragments to allow visualizing the expected knee alignment.

The AP Knee resection line is automatically positioned according to patient anatomy when the tool is selected or a template is selected.

The template sizing for the femoral component size is evaluated according to the lateral image, while the tibial component size is according to the AP image. In case one of images is missing, then automatic sizing is not applied for the relevant template.

The Auto-Alignment tool visualizes alignment correction. Once the femoral and tibial components and the resection lines are placed in the image, auto-alignment functionality is available. This tool creates a tibial fragment and re-positions it together with the tibial component and resection line until they are located in parallel to the femoral component. To perform auto-alignment, right click on one of the templates and select **Show Alignment.**



Knee Resection Tools

The Knee resection tools assist the surgeon in planning the desired femoral distal cut and proximal tibial cut perpendicular to the mechanical axes. The tool measures the size of the medial and lateral bone cuts.

The tools mark the true mechanical axis of the bone on full length images or enable a choice of femoral cut angle, deviating from the anatomical axis, on a limited knee AP view.

The resection line is located by default at 90° to the mechanical axis. It can be rotated by moving the resection anchor. A dotted line remains to indicate the original location of the resection line, and an angle added to represent the varus/valgus rotation.

The program attempts to apply the resection line automatically as described above. If the automatic placement is not successfully, it is possible to apply the resection line manually.

When applying the resection line manually, in **Settings** ➔ **Planning** you can set the default femoral and tibial cut level, the default femoral and tibial cut level side and the default femoral anatomic angle.

From the left panel you can select to show/hide the Resection Line tools.

AP Resection Lines

The AP Resection Lines tool is used for AP images where only the knee joint is shown.

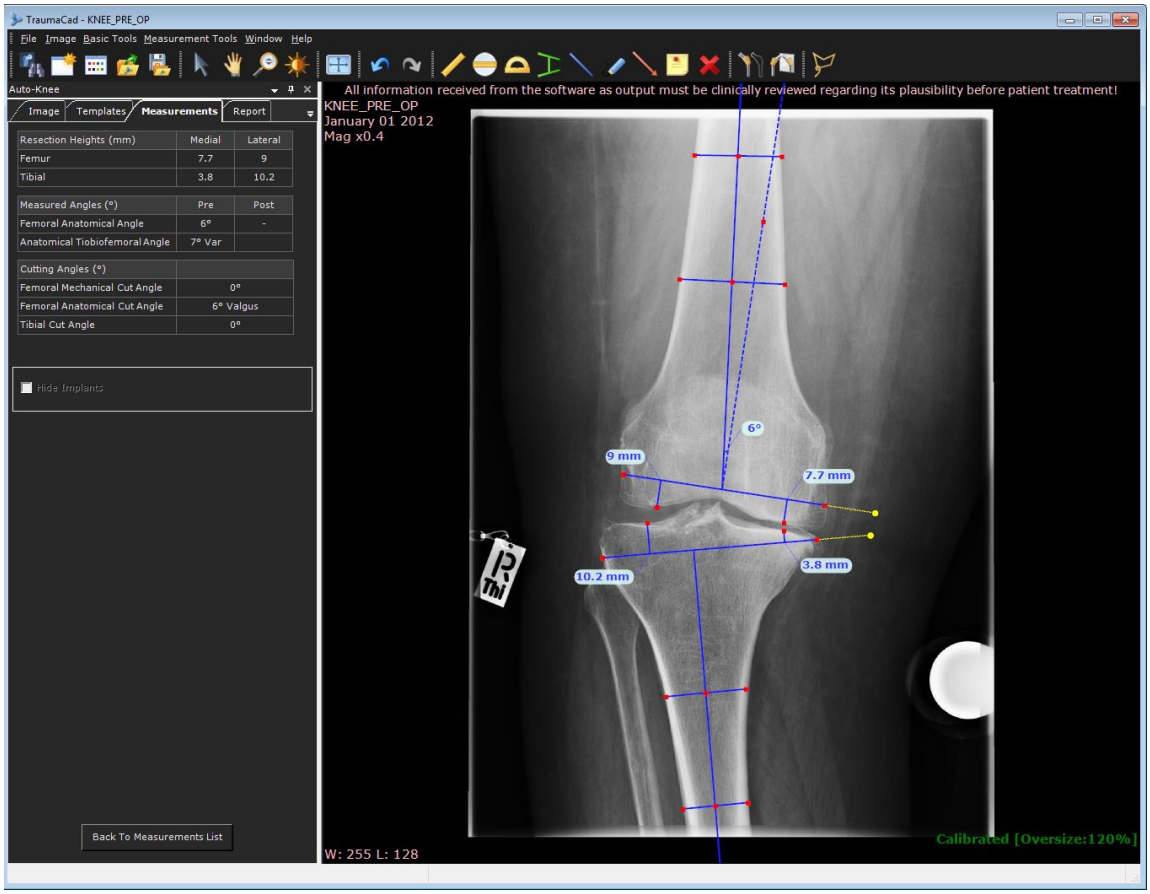
The femoral mechanical axis is assumed to be 6° to the anatomical axis and appears as a dotted line. The angle can be changed by dragging the dotted line.

▶ **To use the AP Resection Line tool manually:**

- If the AP Resection Line tool could not be placed automatically, follow the 12 steps in the wizard to mark anatomical landmarks on the image. You can later, at any stage, reposition any dot by dragging it to a new position.

The results appear in the left panel:

- Femoral values – Medial and Lateral
- Tibial values – Medial and Lateral
- Femoral Anatomical Angle – Anatomical to mechanical angle
- Anatomical Tibiofemoral Angle – Pre and Post
- Femoral Mechanical Cut Angle
- Femoral Anatomical Cut Angle
- Tibial Cut Angle



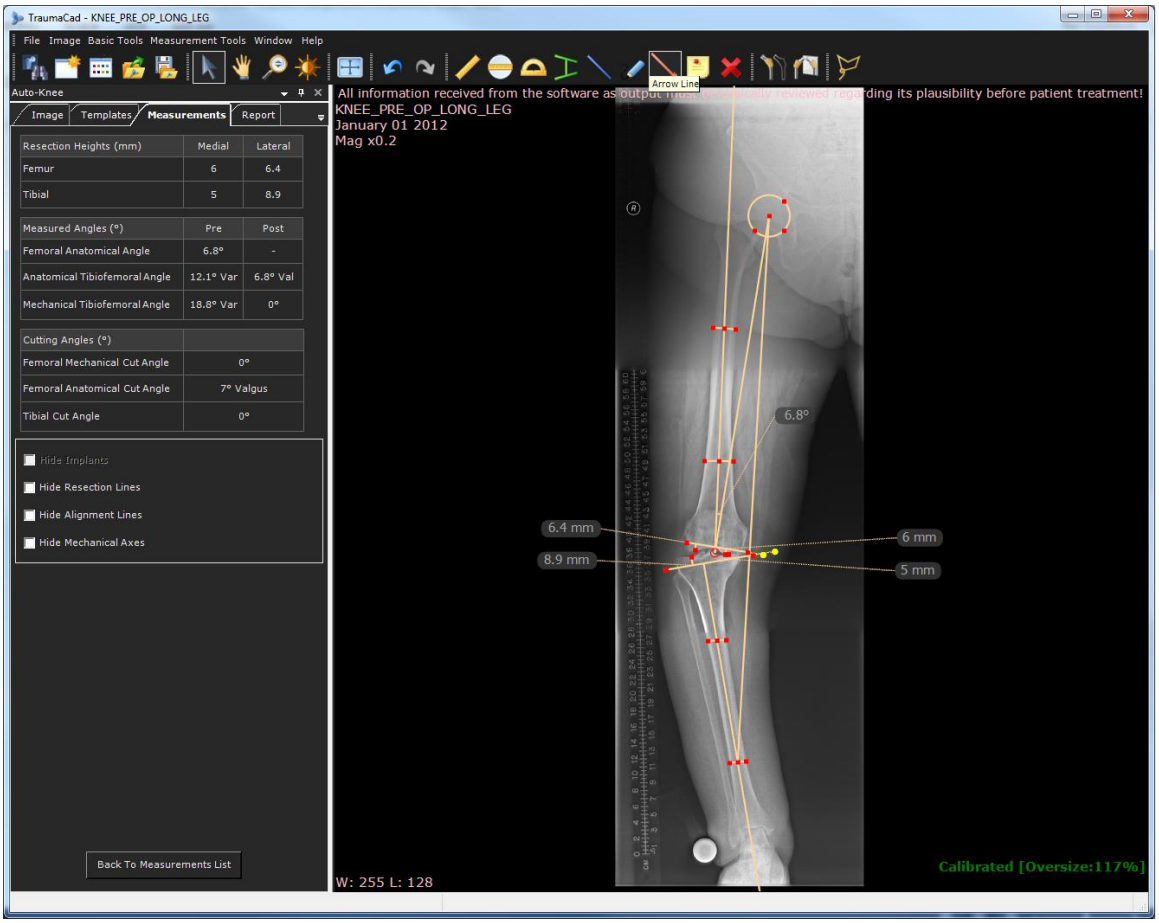
Note: If you wish to plan Total Knee Replacement manually, in **Settings ➔ Planning** unselect **Use automatic knee planning**. TraumaCad remembers your preferences and saves the planning mode you have selected for the next time you choose the Knee procedure.

Long Leg Resection Line

The Long Leg Resection tool is used for AP images where the full leg length is displayed.

▶ **To use the Long Leg Resection tool:**

1. Follow the 13 steps in the wizard to mark measurement points on the image. When completed you can fine-tune the measurements by dragging points to a new position.



The results appear in the **Measurements** tab.

- Femoral values – Medial and Lateral
- Tibial values – Medial and Lateral
- Femoral Anatomical Angle – Anatomical to mechanical angle
- Anatomical Tiobiofemoral Angle – Pre and Post
- Mechanical Tiobiofemoral Angle – Pre and Post
- Femoral Mechanical Cut Angle
- Femoral Anatomical Cut Angle
- Tibial Cut Angle

2. From the left panel you can select whether to show/hide **Resection Lines**, **Alignment Lines** or **Mechanical Axes** on the image. By default all lines are shown.

Limb Alignment Analysis

Knee limb alignment analysis enables orthopedic surgeons to take unilateral or bilateral anatomical measurements, compare them to normative standards and to simulate corrective procedures. Easy-to-use wizards help surgeons produce a wide range of anatomical measurements.

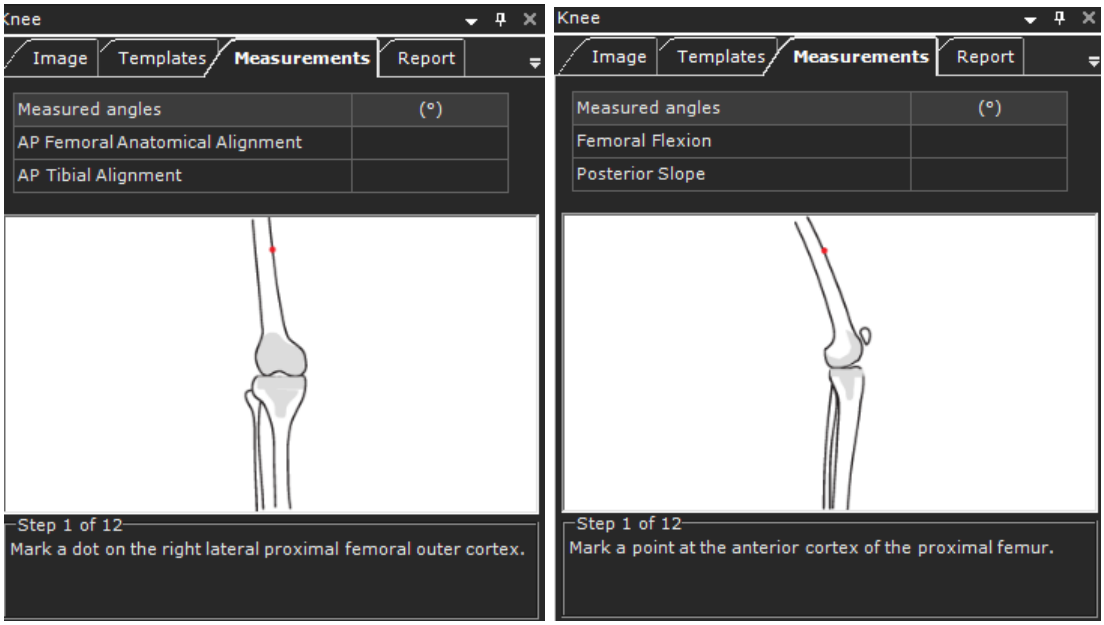
The steps for using this tool are the same as those described in the *Marking Anatomical Points* section on page 112. Consult this section and its subsections for more details.

Knee Outcome

Knee Outcome is used to evaluate the position of the femoral and tibial TKR Implants on a post-operative image for both AP and LAT views.

▶ **To use the Post-operative Knee Outcome**

AP View: **LAT View:**



1. Follow the 12 steps in the wizard to mark points on the image. When completed and measurements are displayed on the image, you can drag points to move them to a new position.
2. If you wish to evaluate the LAT view as well, select the LAT image and then in the **Measurements** tab, click **Back to Measurements List** and select **Knee Outcome.**

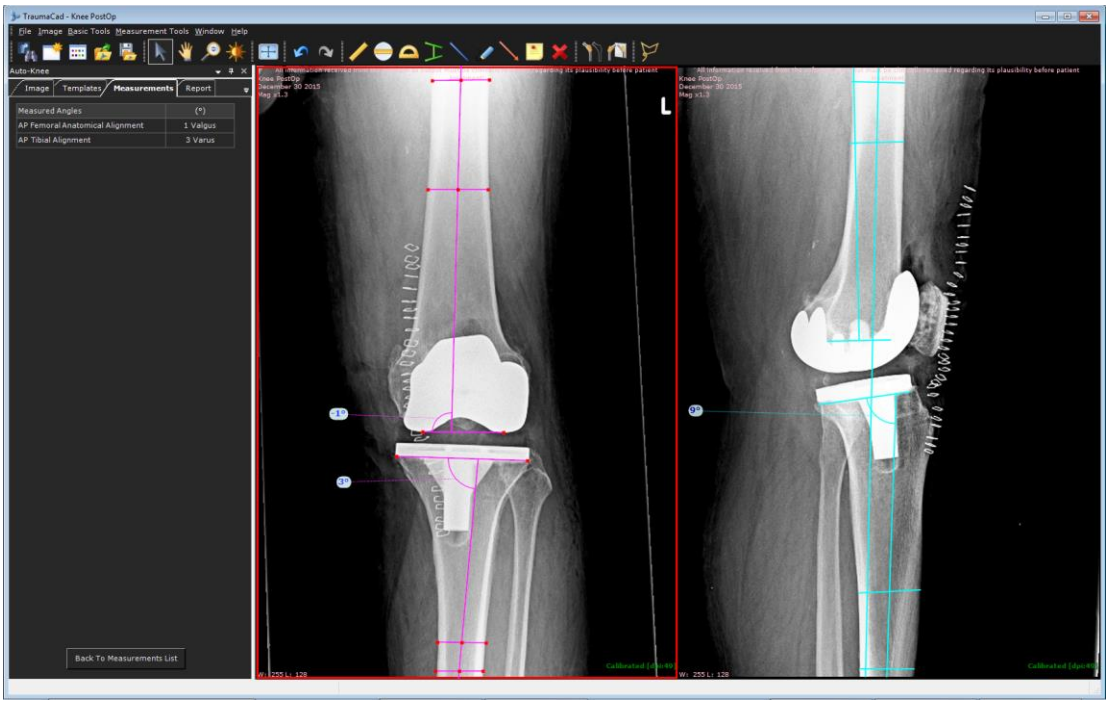
The results appear in the **Measurements** tab:

AP View:

- Femoral: AP Femoral Anatomical Alignment
- Tibial: AP Tibial Alignment
- If α > 90 = Valgus
- If α < 90 = Varus

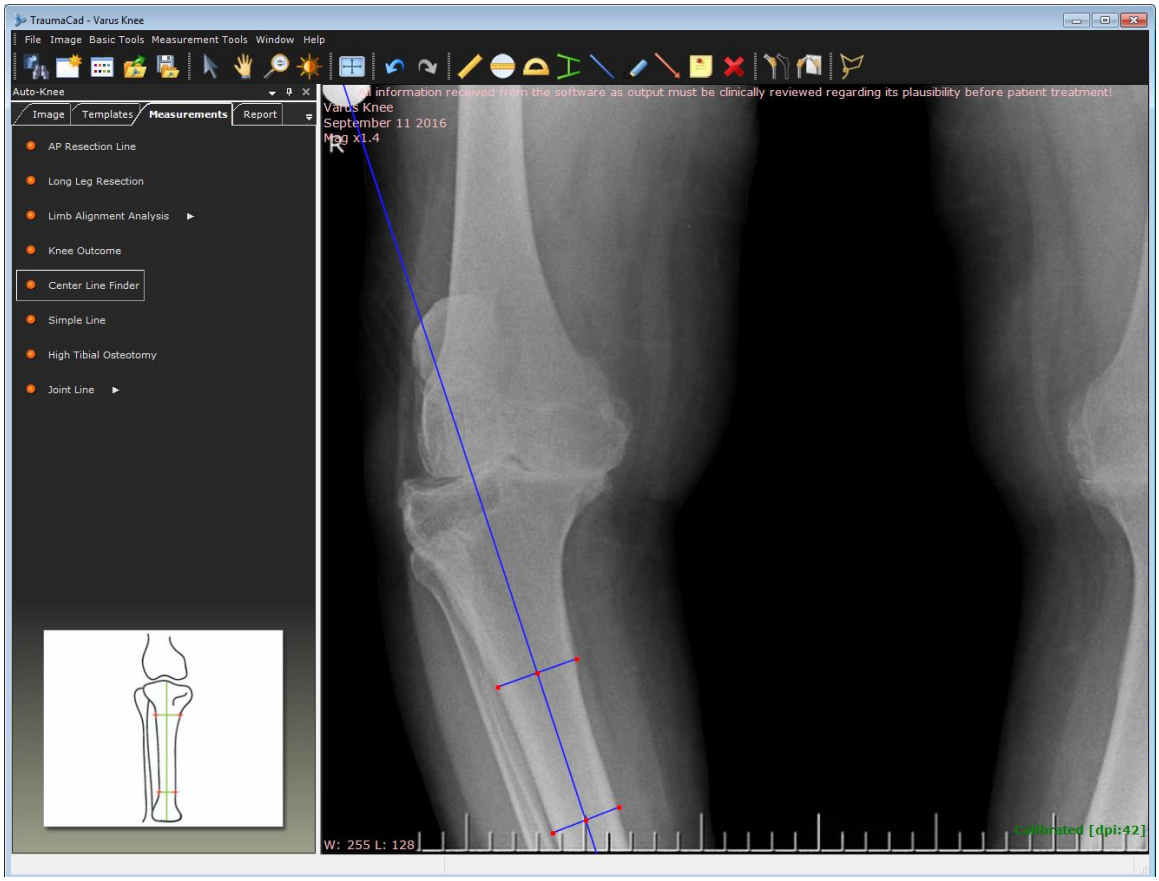
LAT View:

- Femoral: Femoral Flexion
- Tibial: Posterior Slope – if α < 90 = Anterior, If α > 90 = Posterior



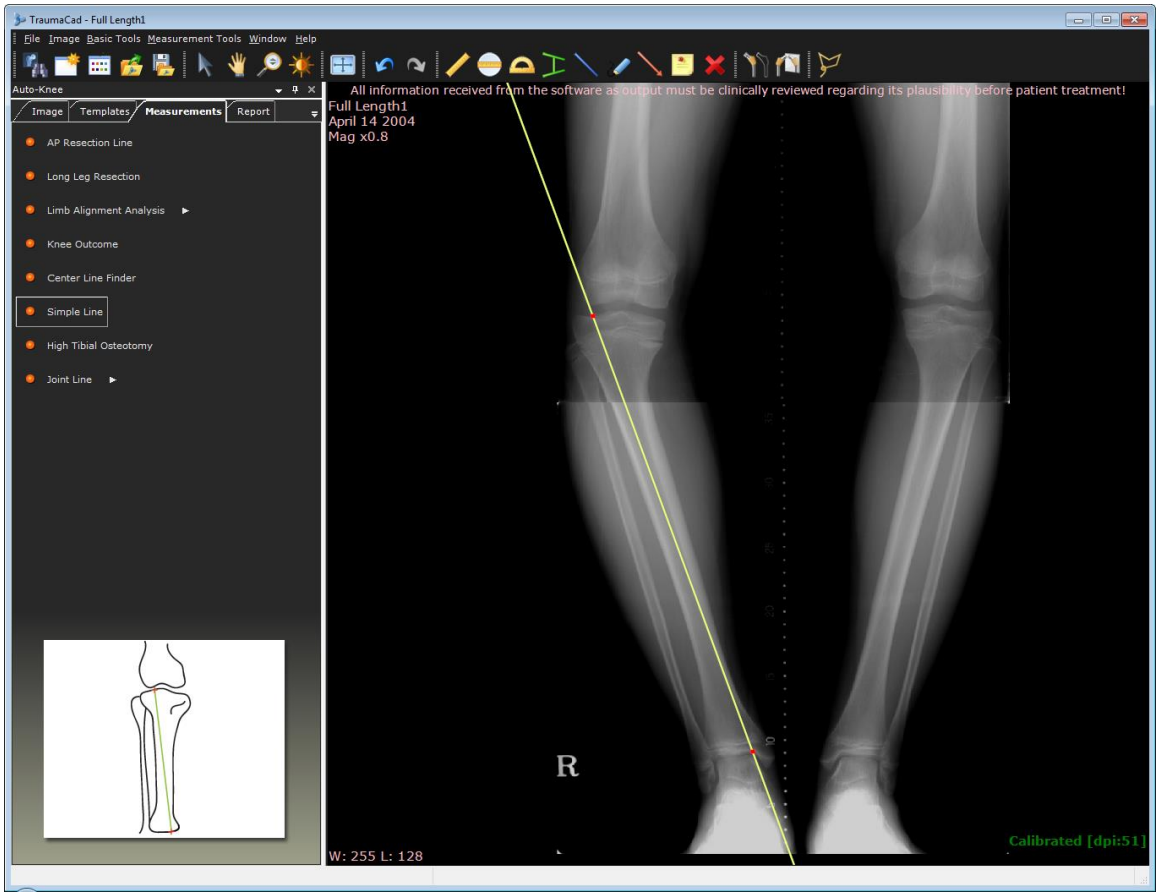
Center Line Finder

The **Center Line Finder** measurement tool is used to locate the center line of long bones. After adjusting the four points to the edges of the bone, the center line is displayed.



Simple Line

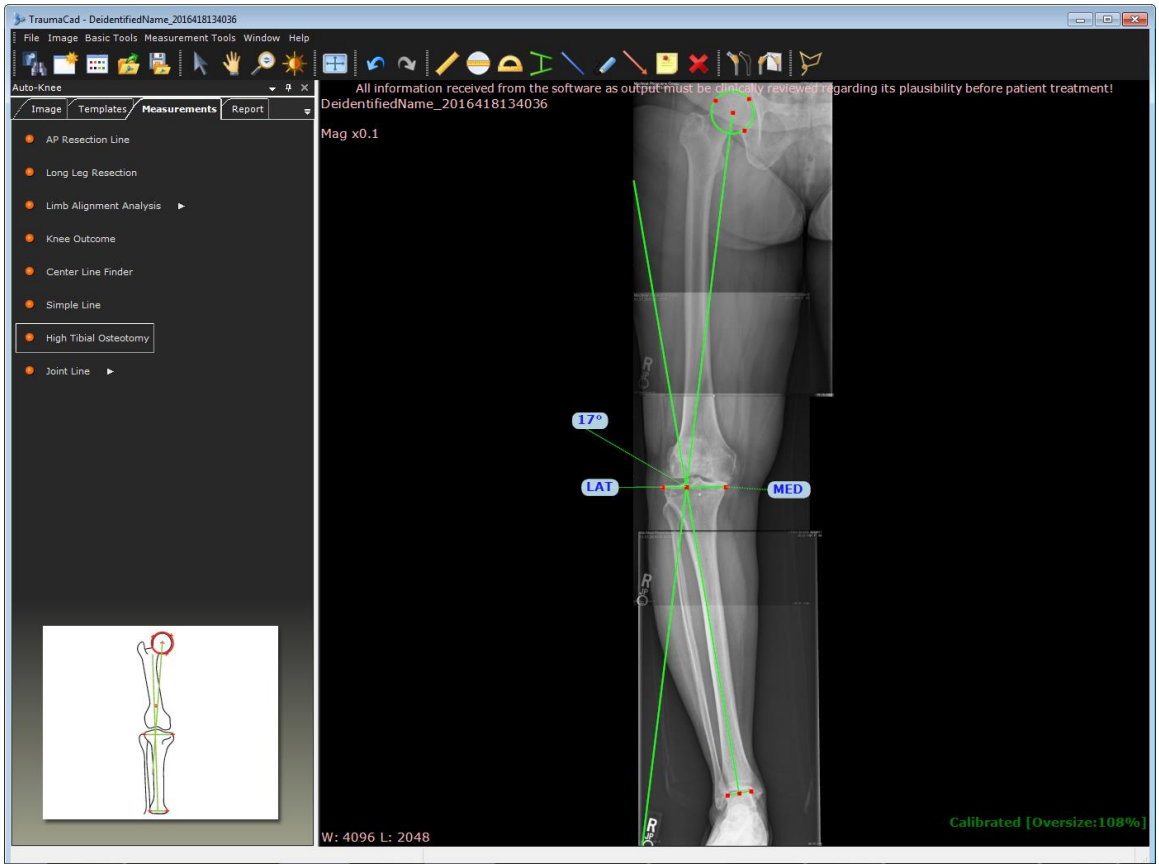
Using this tool, a line is displayed on the image that can be manipulated. If the line crosses a second line, such as a Center line or Joint line, the angle between the lines is calculated.



High Tibial Osteotomy

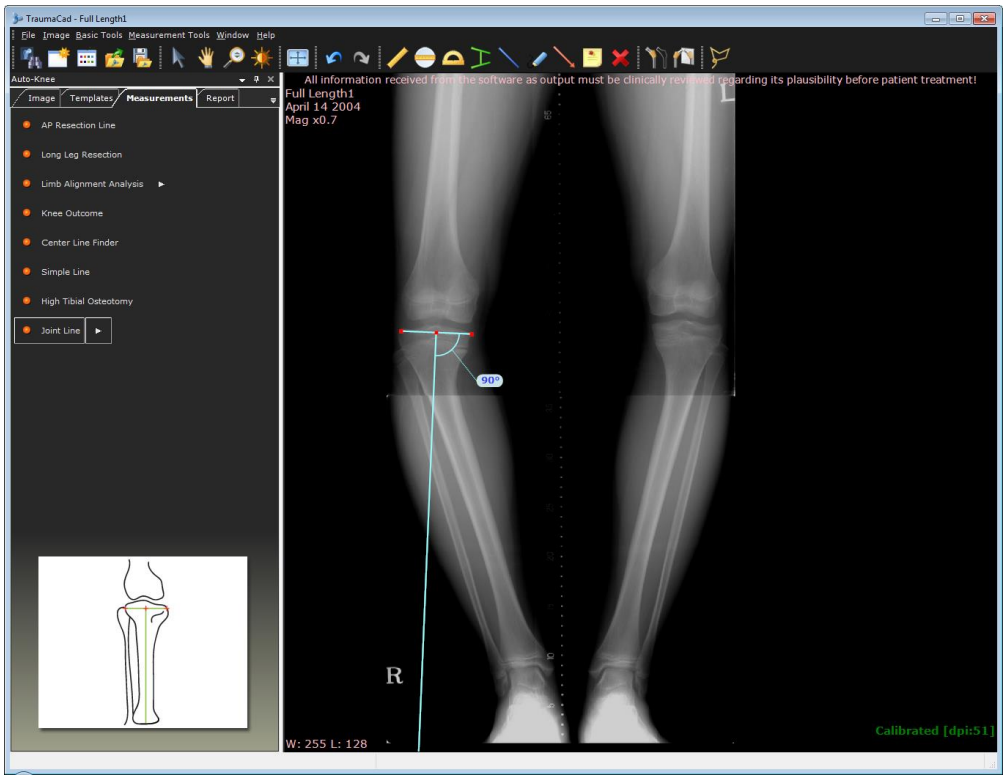
This measurement tool is used to measure the correction angle of a High Tibial Osteotomy (HTO), which is the angle between a line that is drawn from the center of the femur to the 62% coordinate of the knee, and a line from the 62% coordinate to the center of the tibiotalar joint.

- **To use the High Tibial Osteotomy tool:**
  Place the circle around the femoral head, the middle line on the tibial plateau and the distal line on the tibial plafond.

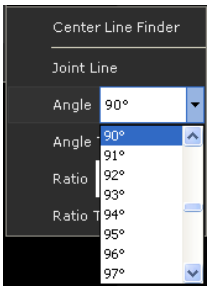


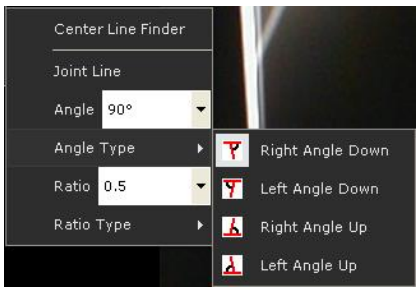
Joint Line

The **Joint Line** measurement tool enables you to select in advance, the inclination, location and orientation of the Joint line for various measurements, such as deformity evaluation, joint replacement, preoperative planning and so on.

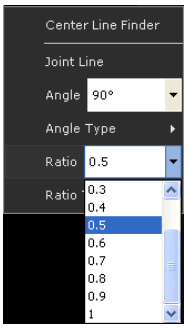


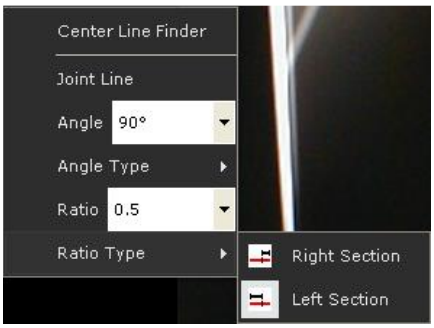
- You can adjust the desired angle and its orientation, as shown below:





- You can also determine the joint line intersection by adjusting the ratio.





PEDIATRIC MEASUREMENTS

The following pediatric measurements can be made using TraumaCad measurements tools:

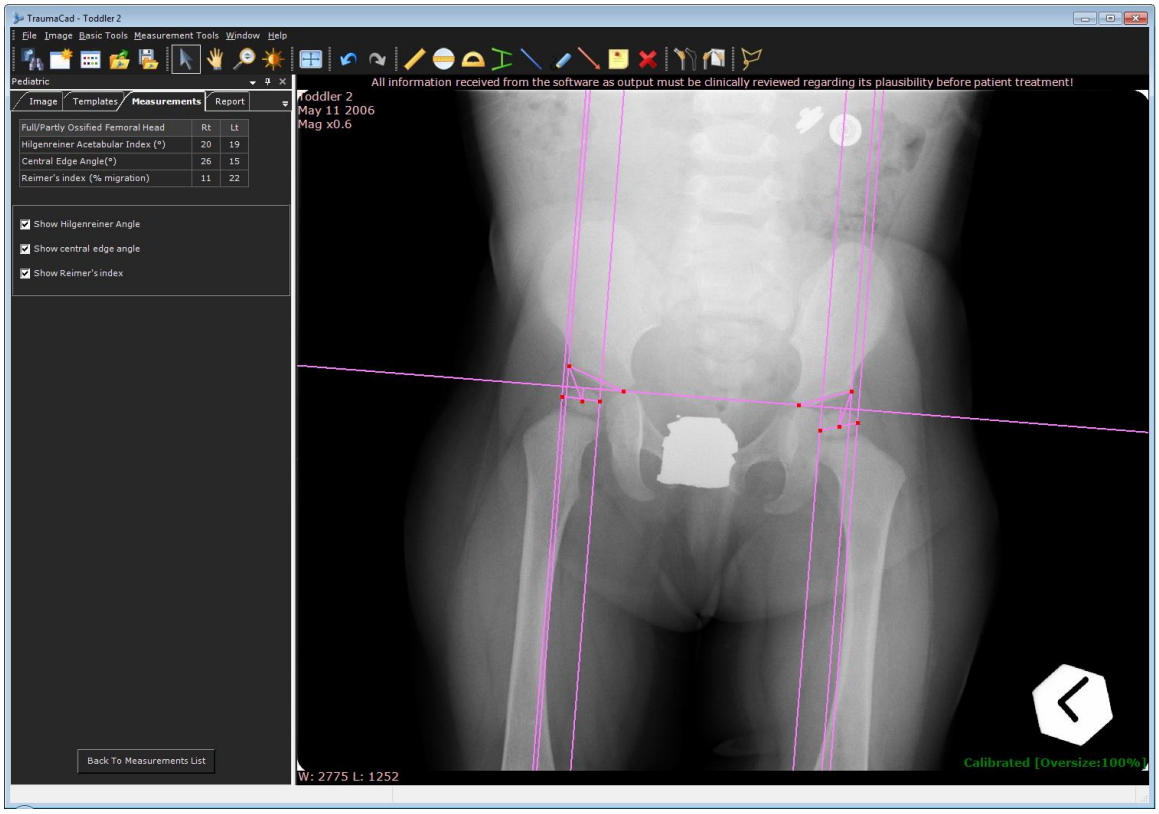
- **Hip Deformity Analysis**, page 101
- **Limb Alignment Analysis**, page 103
- **Acetabular Index**, page 103
- **Reimer's Index**, page 104
- **VCA Angle of Lequesne**, page 104
- **Neck Shaft Angle**, page 105
- **Head Shaft (Slip) Angle**, page 106
- **Articulo-trochanteric Distance**, page 107
- **Epiphyseal Index**, page 108
- **Tibiofemoral Angle**, page 109
- **Metaphyseal-Diaphyseal Angle**, page 110

Hip Deformity Analysis

When using this measurement tool, first select the module that fits the patient's bone age by the ossification stage of the femoral head. The options are:

- Fused Triradiate Cartilage
- Full/Partly Ossified Femoral Head
- Non-Ossified Femoral Head

Follow the steps in the wizard and mark the relevant points on the image corresponding to each step.



The calculated measurements are displayed in the left panel. The following three calculated measurements can also be displayed on the image, as follows:

- **Hilgenreiner Angle:** The angle of inclination of the ossified acetabular roof is measured on an AP radiograph of the pelvis. This is regarded as an estimate of acetabular development. This involves drawing a Hilgenreiner line joining the superior margins of the radiolucent triradiate cartilages. Another line is then drawn from the superolateral margin of the ossified acetabulum to the superolateral margin of the triradiate cartilage. In the neonate, the angle of intersection is normally less than 30°, and by two years of age, the angle is normally less than 20°. Select the **Show Hilgenreiner Angle** checkbox to display this measurement.
- **Central Edge Angle:** This angle is measured from a line that passes through the femoral head center and is perpendicular to the pelvic horizontal line, to a line that passes from

the center of the femoral head to the lateral rim. It measures the acetabular dysplasia. Select the **Show Central Edge Angle** checkbox to display this measurement.

- **Reimer's Index (the hip migration percentage):** Vertical lines are drawn through the edges of the femoral head and the lateral rim of the acetabulum. The index is calculated by dividing the uncovered part of the head by the entire width of the head, which measures the acetabular coverage of the femoral head. Select the **Show Reimer's Index** checkbox to display this measurement.

Limb Alignment Analysis

A wizard opens to guide you through the usage of the tool, as described on page 112.

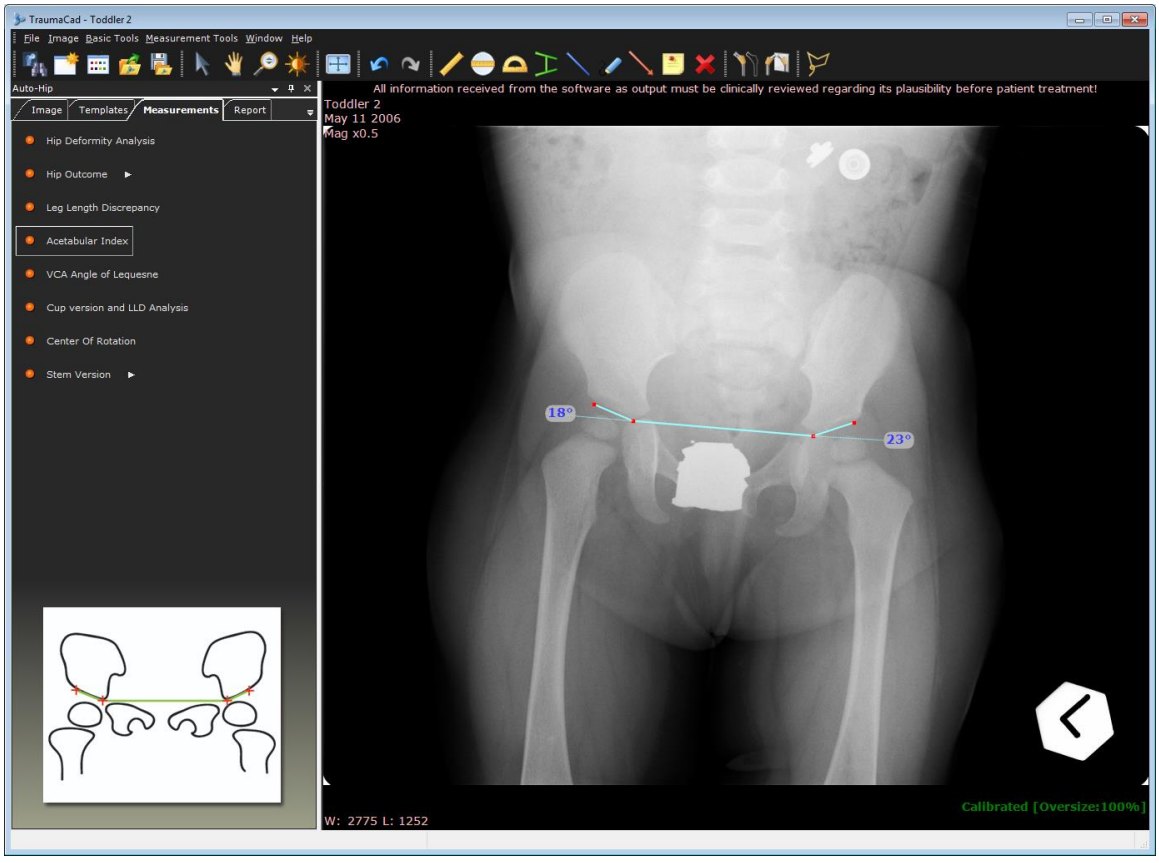
Acetabular Index

A wizard opens to guide you through the usage of the tool, as described on page 85.

The angle of inclination of the ossified acetabular roof is measured on an AP radiograph of the pelvis. This is regarded as an estimate of acetabular development.

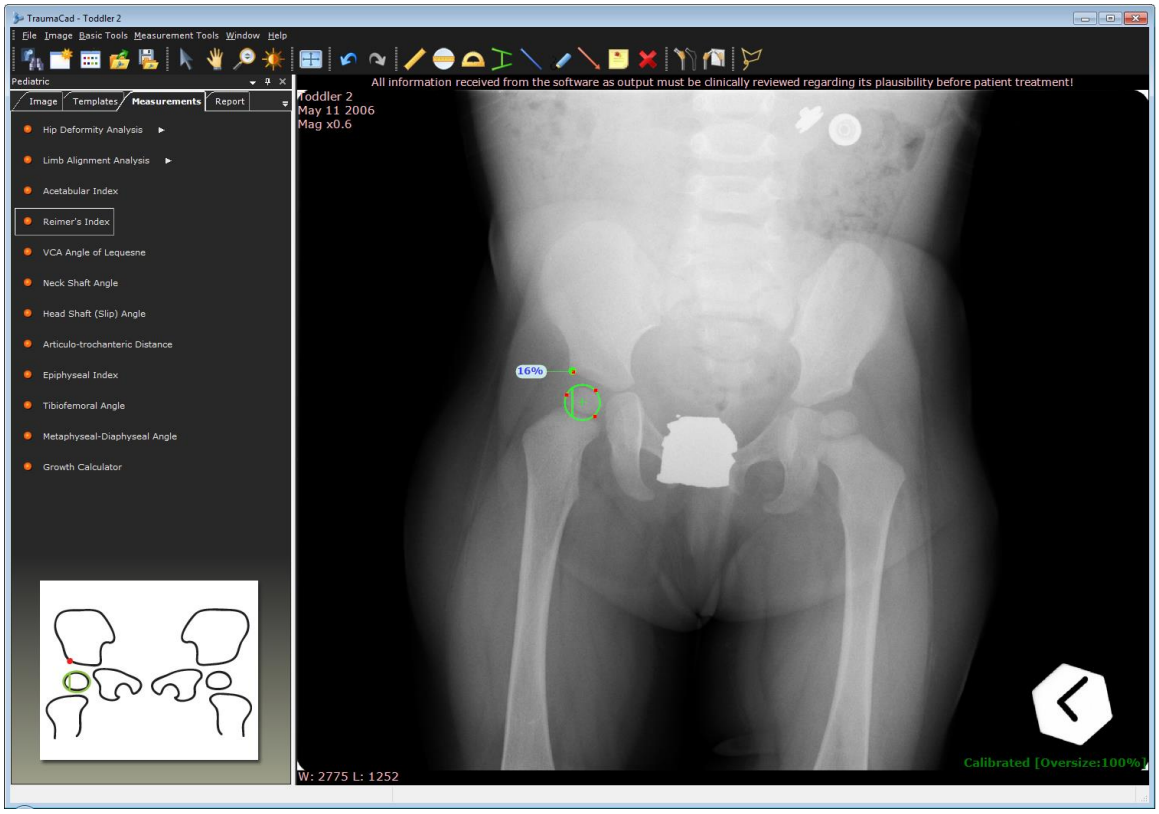
The most commonly used method for measuring the angle is Caffey's. This involves drawing a horizontal line joining the superior margins of the radiolucent triradiate cartilages. Another line is then drawn from the superolateral margin of the ossified acetabulum to the superolateral margin of the triradiate cartilage.

In the neonate, the angle of intersection is normally less than 30°, and by two years of age, the angle is normally less than 20°.



Reimer's Index

The Reimer's Index measures the hip migration percentage. A circle is adjusted to the ossified femoral head. The vertical line is then placed continuous with the lateral rim of the acetabulum. The index is calculated by dividing the lateral part of the circle by the diameter of the circle. This measures the acetabular coverage of the femoral head.



VCA Angle of Lequesne

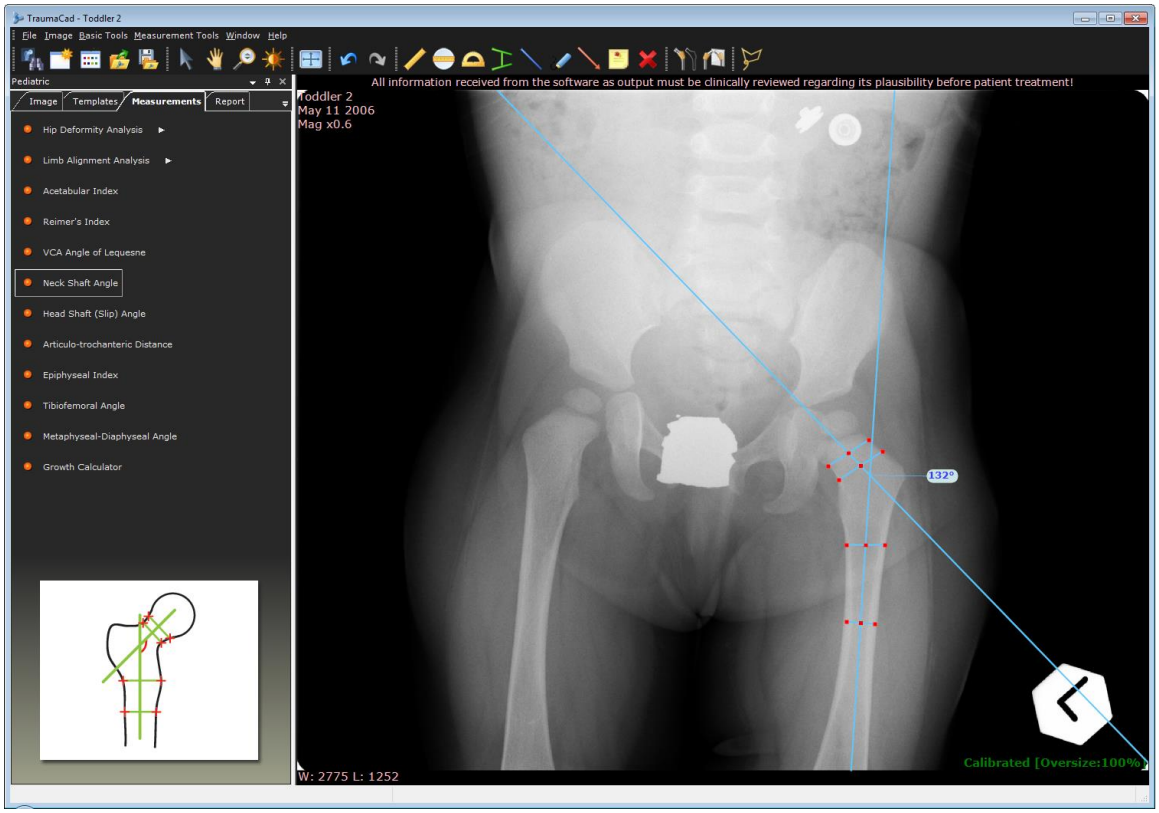
The tool appears on the image as described on page 85.

Neck Shaft Angle

Hip deformity can be evaluated by measuring the angle between the center of the shaft and the center of the neck of the femur.

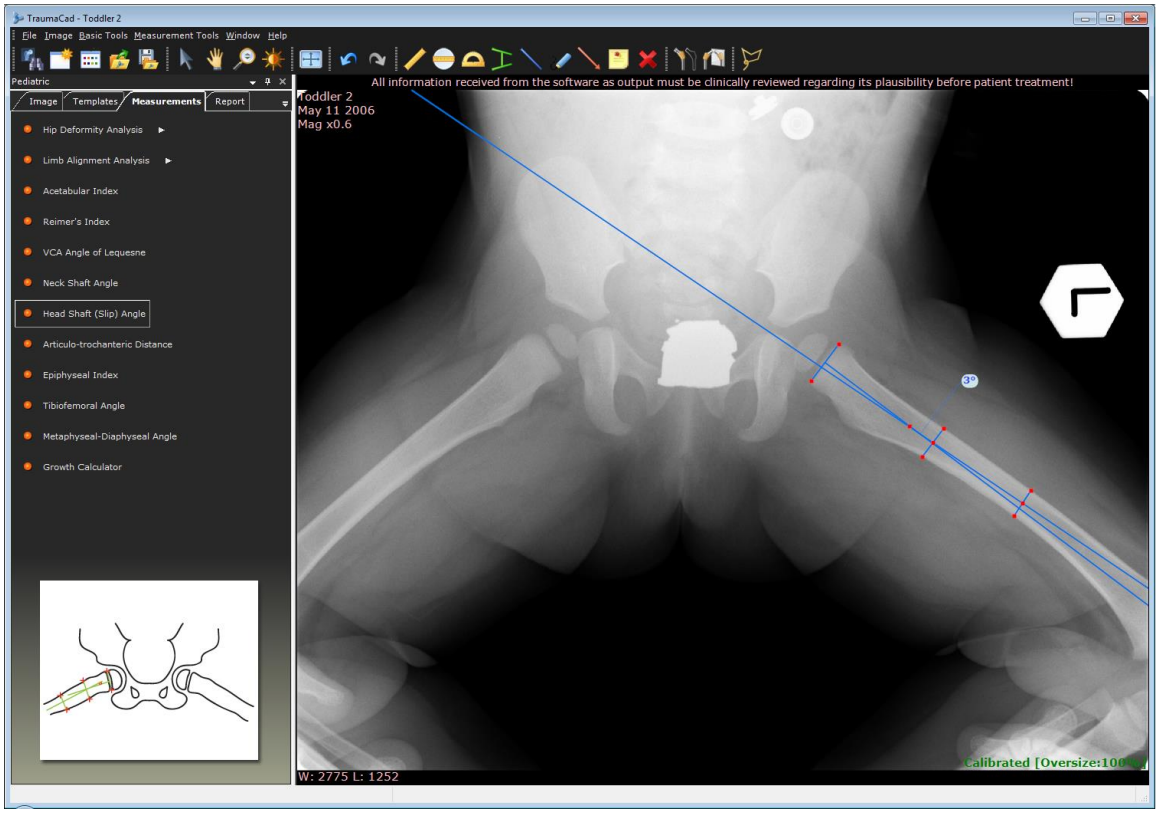
The normal femoral neck-shaft angle in children changes with age, being approximately 150° at birth and gradually reducing to approach the adult value of 130°. It is important that the radiograph is taken with the patient correctly positioned with the leg held in a neutral position and the patellae facing forward, as external rotation of the leg increases and internal rotation decreases the projected neck-shaft angle.

The tool appears on the image.



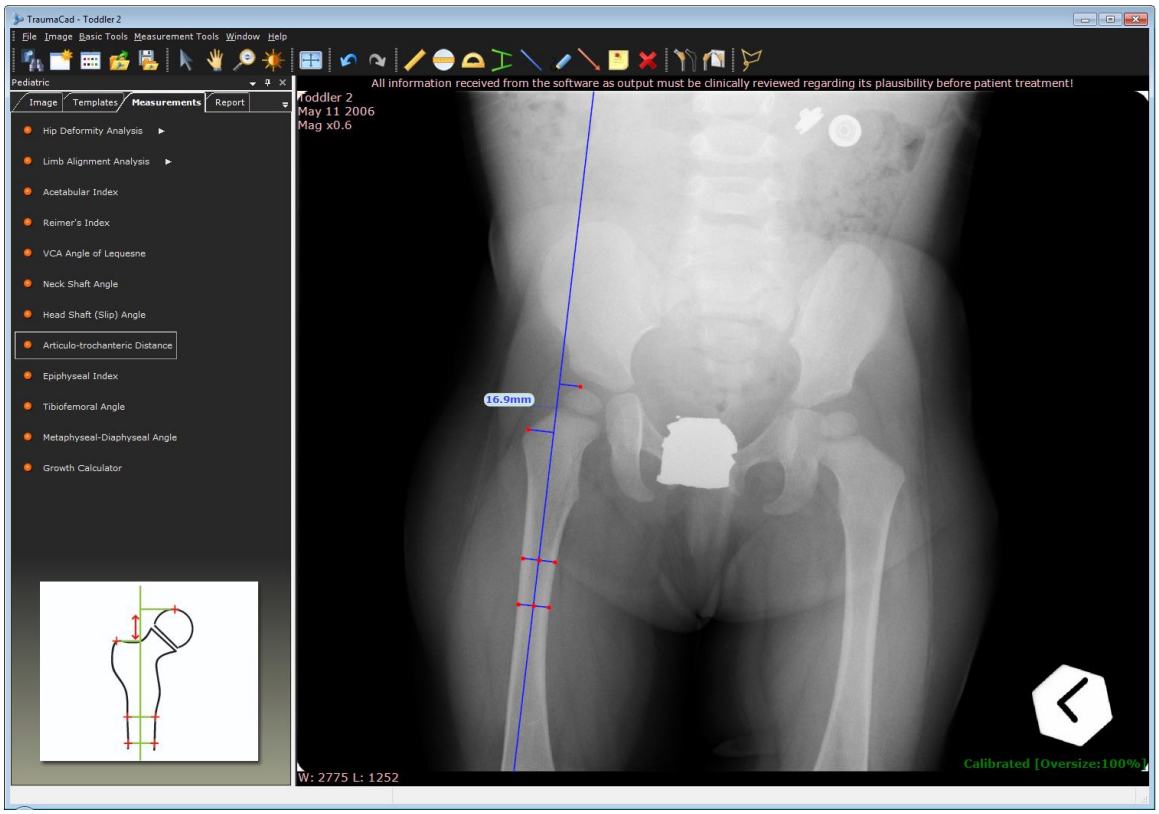
Head Shaft (Slip) Angle

The head shaft (slip) angle of Southwick has been used to characterize slip severity in slipped capital femoral epiphysis. The angle is measured on the frog-lateral radiograph of the pelvis. A line is drawn between the anterior and posterior tips of the epiphysis at the physeal plate level. Then, a perpendicular line is drawn to this Epiphyseal line. Next, a line is drawn along the mid-axis of the femoral shaft. The Epiphyseal-shaft angle is the angle formed by the intersection of the perpendicular line and the femoral shaft line. It is measured for both hips, and the magnitude of slip displacement is the angle of the involved hip minus the angle of the contralateral normal hip. Using the measurement of this angle, a slipped capital femoral epiphysis can be classified as mild (less than 30°), moderate (from 30° to 50°) or severe (greater than 50°). If involvement is bilateral, 12° can be used as the control angle.



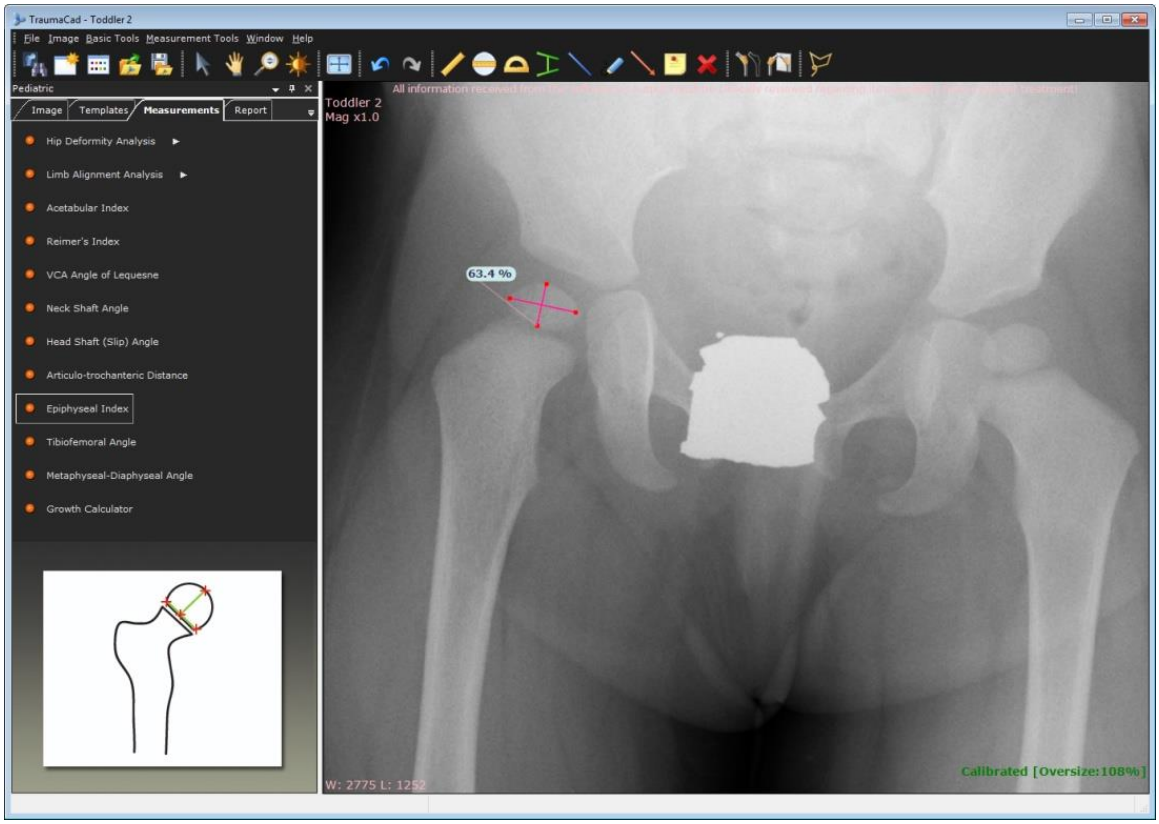
Articulo-trochanteric Distance

This measurement tool measures the vertical distance from the superior articular surface of the femoral head to the proximal point of the greater trochanter along the anatomical axis of the femur. This enables you to assess the degree of growth arrest of the neck-head growth plate.



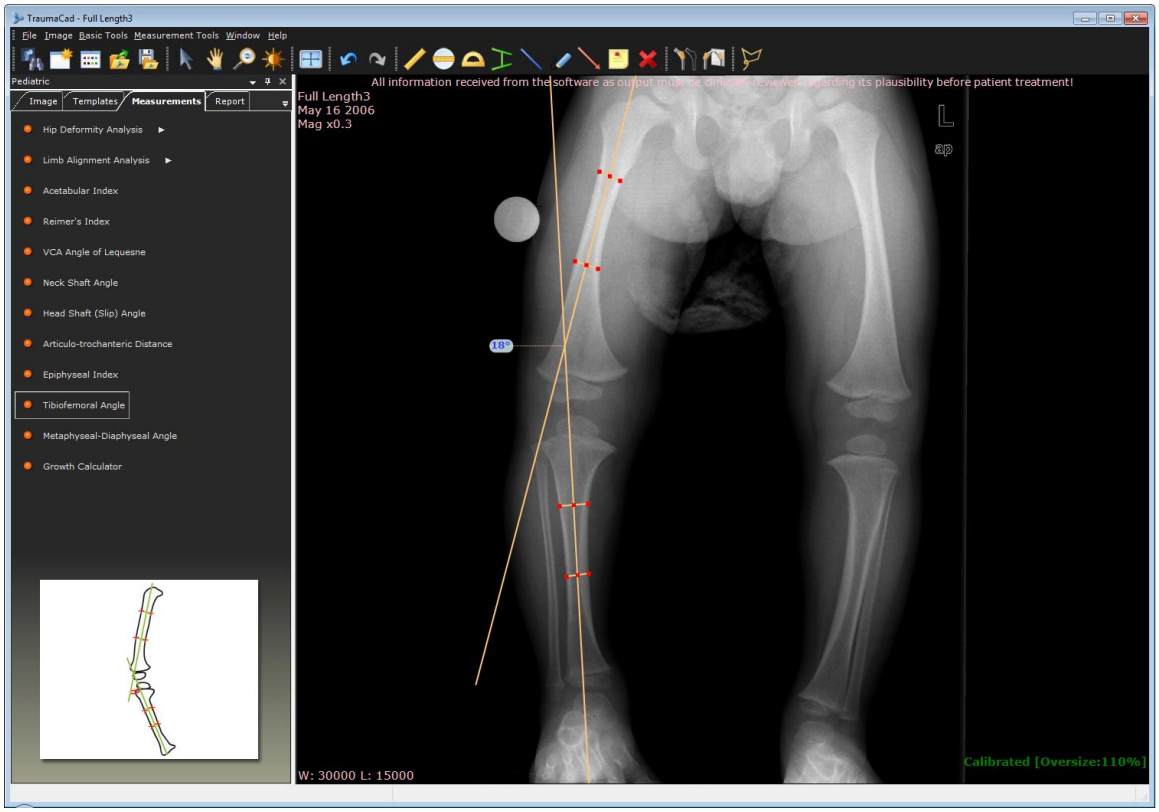
Epiphyseal Index

The Epiphyseal Index is the quotient between the largest width and the largest height of the epiphyseal nucleus, measured on the X-ray plate and shown in percentage of sphericity. This provides an indication of the degree of flattening of the epiphyseal nucleus induced by necrosis or mechanical deformity.



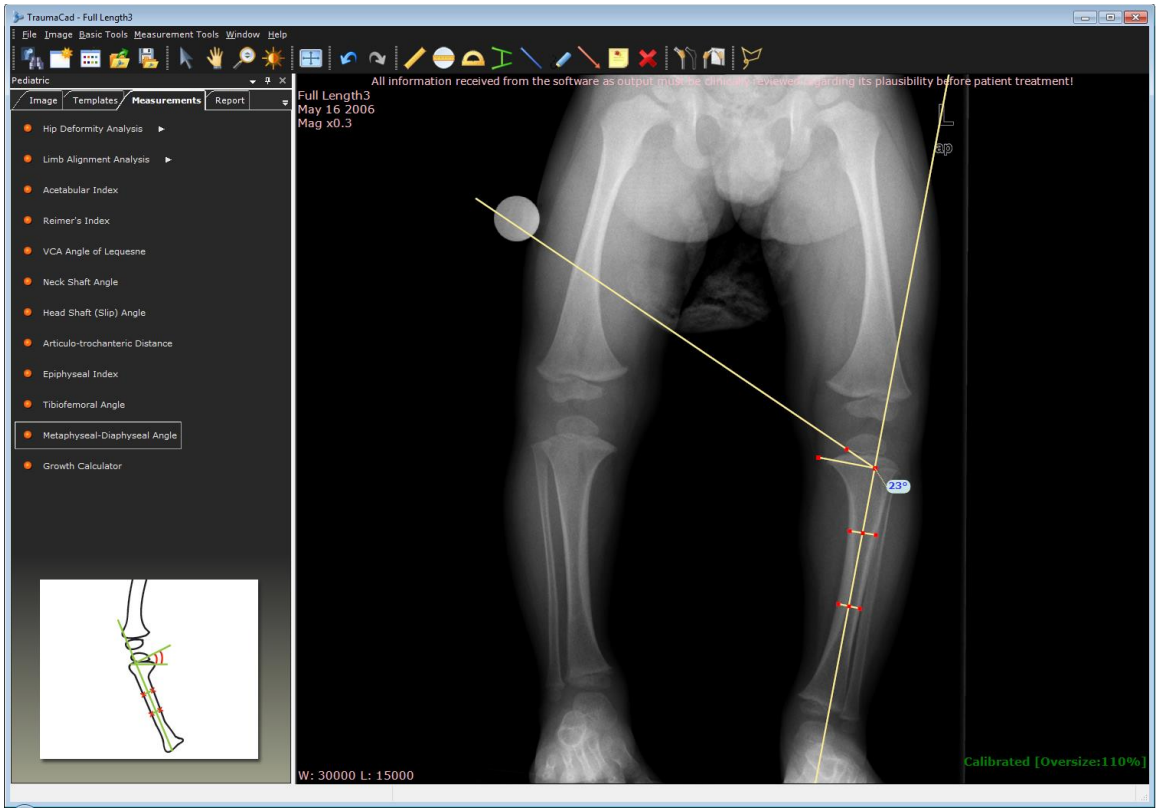
Tibiofemoral Angle

The Tibiofemoral Angle is the angle created by the intersection of the anatomical axes of the femur and the tibia.



Metaphyseal-Diaphyseal Angle

The Metaphyseal-diaphyseal Angle is the angle created by the intersection of a line through the transverse plane of the proximal tibial metaphysis, with a line perpendicular to the long axis of the tibial diaphysis. This angle represents the degree of deformity of the proximal end of the tibia in a patient with clinical bowleg deformity, and permits early differentiation between infantile tibia vara and physiological bowleg before the appearance of the radiographic changes of tibia vara.



DEFORMITY MEASUREMENTS

Currently, the following automatic deformity measurement tools are available:

- **Limb Alignment Analysis**, below
- **Taylor Spatial Frame – Pre Op**, page 121
- **Taylor Spatial Frame – Post Op**, page 123

Limb Alignment Analysis

The **Limb Alignment Analysis** tool enables orthopedic surgeons to measure and display the anatomic and mechanic axes of deformed limbs. The common joint angles are automatically calculated and compared to normative standards and are used to simulate corrective procedures. The anatomical measurements can be unilateral or bilateral.

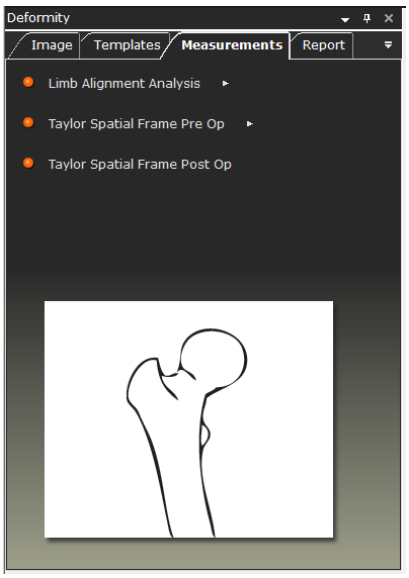
Preplanning for lower limb deformity correction surgery is the art of describing the properties of the deformation and the means of its correction.

The user must draw a model assessing the transfer of load from the point of which it is applied to the limb – usually at the center of the femoral head, through its geometrical relations with the major joints and to the center of the ankle, where it is transferred to the ground.

The purpose of defining the axes of load is to be able to define the centers of any anatomic deformation along the pass of bony structures, calculate its magnitude and suggest the best means of correction.

The outcome of the procedure is a plan describing where a bone should be cut and the angle it needs to rotate around a chosen center of rotation, in order to re-establish the correct length and axis for load transfer.

▶ **To perform limb alignment analysis:**



1. Use the wizard to mark anatomical landmarks on the image for limb alignment analysis, as described below.
2. Use the CORA tools, as described on page 116.
3. You can simulate osteotomies and implant fixation, as described on page 118.

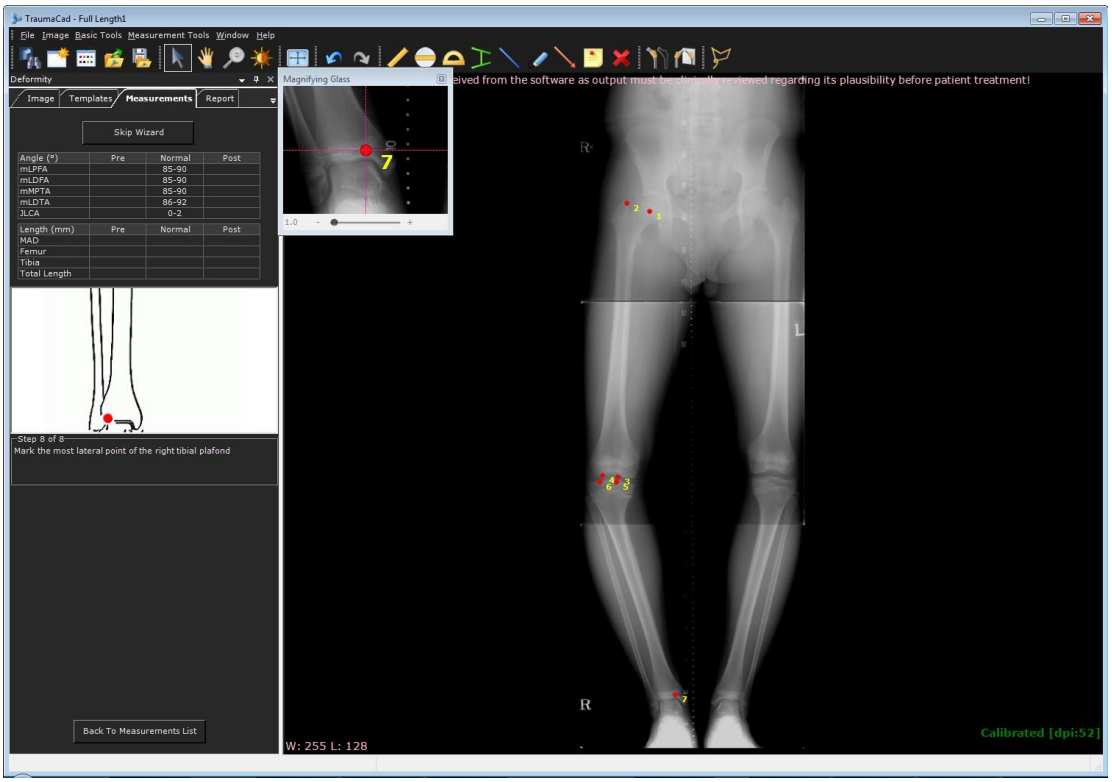
Marking Anatomical Points

Select the **Limb Alignment Analysis** measurement tool in the **Measurements** tab.

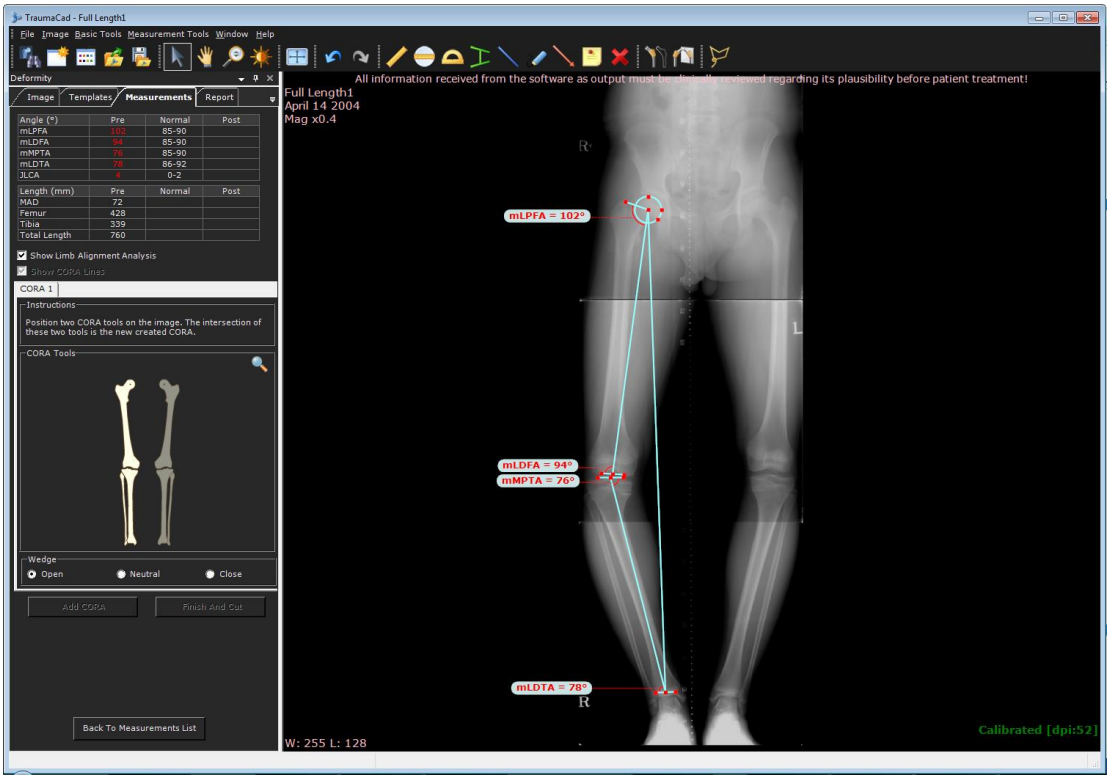
- For an AP image, specify whether you want to produce unilateral versus bilateral measurements.

- The wizard guides you through the process of identifying and marking each of the anatomical reference points required for performing the automatic leg alignment analysis and marking them on the image.
- A magnifying glass opens automatically that enlarges the relevant area to help you position the points.

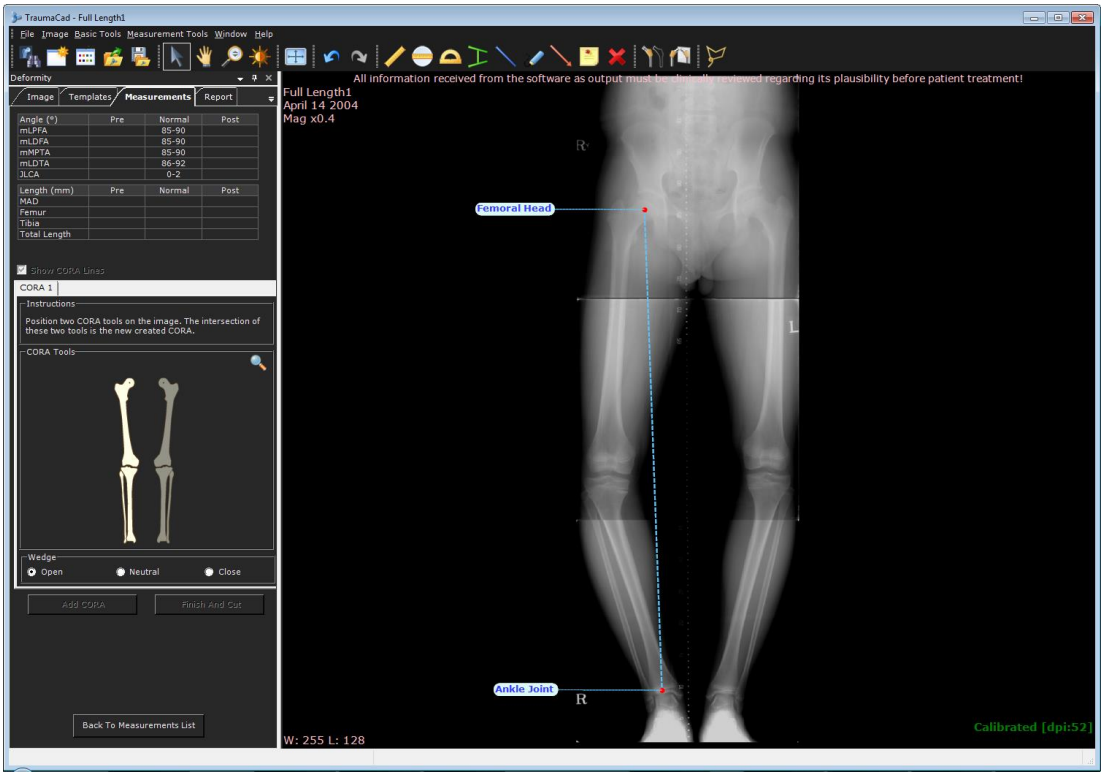
The following shows an example of the image after the 7th point has been marked:



- After you mark the eighth point, the window appears as follows:



- You can now fine tune the position of the measurement points by zooming in the image and dragging them.
- If for any reason you want to skip that stage and perform osteotomy simulation in a predetermined location, click the **Skip Wizard** button in the **Measurements** tab and mark only two reference points for the femoral head and the ankle joint, as shown in the following image:



Note: If the image only shows part of the leg, for example when the femoral head is not in the image and you are using the **Skip Wizard** option, then you must estimate the line to the femoral head's position at the top of the image using the CORA tools, as described on page 116.

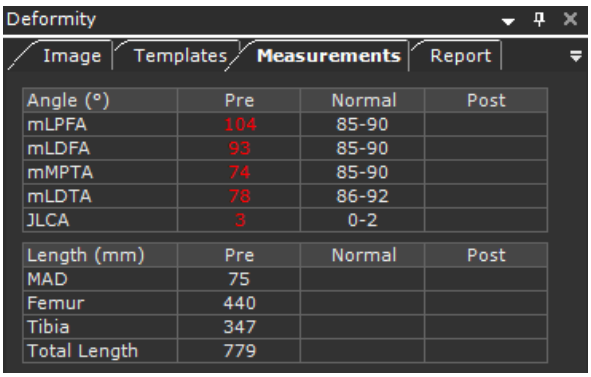
At any stage after marking the anatomy using the wizard, you can click the **Show Limb Alignment Analysis** checkbox under the table to hide/unhide the anatomical measurements on the image.

Limb Alignment Analysis Results

The following unilateral measurements are calculated in an AP image:

- **mLPFA:** Mechanical Lateral Proximal Femoral Angle
- **mLDFA:** Mechanical Lateral Distal Femoral Angle
- **mMPTA:** Mechanical Medial Proximal Tibial Angle
- **mLDTA:** Mechanical Lateral Distal Tibial Angle
- **JLCA:** Joint Line Convergence Angle
- **MAD:** Mechanical Axis Deviation
- **Femur:** Total length of femur segment
- **Tibia:** Total length of tibia segment
- **Total Length:** Total limb length

The results appear in the **Measurements** tab:



In the table, normal values appear green and abnormal values appear red.

CORA Tools

The Center of Rotation of Angulation (CORA) is the intersection of the proximal segment's axis and the distal segment's axis. The angle created is the magnitude of the deformity in the frontal plane.

You can now use the CORA tools to establish where to perform the osteotomy.

The CORA can be found by establishing either the anatomical or the mechanical axis of each bone. Different tools are provided for each of these options.

Typically, one tool is placed on the proximal segment and one on the distal. The CORA is found at the intersection between the two tools. For multiple deformities, recalculate above and below each deformity, either on the same bone or on multiple bones.

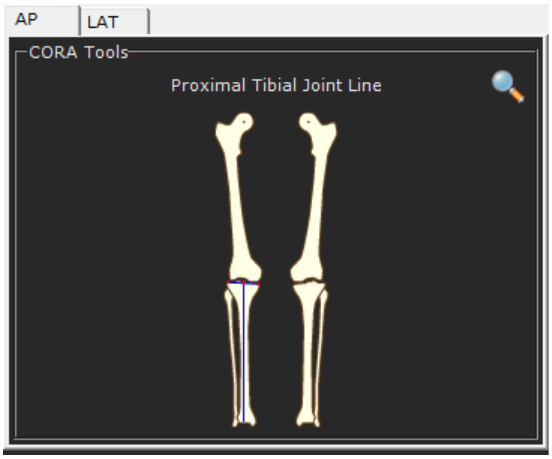
For each CORA, you must use either two mechanical tools or two anatomical tools.

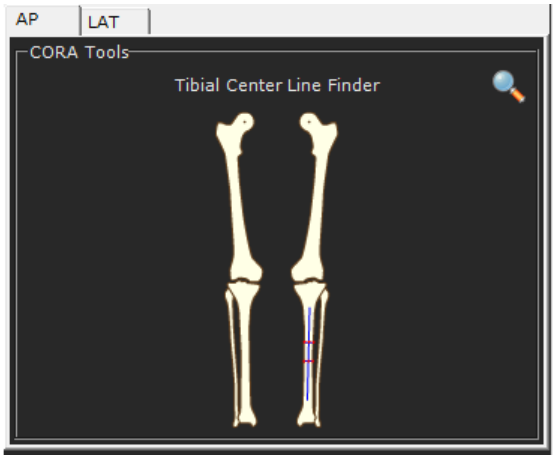
The illustrations in the **Measurements** tab guide you through the process.

Note: We recommend that at this stage you uncheck the **Show Limb Alignment Analysis** checkbox so that the limb alignment lines are not shown, thus enabling you to concentrate on finding the CORA.

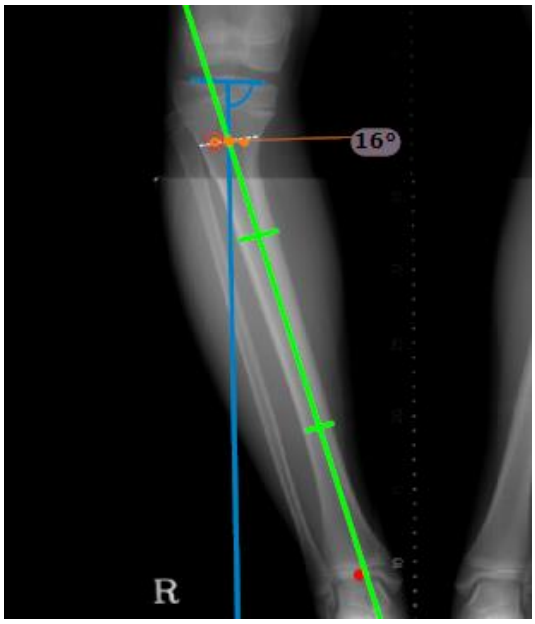
▶ **To use the CORA tools:**

1. In the **Measurements** tab, hover with the mouse over an anatomical part of a leg to display the relevant CORA tools for that leg part, as shown below:



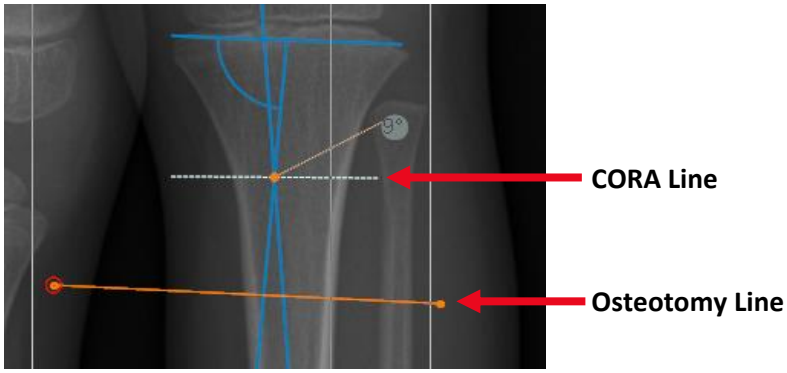


2. Click to select the first tool. The tool appears on the image.
3. Hover over the illustration again to select the second tool. Both tools now appear on the image, as shown below:

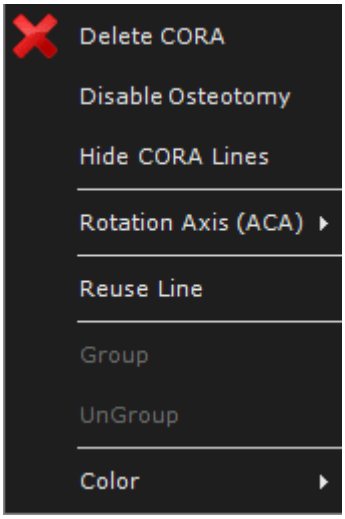


4. Zoom in the image to better see where the lines intersect.

   The CORA (dashed line) and the osteotomy lines (orange line) are indicated at the intersection between the tools and it shows its bisectoral angle, which is 16° in this example. Both lines appear on top of each other by default.
   You can move the osteotomy line to where you plan to perform the osteotomy. By default, it is positioned on the CORA.



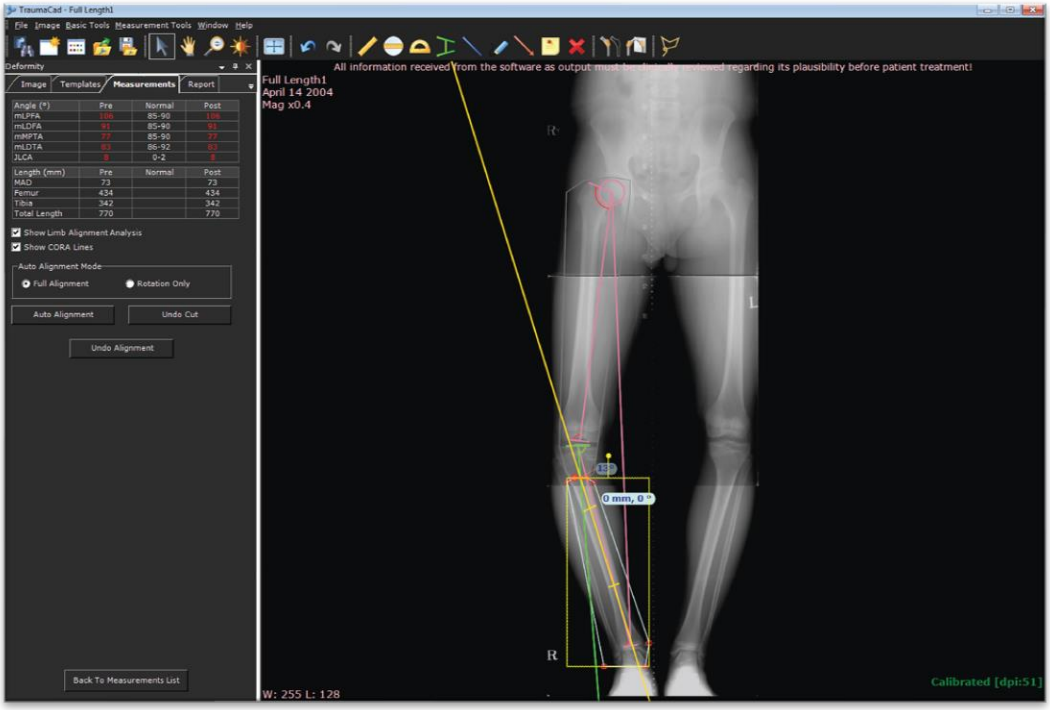
   The following options are provided when you right-click the CORA:



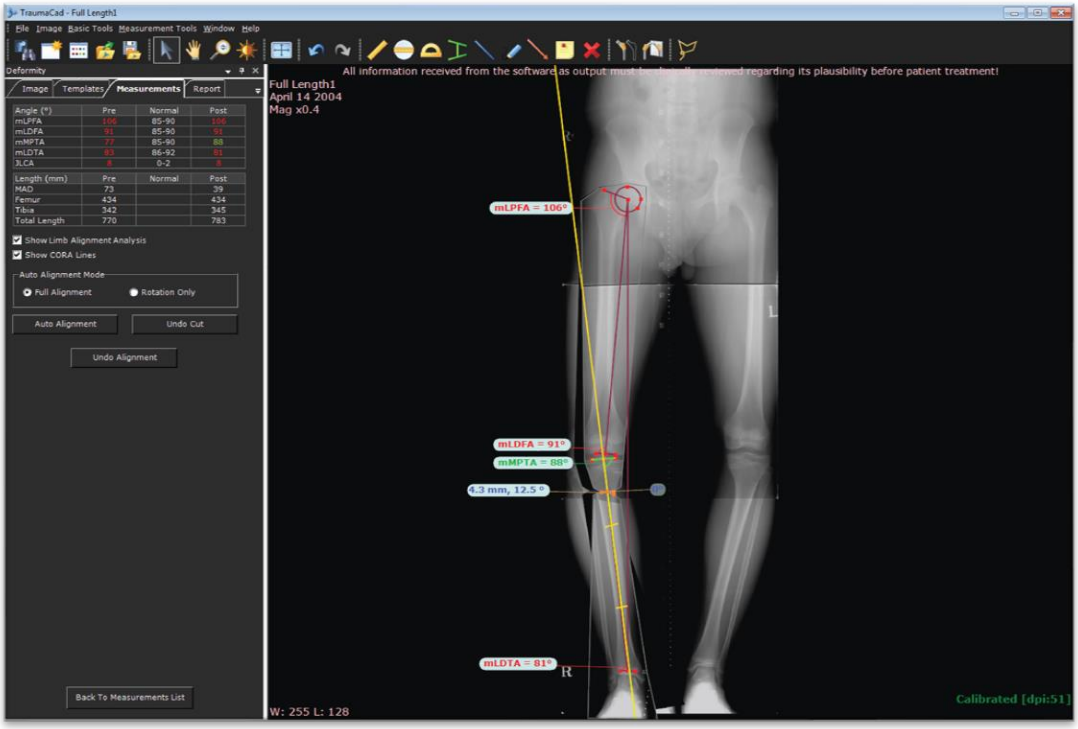
- **Delete CORA**: Deletes the selected CORA from the image.
- **Disable Osteotomy**: Hides the osteotomy line in the image, but leaves the CORA.
- **Hide/Show CORA Lines**: Hides/shows the CORA lines in the image.
- **Rotation Axis (ACA)**: After the level of osteotomy is defined, the type of wedge can be selected (open, closed, neutral [through the CORA]), or Manually Positioned Center of Rotation can be selected for the moving the fragment.
- **Reuse Line**: Automatically creates another CORA line (for example CORA 2) with the same definitions, which you can then modify.
- **Color**: Enables you to specify the color of the tools in the image.

5. In the **Measurements** tab Wedge section, select either the **Open**, **Neutral** or **Close** osteotomy wedge. You can also right-click the osteotomy line and select the **Rotation Axis (ACA)** ➔ **User Defined** option, and then the wedge point can be manually moved to any location.
6. To perform multiple osteotomies, you can add another CORA by clicking the **Add CORA** button. After you add another CORA, it appears as a tab in the **Measurements** tab.

   Up to four CORAs can be added.
7. Click the **Finish and Cut** button. Fragments of the image are then automatically created around the osteotomy line, one on the top and one on the bottom, as shown in the following image:



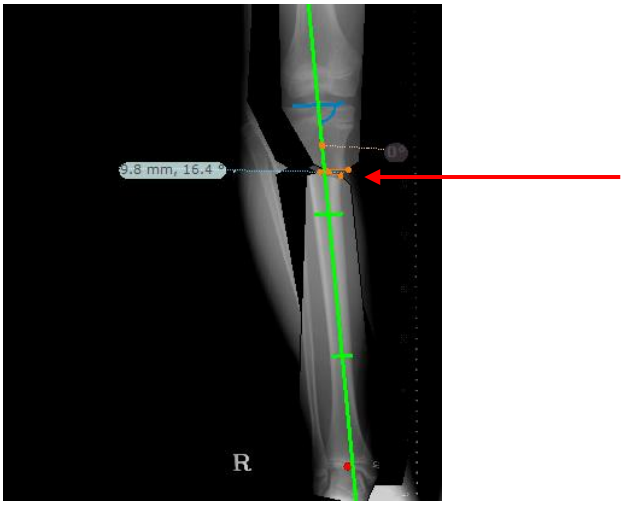
8. If you want to automatically align the leg, select either the **Full Alignment** option or the **Rotation Only** option in the **Measurements** tab. Full alignment performs both translation and rotation.
9. To automatically align the leg, click the **Auto Alignment** button in the **Measurements** tab. The image fragments of the leg are then automatically aligned, as shown below:



The new mechanical angles of the axes are shown in the **Post** column of the **Measurements** tab.

10. Check the values that appear in the **Measurements** tab. Normal values appear green and abnormal values appear red.

    The angle and opening of the wedge are indicated as follows:



> **Note:** The **Undo Cut** button returns the image to the state it was before the **Finish and Cut** button was clicked. The **Undo Alignment** button returns the image to the state it was before the **Auto Alignment** button was clicked.

11. At any stage, you can manually align the femur and tibia fragments by clicking the fragments and moving them as required.

Taylor Spatial Frame

Taylor Spatial Frame (TSF) is an external fixator used to treat complex fractures and bone deformities. It is a hexapod device based on a Stewart platform, which consists of two aluminum rings connected by six struts. Each strut can be independently lengthened or shortened. Connected to a bone by wires or half pins, the attached bone can be manipulated in six axes. Angular, translational, rotational and length deformities can all be corrected simultaneously with the TSF.

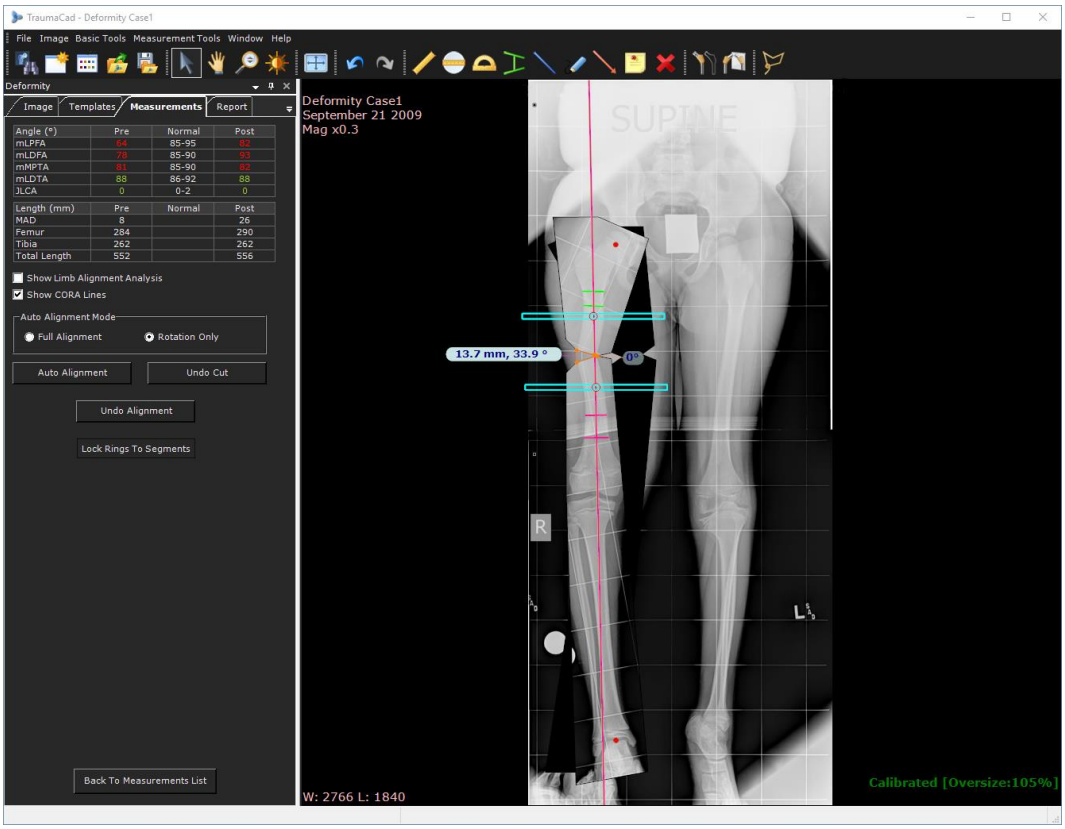
The TSF wizards offer pre-operative planning on long-leg images and post-operative evaluation on the x-ray images with the TSF device. The post-op case values can be used on the SpatialFrame.com website to generate according prescriptions.

Taylor Spatial Frame – Pre Op

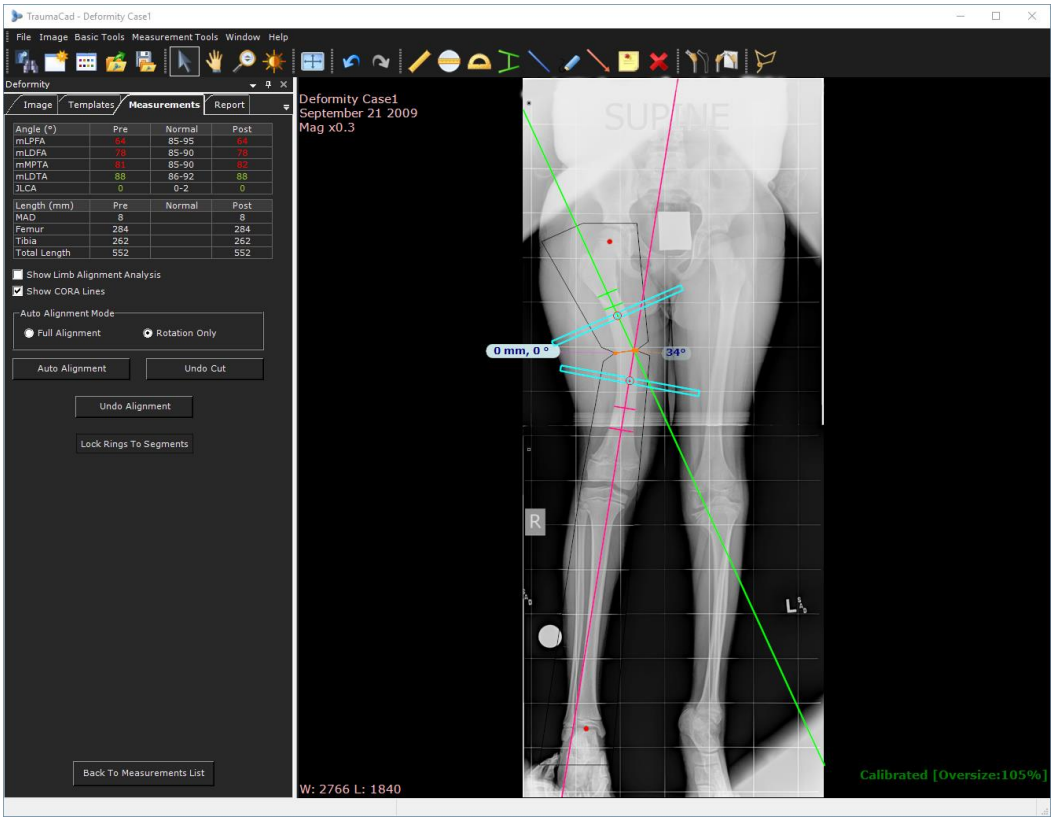
The pre-op planning allows you to analyze the limb alignment, define osteotomies based on the CORA method and planning ring positions on long leg films.

▶ **To use the Taylor Spatial Frame Pre Op tool:**

1. The wizard guides you through limb alignment analysis as described in the Limb Alignment Analysis section, followed by CORA planning using the same tools as described above. Follow all the wizard steps, including **Finish and Cut** (mandatory) and **Auto Alignment** (optional). Once the osteotomy planning is ready, the TSF rings can be added to the plan.
2. To insert rings, go to the **Templates** tab and choose the desired ring templates. Position the rings in the correct location and press the **Lock Rings to Segments** button to associate them with the segments. The rings can still be moved even when locked. At any point you can release the ring/segment association by pressing the **Lock Rings to Segments** button again.



3. Once planning is completed and rings are correctly positioned, select the **Undo Alignment** option in order to bring the segments and rings back to the pre-op state.



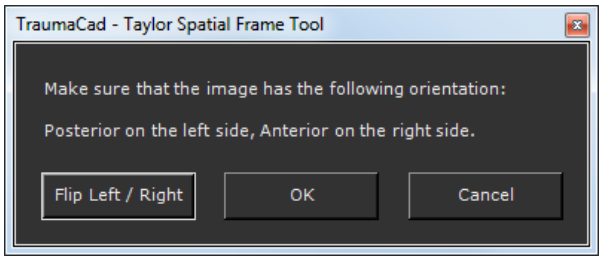
Taylor Spatial Frame – Post Op

In the TSF Post Op evaluation tool, you position the rings and the master tab in their proper positions on two images: an AP image and a LAT image. Both images are required to use this tool. All required parameters for the use of the TSF device are calculated.

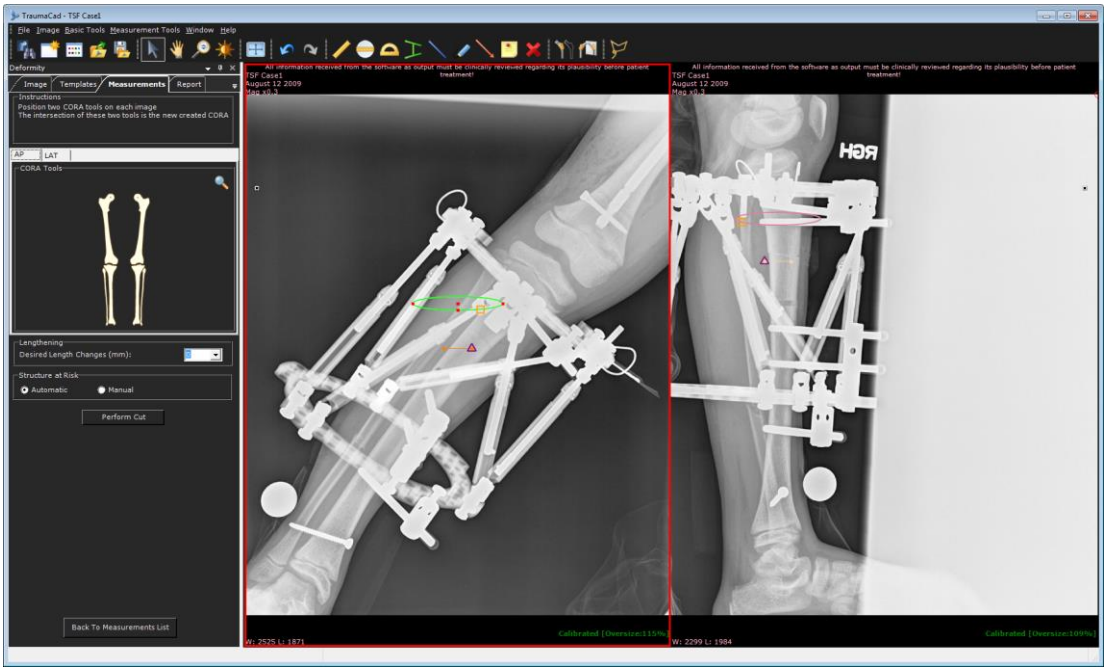
> **Warning!** Use of the TSF tool in TraumaCad presumes that the patient already has the required fixation device attached to his/her body and that the osteotomy has already been performed.
> Before using the TSF tool, be sure that the images were taken 90° perpendicular between them, or as close to 90° as possible.
> Before using the TSF tool, be sure that at least one of the two rings (which is the reference frame) in the image is as close as possible to being perpendicular to both images (AP and Lateral).

▶ **To use the Taylor Spatial Frame Post Op tool:**
The following window appears:

1. Ensure that the selected image is oriented so that the posterior is on the left and the anterior is on the right. If it is not, click **Flip Left/Right** to flip the image accordingly and then **OK**.

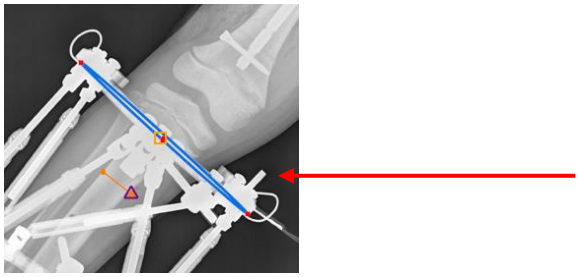


After the image has the proper orientation, the window displays as shown below:

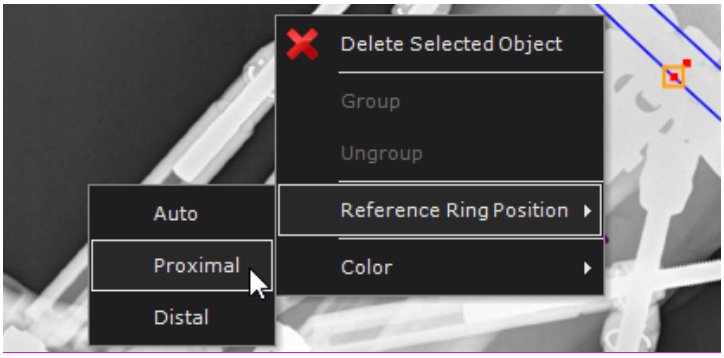


2. The window shows a ring representing the top frame in both images. Drag the entire ring so that it sits exactly on the proximal frame or the distal frame. Alternatively, you can drag the red dots to resize the ring. You should select the frame (proximal or distal) that is most perpendicular to both images. This frame serves as the *reference frame*, which must be perpendicular to the image plane.

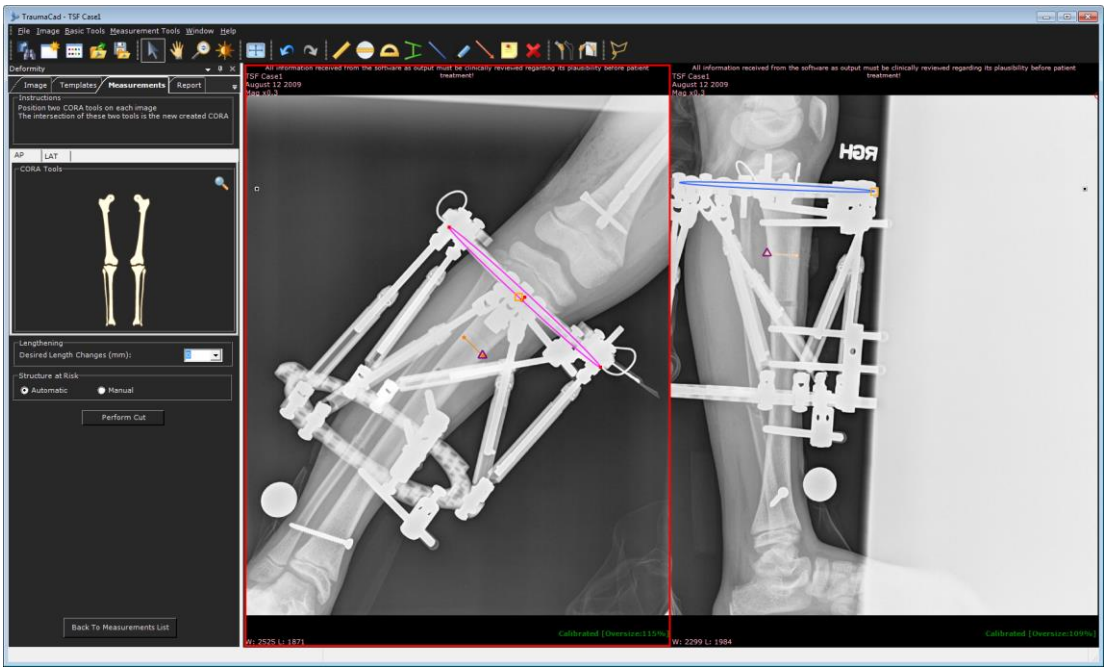
   Note that when you resize the frame on one image, it is automatically resized accordingly on the other image. The reference frame can only be moved in one image at a time.



If required, select the ring and open the right click menu to define the **Reference Ring Position**: Auto, Proximal or Distal.



3. Position the master tab, which is the small orange square ( ) on the right of the ring, on the reference frame so that it is located correctly in both images. Moving the master tab on one image automatically moves it correspondingly on the other image.

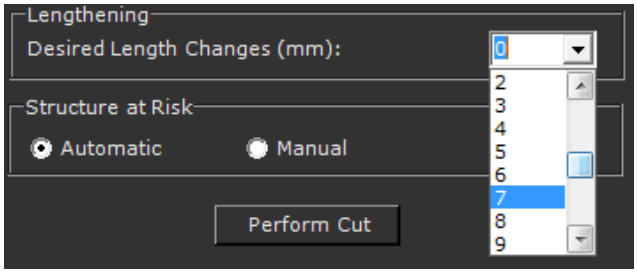


4. Position the osteotomy line (the orange line) on the osteotomy in both images. Note that when you move it on one image, it automatically moves on the other image.
5. The Structure at Risk (SAR) point appears on the osteotomy line . You can define the SAR using one of the following options:

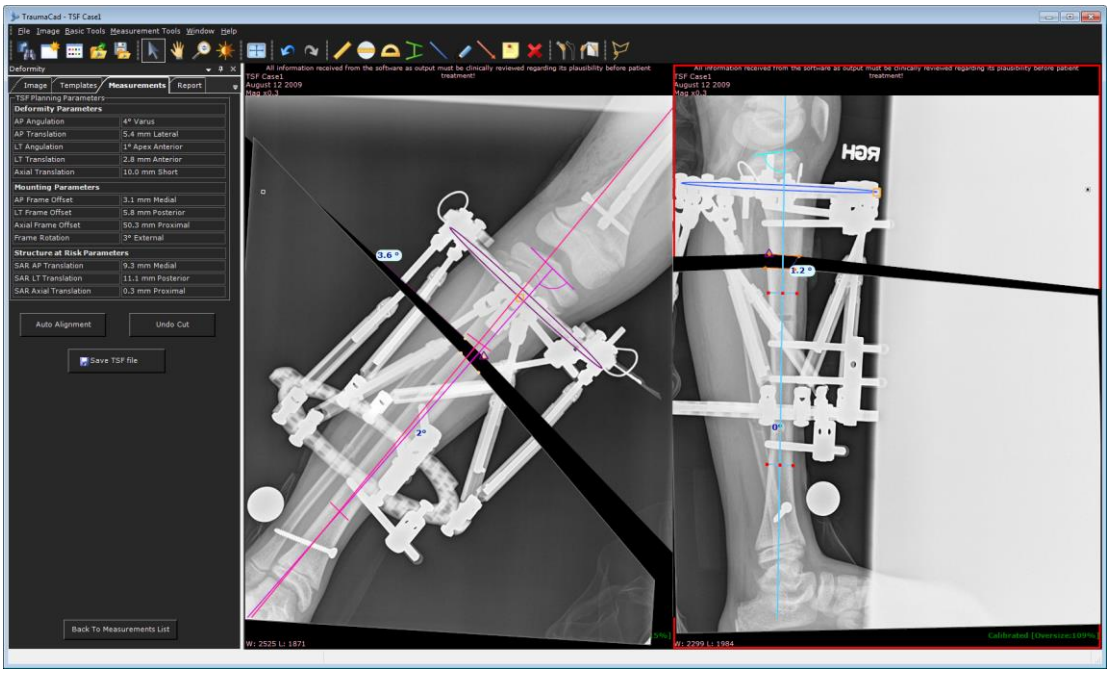
   - **Automatically:** Select the **Automatic** radio button in the Structure at Risk area to automatically place the SAR on the osteotomy side to be moved the most. Selecting this option always places the SAR triangle at the end of the orange line, as shown above.
   - **Manually:** Select the **Manual** radio button to position the SAR at a point of your choice on the image. When you select this option, the SAR triangle can be moved separately from the orange line.

6. Next, you define the target positions. In order to define the target position, you can optionally use the CORA tools and the **Desired Length Changes** options to obtain automatic positioning assistance (by clicking **Auto Alignment** after performing the cut), or you can skip these steps and define the target position manually after performing the cut.

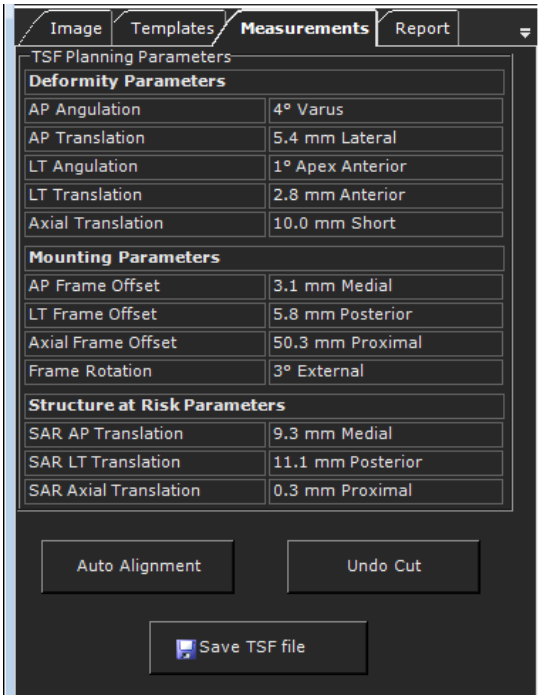
   For automatic positioning, use the default CORA tools and position them appropriately. For more details about using CORA tools, see page 116.
   When selecting this option, you must also specify the required length change in the **Desired Length Changes** field.



7. Then, perform the cut by clicking **Perform Cut**. This makes a fragment out of the segment under the osteotomy, which you then position in the correct location on the image.



8. The fragment can be moved automatically or manually. To automatically position the fragment, click **Auto Alignment**. This option positions the fragment on the image, based on the CORA lines placement and the **Desired Length Changes** (as defined before performing the cut). Alternatively, you can manually position the fragment by dragging, moving or rotating it so that it is in the correct location.



The TSF Planning Parameters area shows all calculated parameters for the Taylor Spatial Frame tool.

9. Click **Save TSF File** to save calculated parameters to a file.

TRAUMA MEASUREMENTS

The following trauma measurements can be made using TraumaCad measurements tools:

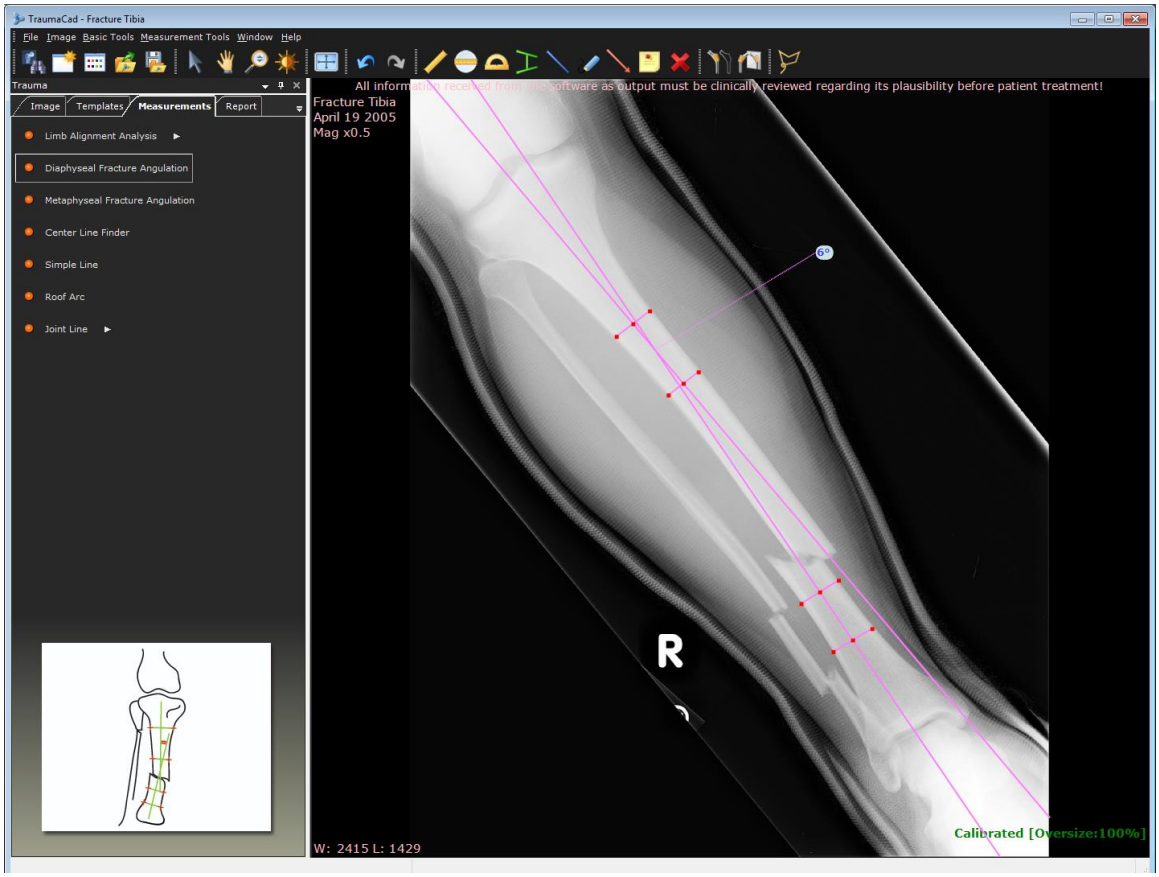
- **Limb Alignment Analysis**, page 129
- **Diaphyseal Fracture Angulation**, page 129
- **Metaphyseal Fracture Angulation**, page 130
- **Center Line Finder**, page 130
- **Simple Line**, page 130
- **Joint Line**, page 130
- **Roof Arc**, page 131

Limb Alignment Analysis

A wizard opens to guide you through the usage of the tool, as described on page 112.

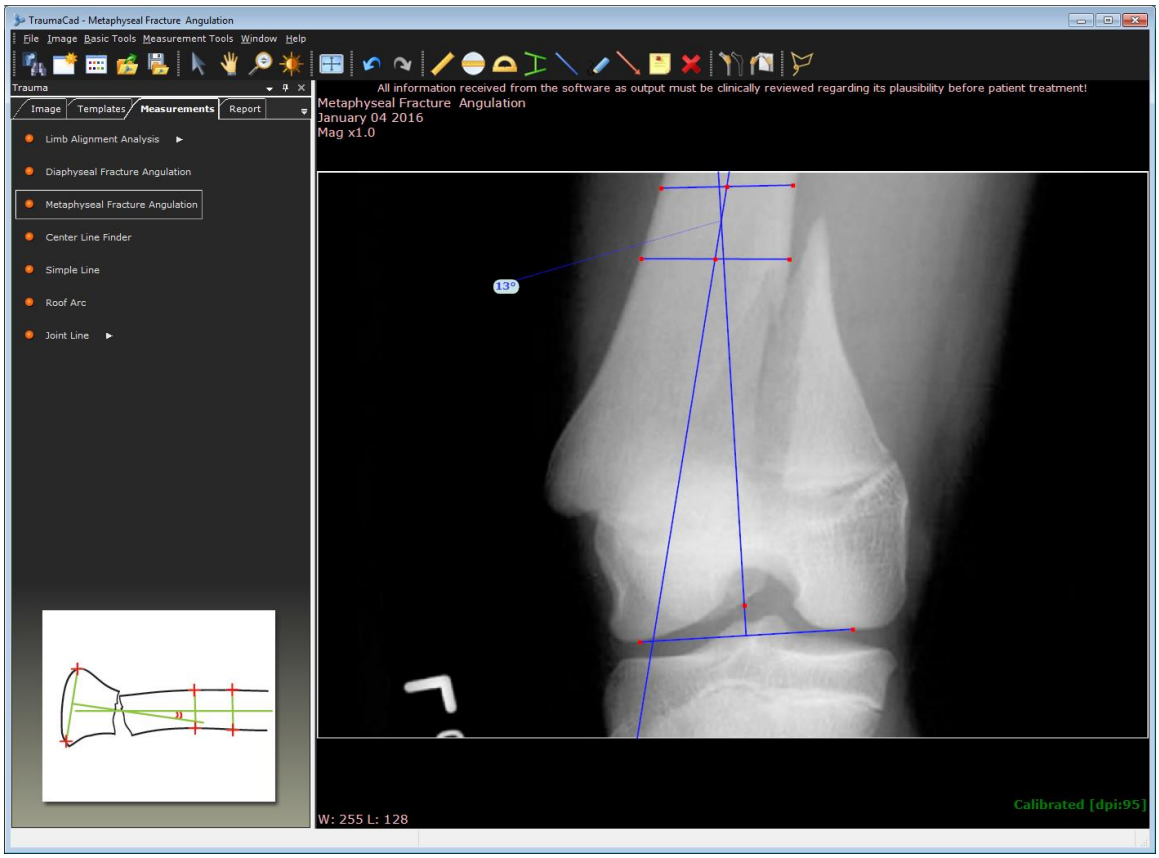
Diaphyseal Fracture Angulation

This measurement tool measures the angle between the long axes of two long bones. The points are adjusted to the edges of the bones and the angle between their center lines is measured and displayed.



Metaphyseal Fracture Angulation

This tool measures the angle between the long axis of a long bone and the joint line of the bone. The points are adjusted to the edges of the bone and its articular surface and the angle between them is measured and displayed.



Center Line Finder

The tool appears on the image. This tool works as described in *Center Line Finder* on page 96.

Simple Line

The tool appears on the image. This tool works as described in the *Simple Line* section on page 97.

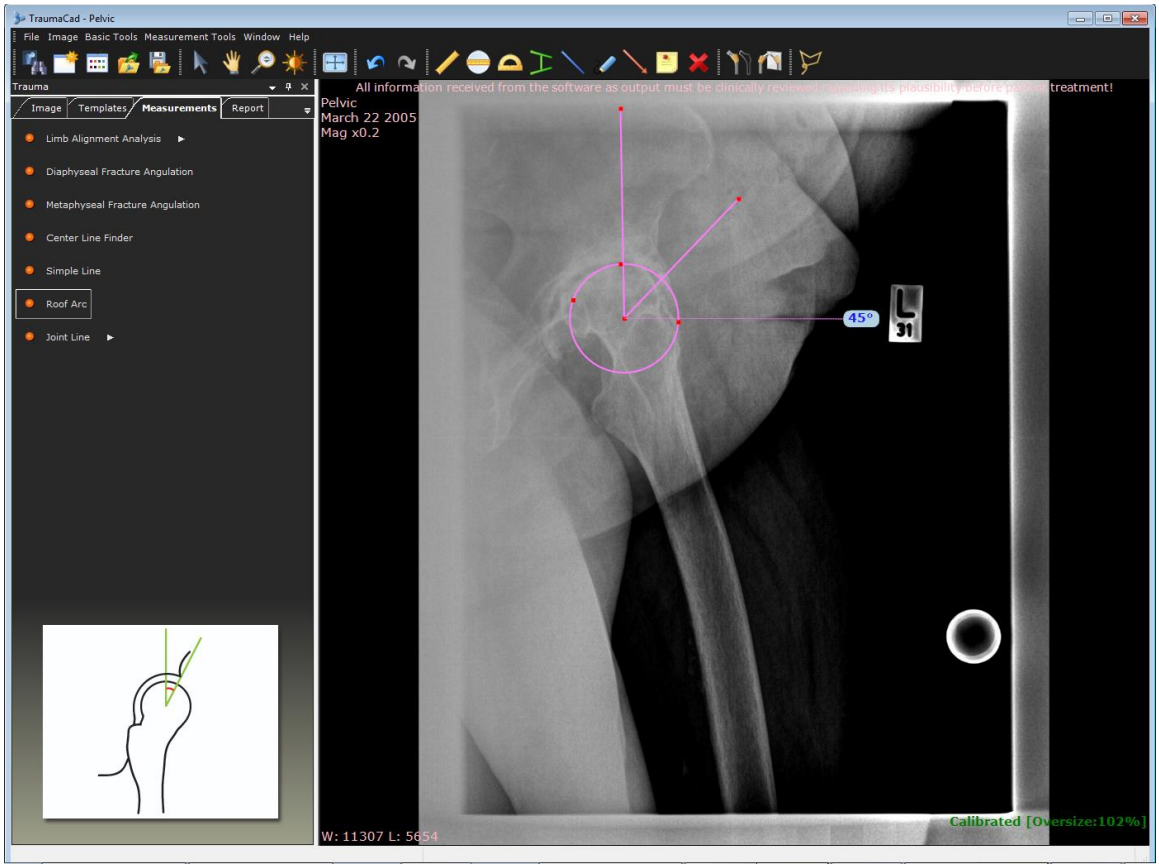
Joint Line

The tool appears on the image. This tool works as described in the *Joint Line* section on page 99.

Roof Arc

The roof arc concept was originally described by Matta. It helps determine the amount of intact acetabular dome and is a useful method for determining the need for surgery. Measurements are made on AP, obturator and iliac oblique views, as follows:

- A vertical line is drawn to the geometric center of the acetabulum.
- Another line is drawn through a point where a fracture line intersects the acetabulum and again to the geometric center of the acetabulum.
- Angles drawn in this way represent medial, anterior or posterior roof arcs as seen on AP, obturator oblique or iliac views, respectively.



SPINE MEASUREMENTS

The following spine measurements can be made using TraumaCad measurements tools:

- **Cobb Angle**, page 133
- **Double Cobb Angle**, page 134
- **Triple Cobb Angle**, page 134
- **Vertebrae Labeling**, page 135
- **Clavicle Angle**, page 137
- **Coronal Balance**, page 138
- **Sagittal Balance**, page 139
- **Lumbar Lordosis Angle**, page 140
- **Pelvic Radius Angle**, page 141
- **Sacral Obliquity**, page 142
- **Spine Slip Angle**, page 143
- **Spondylolysthesis**, page 144
- **T1 Tilt Angle**, page 146
- **Thoracic Kyphosis Angle**, page 147
- **Thoracic Trunk Shift**, page 148

Cobb Angle

The **Cobb Angle** measurement is used for evaluation of curves in scoliosis on an AP radiographic projection of the spine.

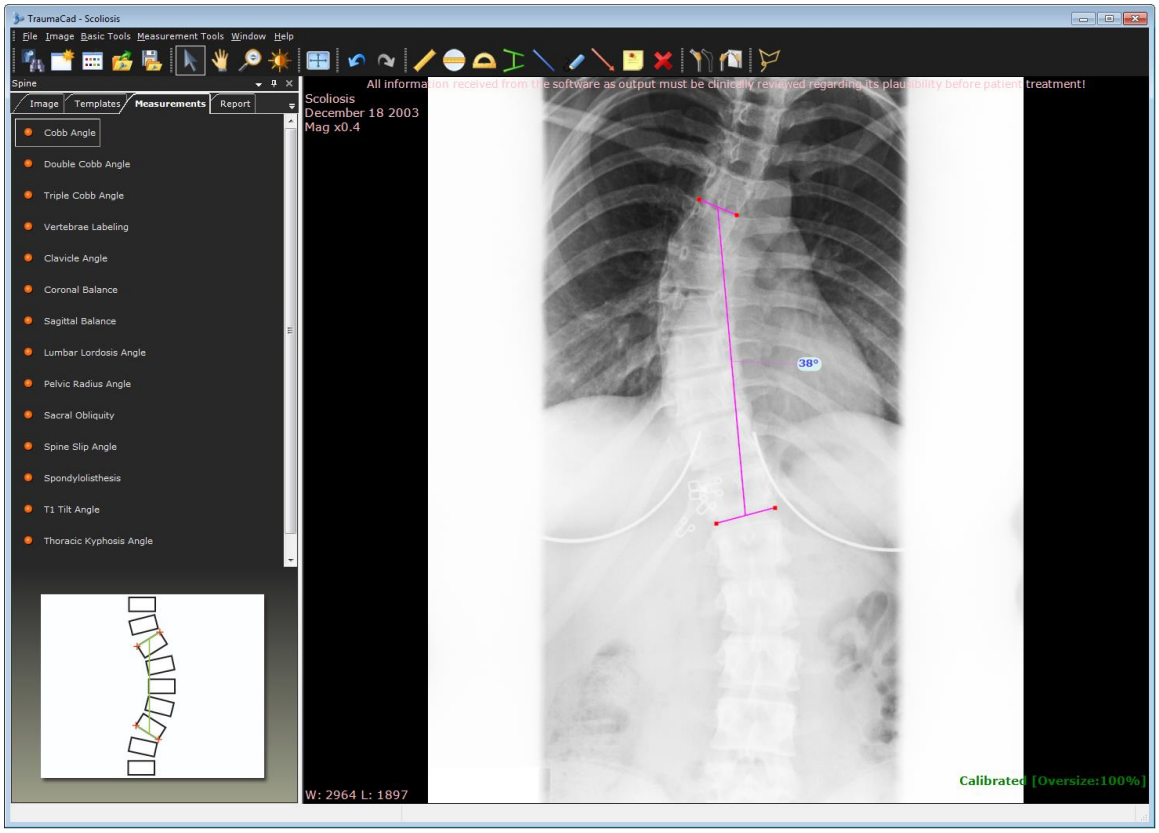
When assessing a curve, the apical vertebra is first identified. This is the most likely displaced and rotated vertebra with the least-tilted endplate. The end/transitional vertebra are then identified through the curve above and below. The end vertebrae are the most superior and inferior vertebrae that are least displaced and rotated and have the maximally tilted endplate.

A line is drawn along the superior endplate of the superior end vertebra and a second line is drawn along the inferior endplate of the inferior end vertebra. The angle between these two lines is measured as the Cobb angle.

In S-shaped scoliosis, where there are two contiguous curves, the lower-end vertebra of the upper curve represents the upper-end vertebra of the lower curve. In some cases, there may be a third contiguous curve.

As a general rule, a Cobb angle of 10° is regarded as a minimum angulation to define scoliosis.

- **To use the Cobb angle wizard:**
  - Follow the 4 steps in the wizard to mark measurement points on the image. When completed you can fine-tune the measurements by dragging points to a new position.



Double Cobb Angle

The **Double Cobb Angle** measurement tool works the same as the Cobb Angle tool. See page 133 for more details.

Triple Cobb Angle

The **Triple Cobb Angle** measurement tool works the same as the Cobb Angle tool. See page 133 for more details.

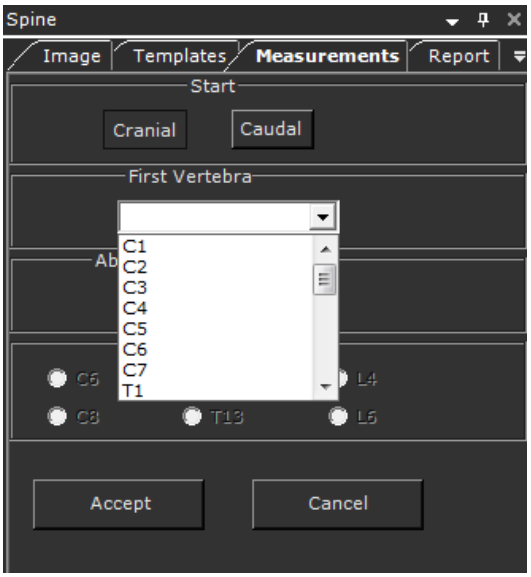
Vertebrae Labeling

This tool enables you to label spine vertebrae. There are various kinds of vertebrae, including:

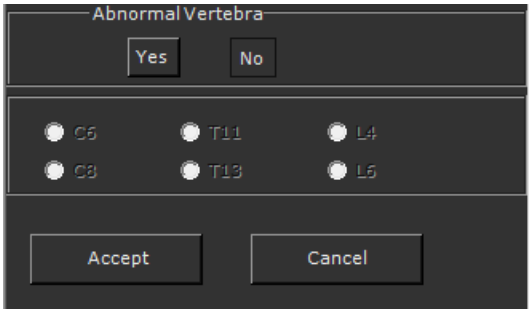
- Cervical, designated by **C** on the image
- Thoracic, designated by **T** on the image
- Lumbar, designated by **L** on the image

▶ **To use the Vertebrae Labeling tool:**

1. Click the **Cranial** button to start labeling from cranial (superior) to caudal vertebrae (downwards), or click the **Caudal** button to label from a lower vertebra upwards.
2. Select the first vertebra to label in the **First Vertebra** dropdown list, as shown below:

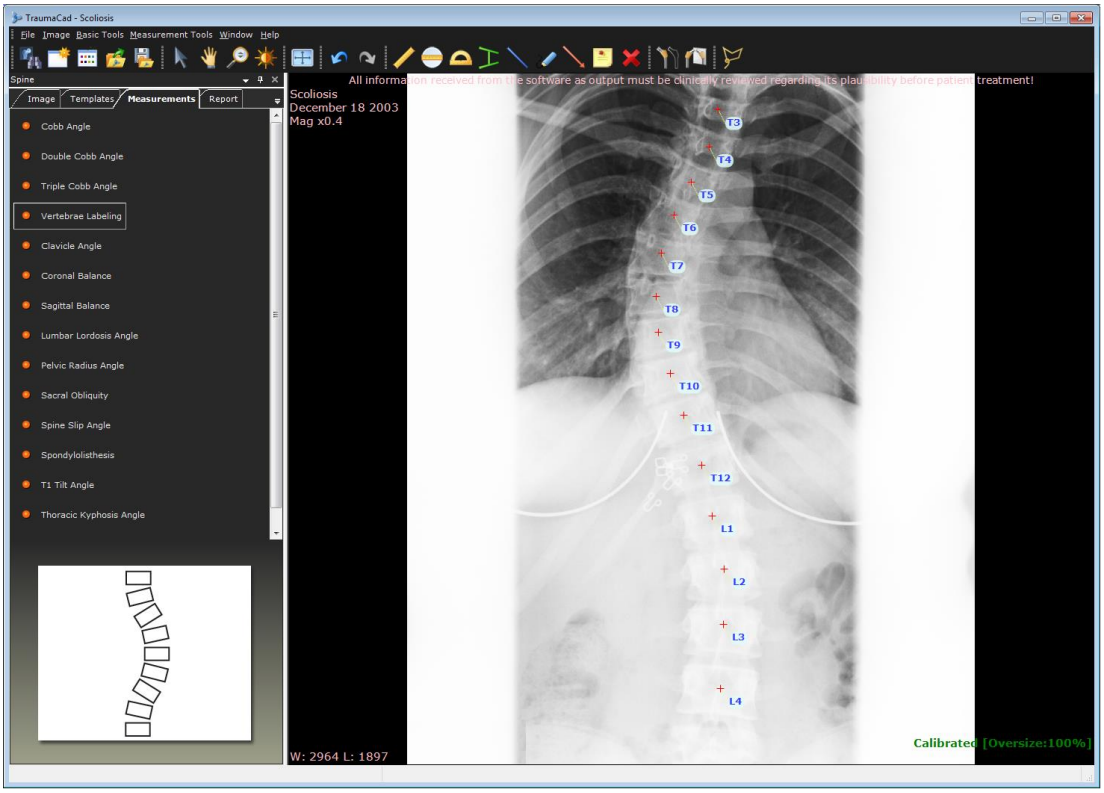


3. Click the **Yes** or **No** button, as appropriate, to indicate whether there are abnormal vertebrae. If you select **Yes**, select the appropriate radio button(s) for the abnormal vertebra(ae).



4. Click **Accept** to label the first vertebra.
5. Click the first vertebra you want to label, as described in step **3** above. The label is added to the image.

6. Repeat step **5** as many times as needed to label adjacent vertebrae in the direction defined in step **1**. TraumaCad automatically labels the next vertebra. It also takes any abnormal vertebrae into account for this purpose.



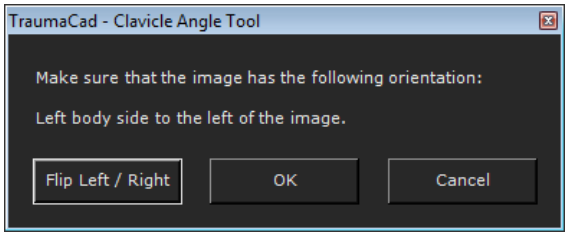
7. After you have labeled the vertebrae in the image, click **Finish**. You can move the labels on the image using standard TraumaCad methods.

Clavicle Angle

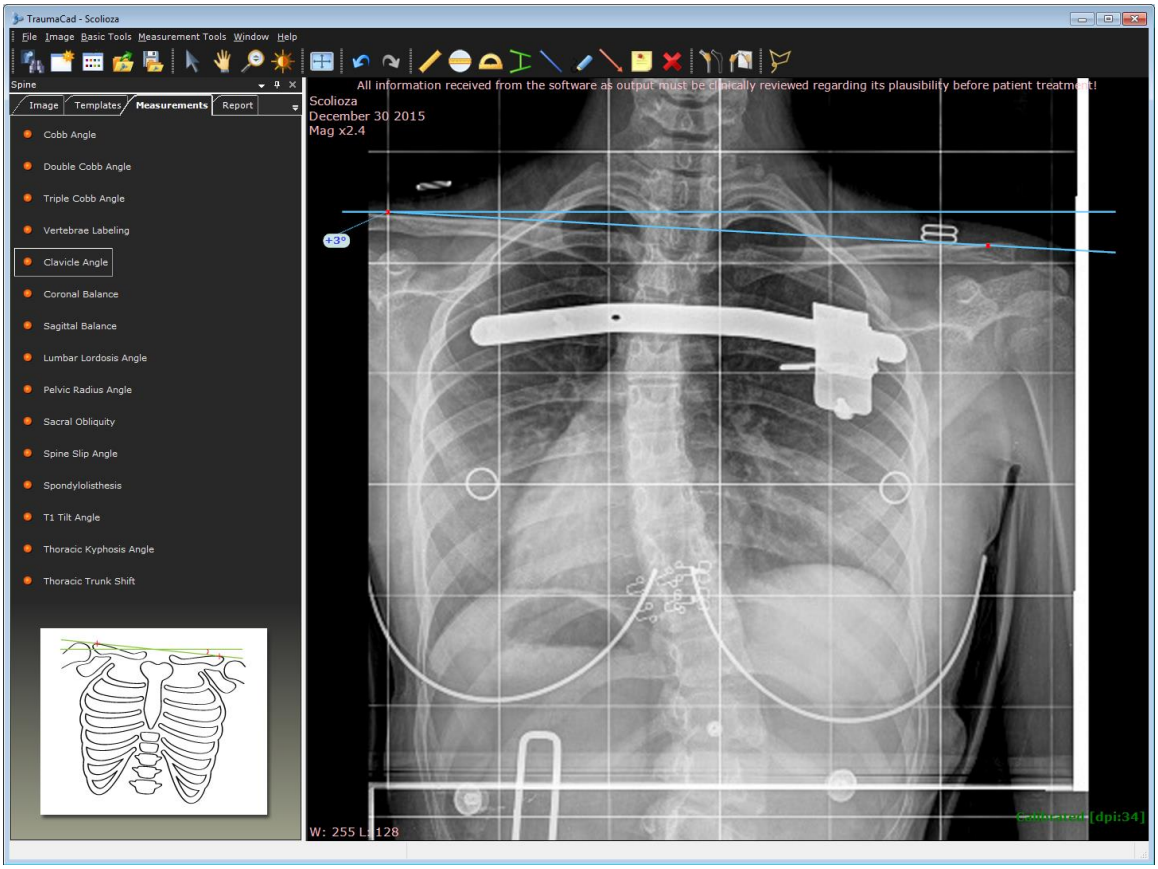
The Clavicle Angle tool evaluates shoulder balance by measuring the horizontal tilt of T1 and the clavicle angle.

▶ **To use the Clavicle Angle tool:**

When the tool is started the following message appears.



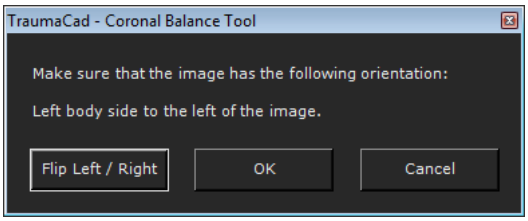
1. Ensure that the selected image is oriented so that the left body side is on the left and the right body side is on the right. If it is not, click **Flip Left/Right** to flip the image accordingly and then **OK**.
2. The tool appears on the image. You can drag the points to change the angle of the tool.



Coronal Balance

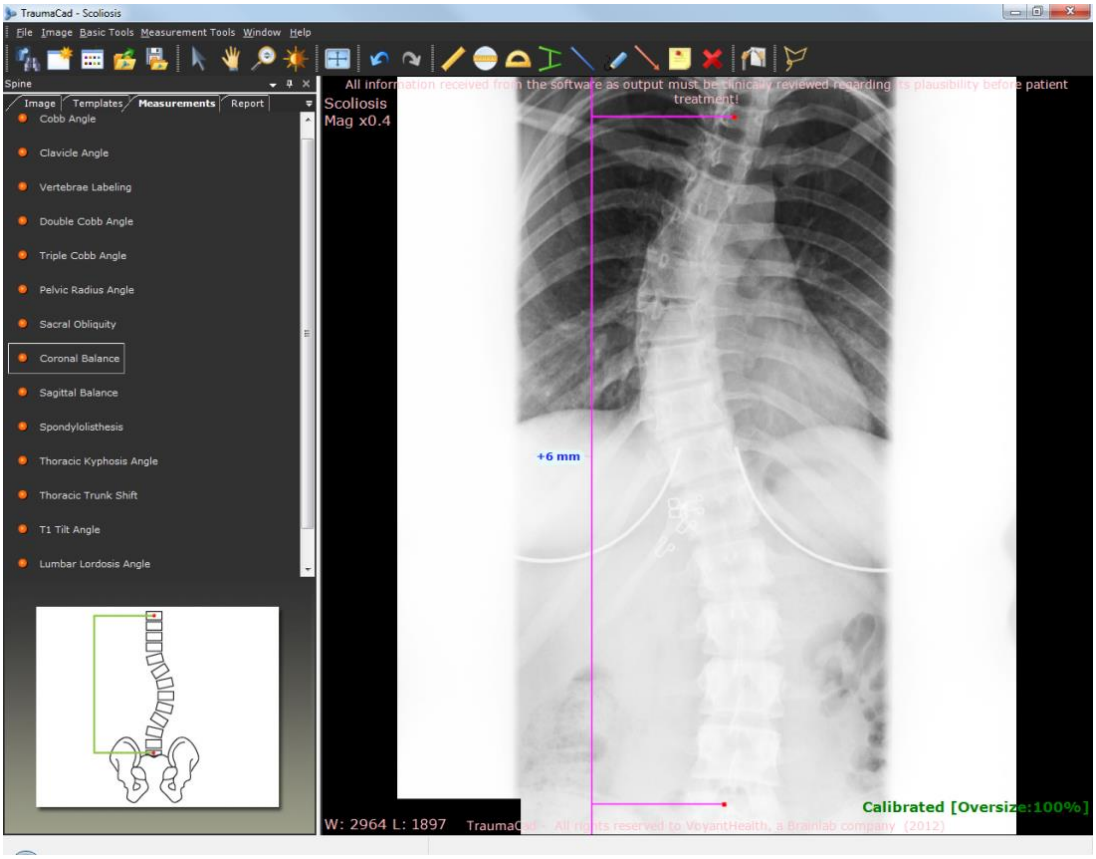
This tool measures the alignment of the spine on the coronal plane. The horizontal distance between the midpoints of the C7 body to the center of the sacrum on an upright long cassette PA radiograph of the spine is measured and displayed.

- When the tool is started the following message appears.



- Ensure that the selected image is oriented so that the left body side is on the left and the right body side is on the right. If it is not, click **Flip Left/Right** to flip the image accordingly and then **OK**.

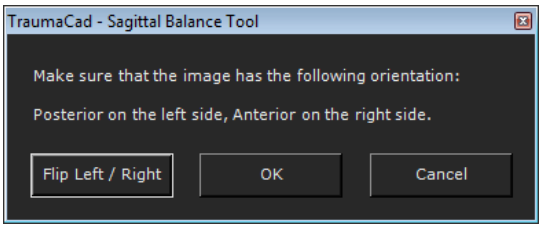
  The tool appears on the image, as shown below.



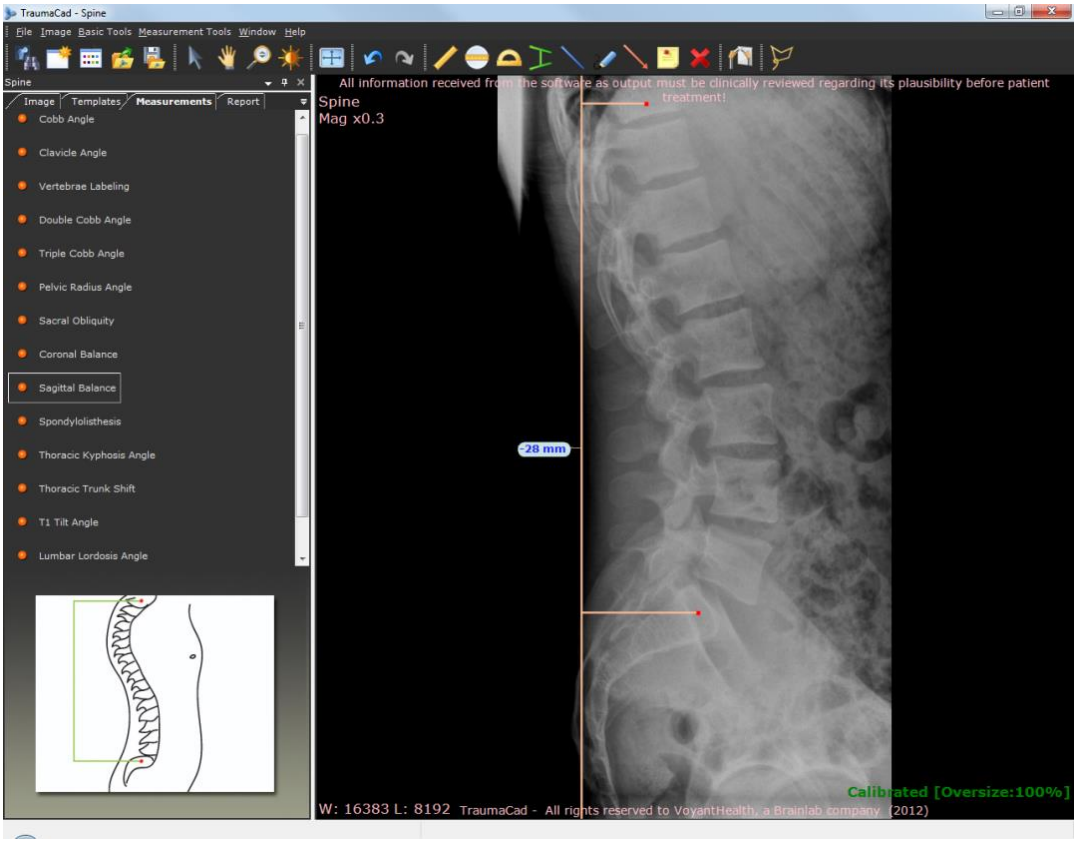
Sagittal Balance

This tool measures the alignment of the spine on the sagittal plane. The horizontal distance between the midpoints of the C7 body to the posterior superior corner of the sacrum on an upright long cassette lateral radiograph of the spine is measured and displayed.

- When the tool is started the following message appears.

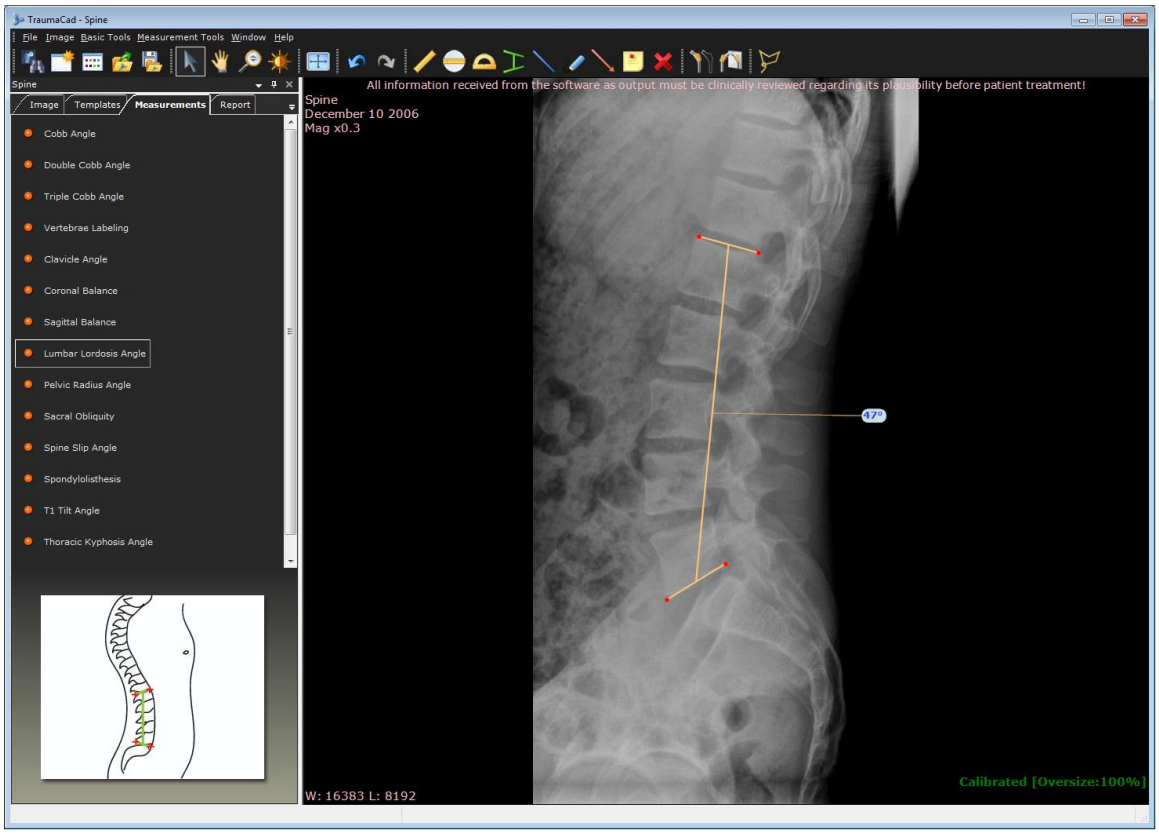


- Ensure that the selected image is oriented so that the posterior is on the left and the anterior is on the right. If it is not, click **Flip Left/Right** to flip the image accordingly and then **OK**.



Lumbar Lordosis Angle

This tool measures the anterior convex angulation of the lumbar spine. The recommended measurement of lumbar lordosis from a lateral radiograph is the angle between the superior endplate of L-1 and the superior endplate of S-1.



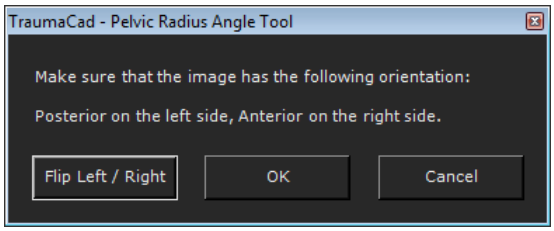
Pelvic Radius Angle

There are three different measurements that are used to describe pelvic morphology, based on sagittal plane radiographic measurements:

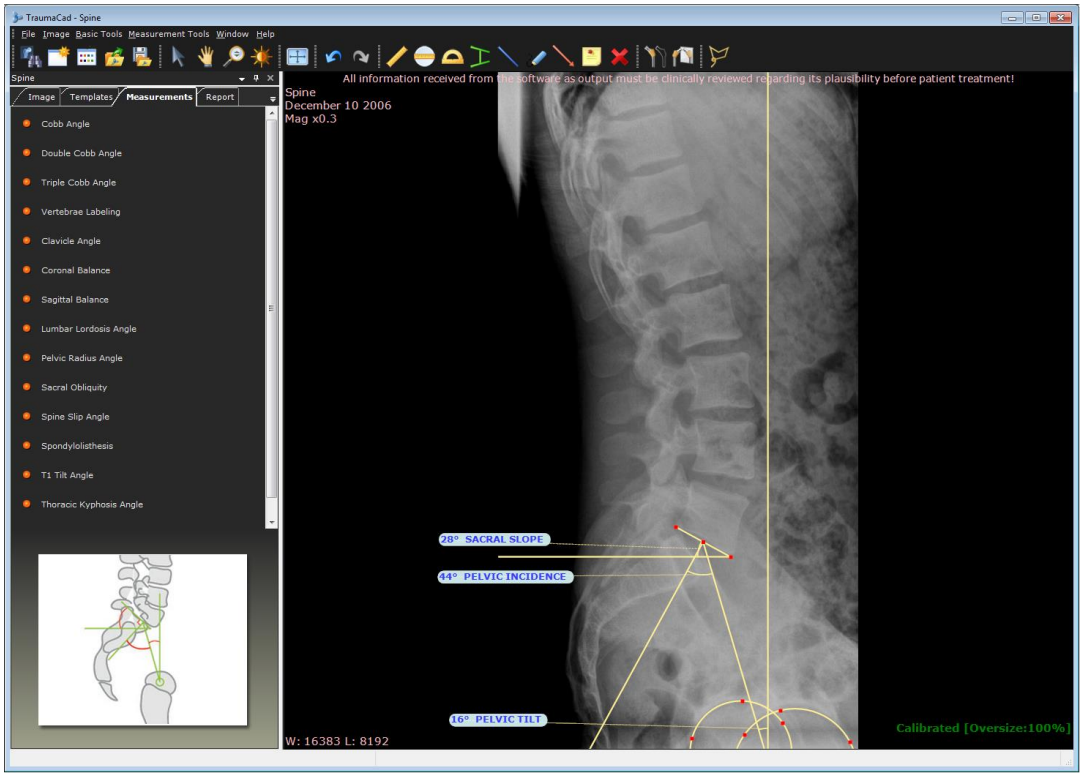
- **Sacral Slope (SS)**, which represents the angle between a line tangent to the sacral endplate and the horizontal reference line
- **Pelvic incidence (PI)**, represents the angle formed between the perpendicular to the tangent of the sacral endplate and a line connecting the center of the average hip joint and the center of sacral endplate
- **Pelvic tilt (PT)**, which represents the angle between a line connecting the center of the average hip joint and the center of sacral endplate to the vertical reference line

The SS, PI and PT are very similar and are equally good methods to assess pelvic morphology.

- When the tool is started the following message appears.

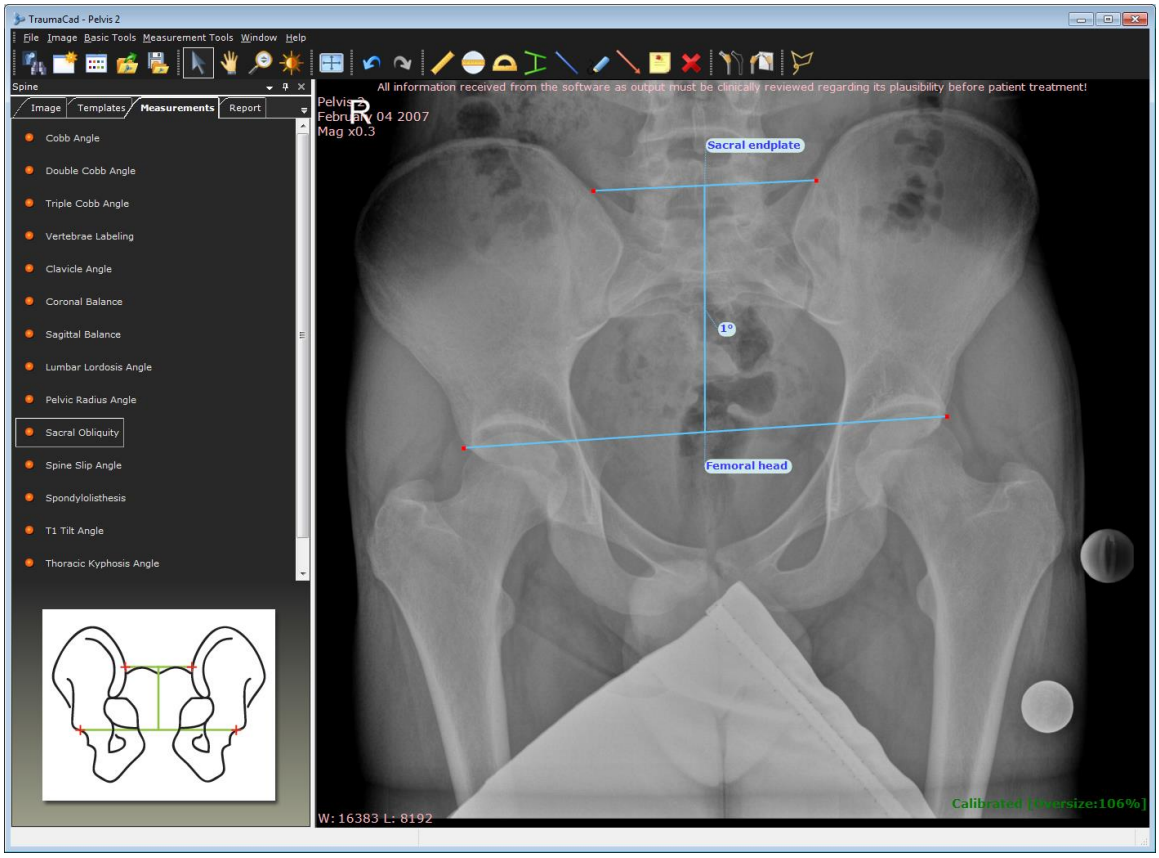


- Ensure that the selected image is oriented so that the posterior is on the left and the anterior is on the right. If it is not, click **Flip Left/Right** to flip the image accordingly and then **OK**.



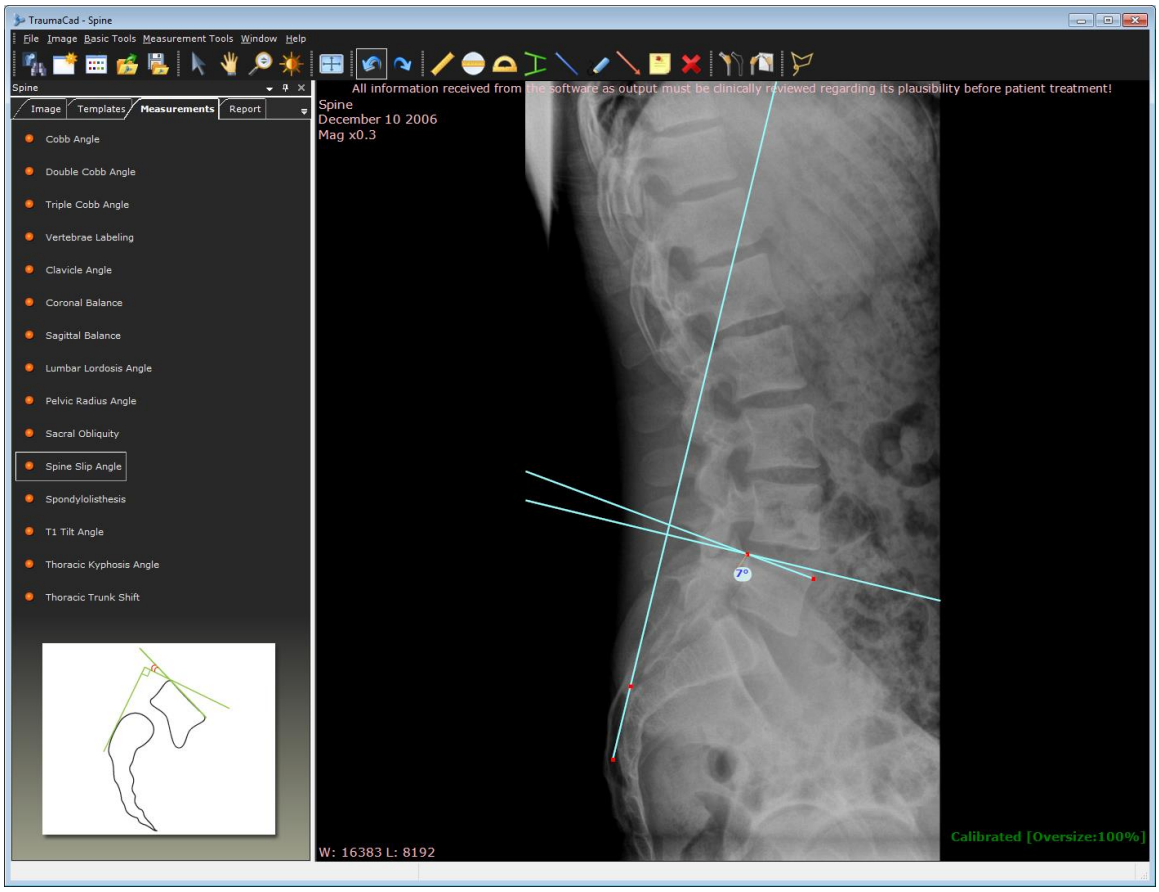
Sacral Obliquity

This tool measures the angular deviation of the sacrum from the line drawn parallel to a line across the femoral heads on a supine AP view of the sacrum.



Spine Slip Angle

This tool measures the angle that is formed by extending a line along the superior endplate of the body of L5 until it intersects with a line that is perpendicular to a line that is drawn along the posterior border of the body of first sacral vertebra.



Spondylolysthesis

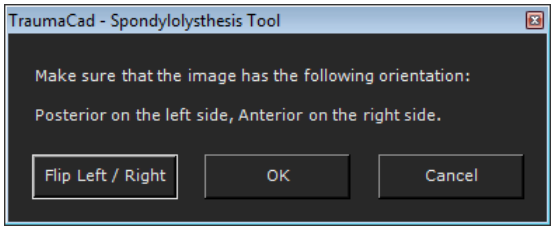
Spondylolysthesis is forward slippage of a vertebra onto the next vertebra below it. The most commonly used grading system for Spondylolysthesis is the one proposed by Meyerding in 1947.

The degree of slippage is measured as the percentage of distance the anteriorly translated vertebral body has moved forward relative to the superior endplate of the vertebra below. Classifications use the following grading system:

- **Grade 0:** No slippage
- **Grade 1:** 1-25% slippage
- **Grade 2:** 26-50% slippage
- **Grade 3:** 51-75% slippage
- **Grade 4:** 76-100% slippage
- **Grade 5:** Greater than 100% slippage (spondyloptosis)

▶ **To use the Spondylolysthesis tool:**

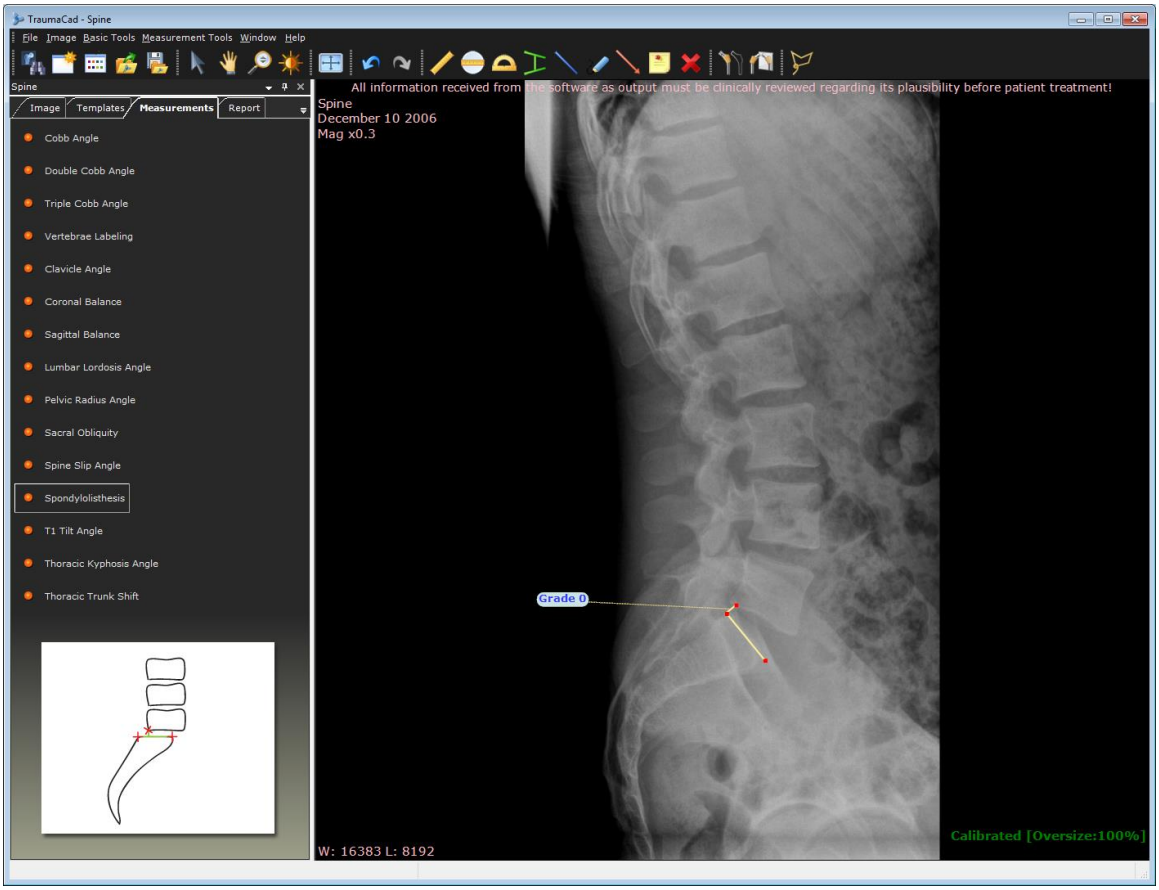
1. When the tool is started the following message appears.



2. Ensure that the selected image is oriented so that the posterior is on the left and the anterior is on the right. If it is not, click **Flip Left/Right** to flip the image accordingly and then **OK**.

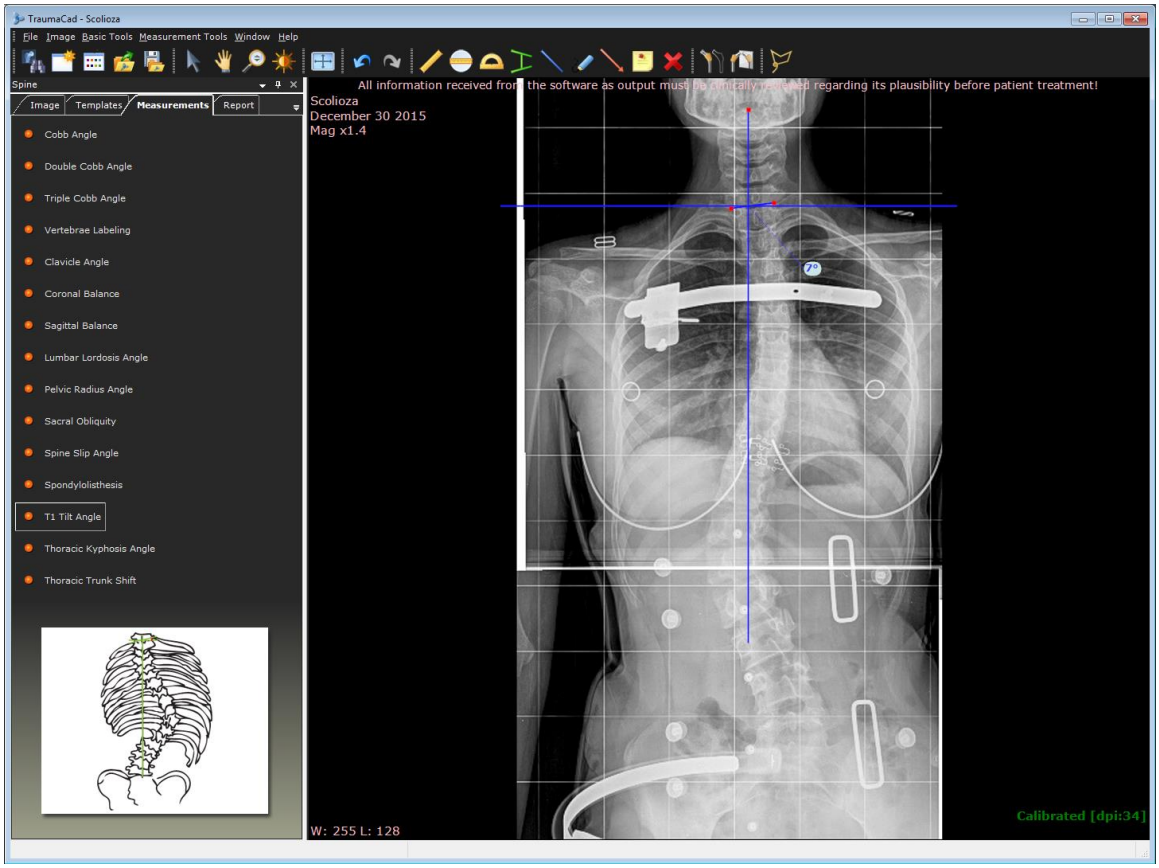
   The tool appears on the image.

3. You can drag the points to change the angle of the tool.


TraumaCad - Spine
File Image Basic Tools Measurement Tools Window Help
Spine
Image Templates Measurements Report
Cobb Angle
Double Cobb Angle
Triple Cobb Angle
Vertebrae Labeling
Clavicle Angle
Coronal Balance
Sagittal Balance
Lumbar Lordosis Angle
Pelvic Radius Angle
Sacral Obliquity
Spine Slip Angle
Spondylolisthesis
T1 Tilt Angle
Thoracic Kyphosis Angle
Thoracic Trunk Shift
All information received from the software as output must be clinically reviewed regarding its plausibility before patient treatment!
Spine
December 10 2006
Mag x0.3
Grade 0
W: 16383 L: 8192
Calibrated [Oversize:100%]

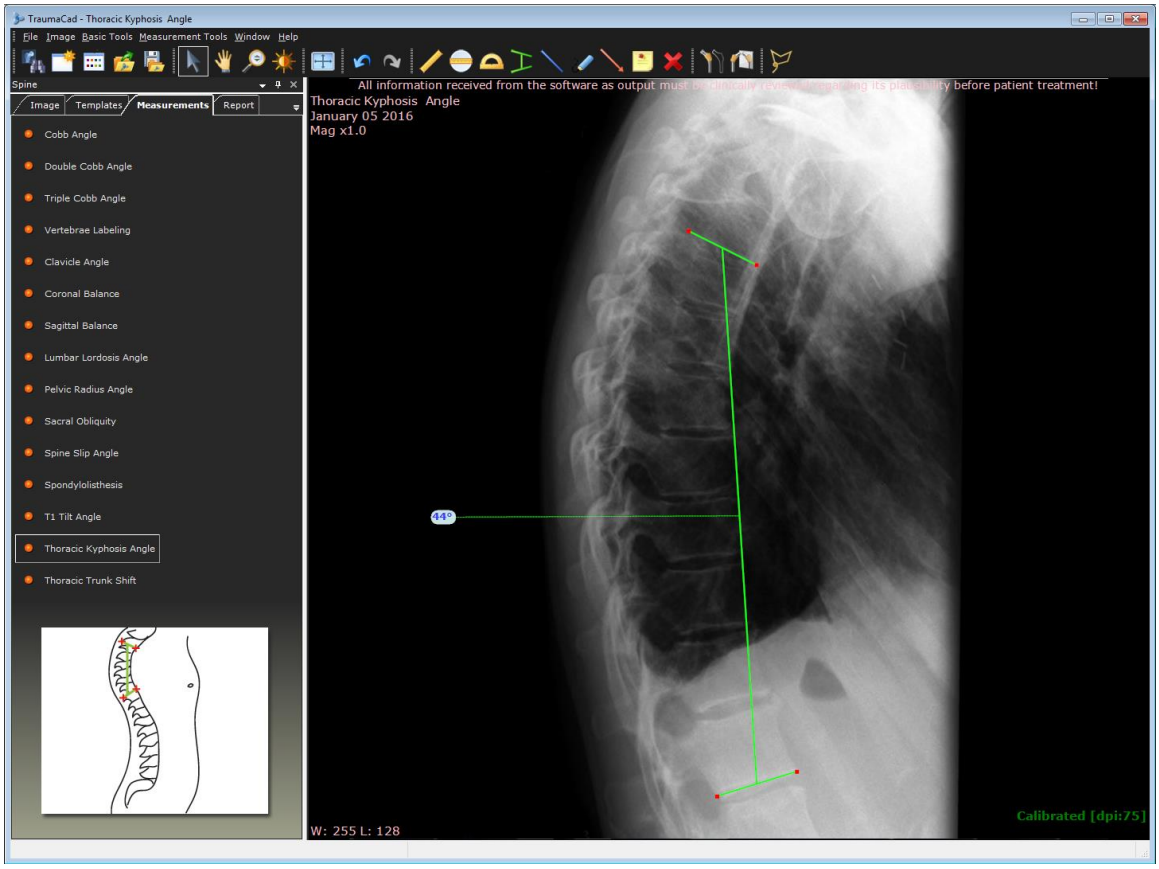
T1 Tilt Angle

This tool measures the angle between a line along the cephaled endplate of T1 to a line perpendicular to the vertical edge of the radiograph.



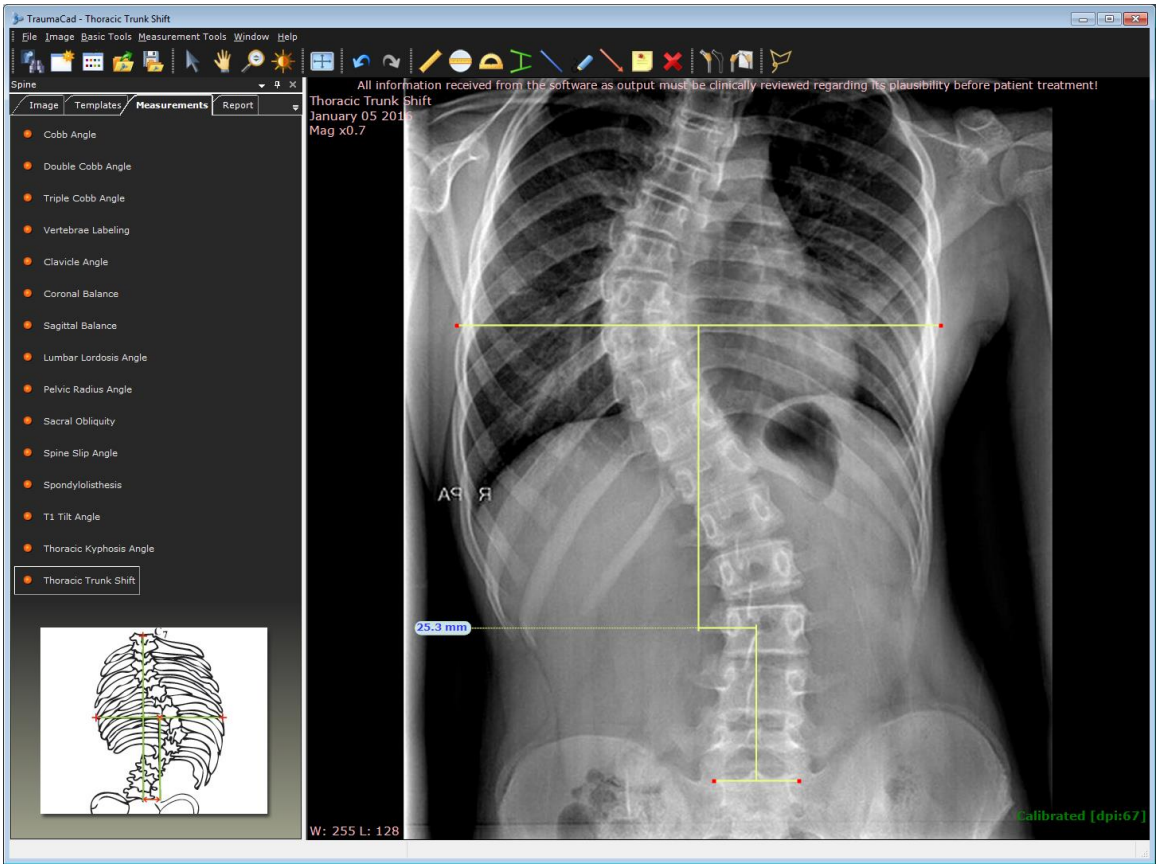
Thoracic Kyphosis Angle

This tool measures the posterior convex angulation of the thoracic spine. The recommended measurement of thoracic Kyphosis from a lateral radiograph is the angle between the superior endplate of the highest measurable thoracic vertebra, usually T-2 or T-3, and the inferior endplate of T-12.



Thoracic Trunk Shift

This tool measures the trunk shift from the center of a line at the height of the apical thoracic vertebra to the central sacral vertebral line.



FOOT AND ANKLE MEASUREMENTS

The following foot and ankle measurements can be made using TraumaCad measurements tools:

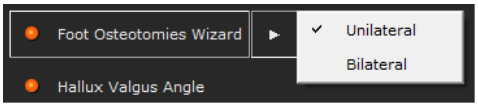
- **Foot Osteotomies Wizard**, page 150
- **Hallux Valgus Angle**, page 154
- **Hallux Valgus Interphalangeus Angle**, page 155
- **Intermetatarsal Angle**, page 156
- **DMAA - Distal Metatarsal Articular Angle**, page 157
- **PMAA - Proximal Metatarsal Articular Angle**, page 158
- **Talar Tilt**, page 159

Foot Osteotomies Wizard

The Foot Osteotomies Wizard enables orthopedic surgeons to take unilateral or bilateral anatomical measurements, compare them to normative standards and to simulate corrective procedures. Easy-to-use wizards help surgeons produce a wide range of anatomical measurements. Measurements and evaluations integrate into patient files for an easy transition to digital radiology.

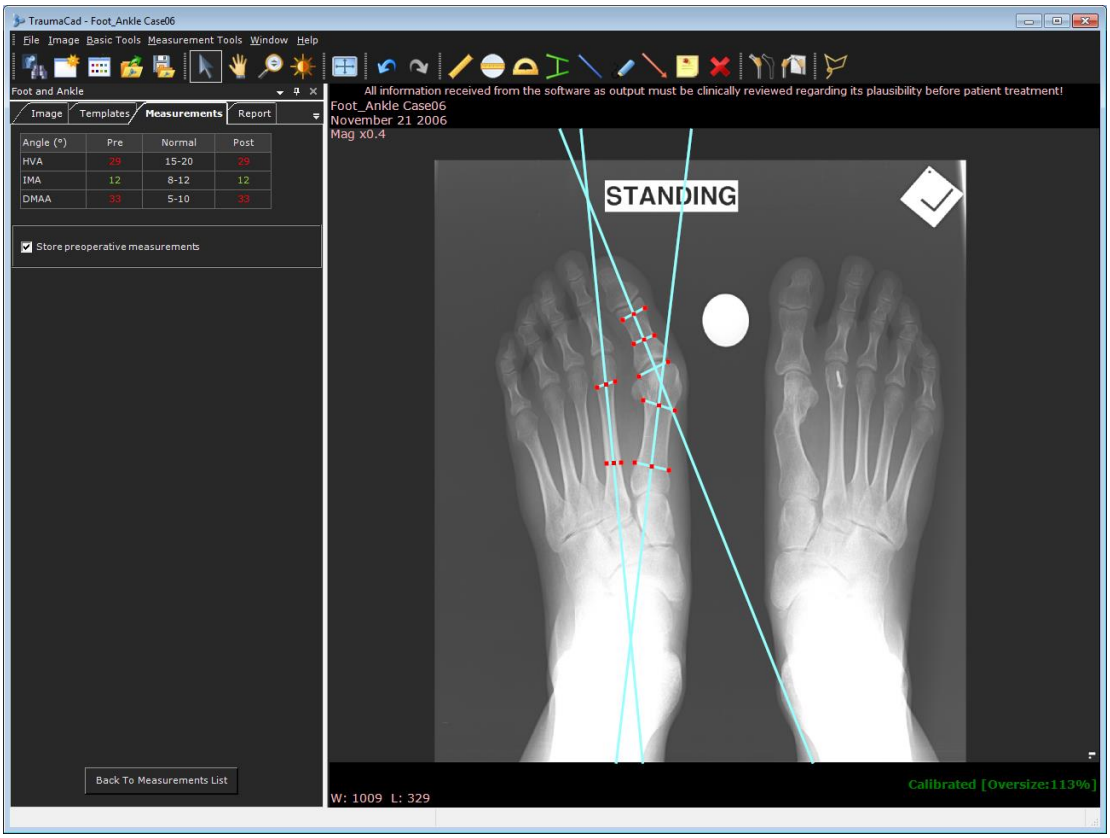
▶ **To use the Foot Osteotomies wizard:**

1. Specify whether you want to measure unilaterally or bilaterally by selecting the appropriate option.



The steps shown below are those that appear in the wizard when you select **Unilateral**. For the **Bilateral** option, these same steps are performed on both feet.

2. Follow the 14 steps in the wizard and mark the relevant points on the image corresponding to each step.



The anatomical measurements are shown in the top-left corner of the **Measurements** tab.

The following measurements are calculated using the wizard:

- **Hallux Valgus Angle (HVA):** The angle between the longitudinal axes of the metatarsus and proximal phalanx of the big toe.
- **Intermetatarsal Angle (IMA):** The angle between the longitudinal axes of the first and second metatarsal bones.
- **Distal Metatarsal Articular Angle (DMAA):** The complement angle to 90° for an angle between the longitudinal axis of the first metatarsus to its distal articular surface.
- In the table, normal values appear green and abnormal values appear red.

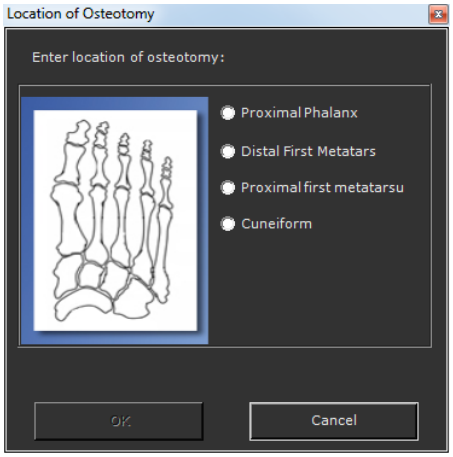
3. Select the **Store preoperative measurements** checkbox to store the associated measurements.

Foot Osteotomies Simulation

After completing the foot deformity measurements, a simulation of osteotomies can be done. Be sure that you stored the measurements from the Foot Osteotomies Wizard before proceeding.

For osteotomies, define the fragments using the **Define Fragment** tool, which is accessible from the toolbar and the menu bar. Double-click a fragment to cut the fragment.

Then, choose the exact location of the osteotomy in the *Location of Osteotomy* window. This window appears automatically after you cut a fragment.

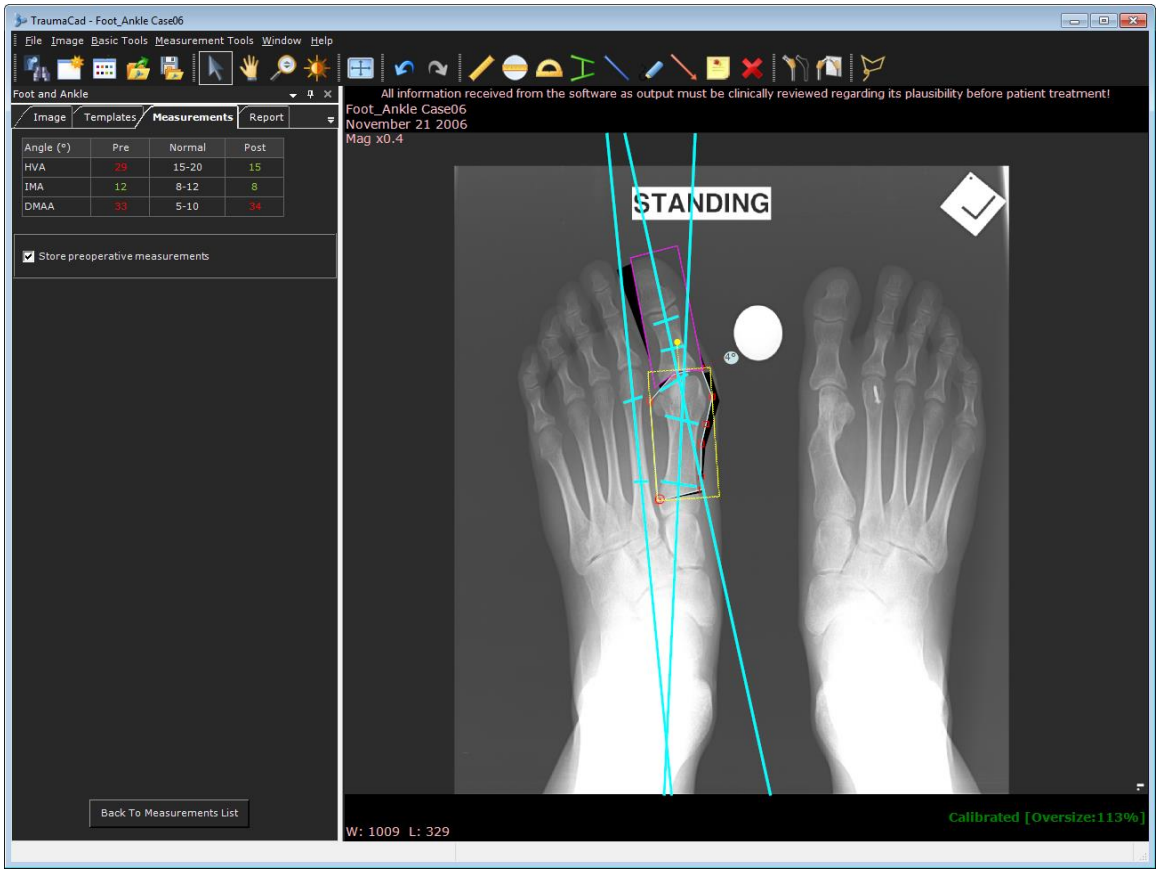


The red circle that appears after completing the osteotomy is the axis of rotation of the fragment and should be placed manually on the medial or lateral cortex of the bone for the opening/closing wedge.

Simulation of the osteotomies can now be done by rotating the yellow fragment handle or by clicking on the **Ctrl** key on the keyboard while moving the fragment.

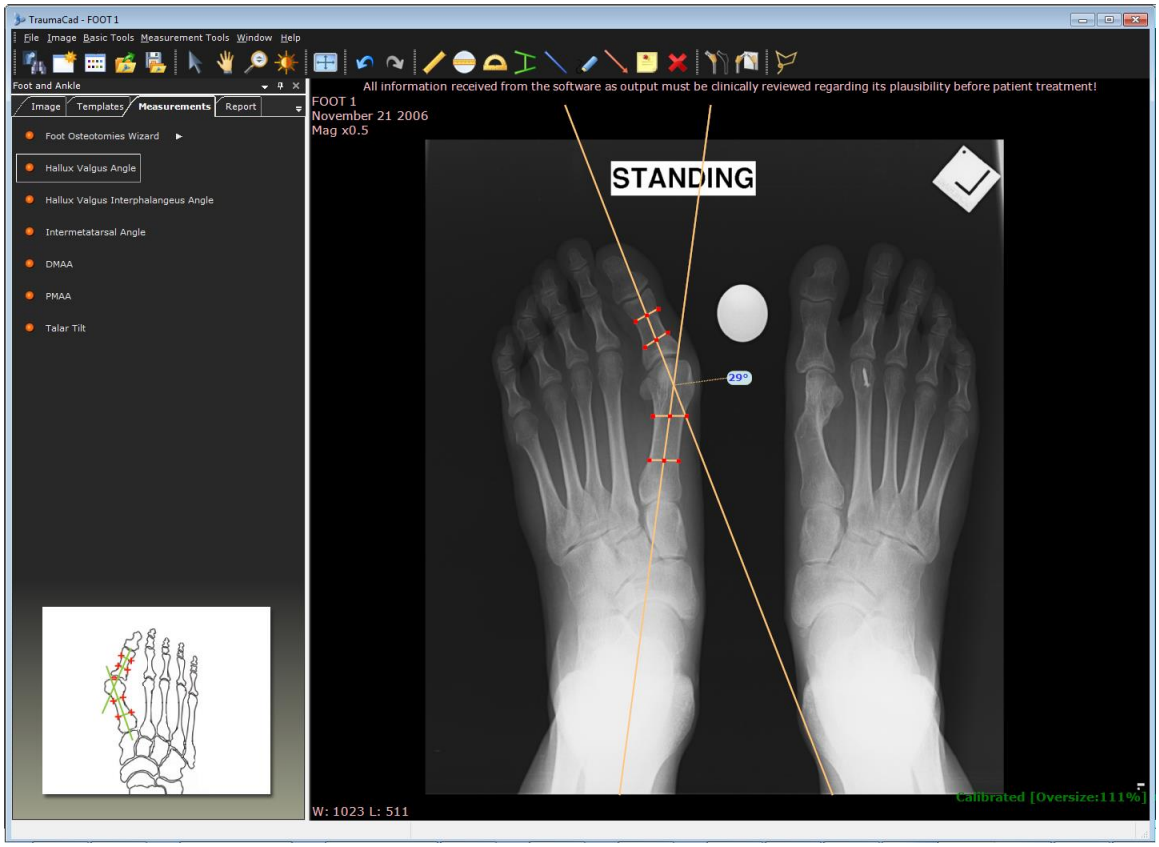
Now you can zoom in and measure the osteotomies' parameters, such as length angle and so on.

The projected post-operative measurements are displayed in a table in the **Measurements** tab.


TraumaCad - Foot_Ankle Case06
File Image Basic Tools Measurement Tools Window Help
Foot and Ankle
Image Templates Measurements Report
Angle (°) Pre Normal Post
HVA 29 15-20 15
IMA 12 8-12 8
DMAA 33 5-10 34
Store preoperative measurements
Back To Measurements List
All information received from the software as output must be clinically reviewed regarding its plausibility before patient treatment!
Foot_Ankle Case06
November 21 2006
Mag x0.4
STANDING
W: 1009 L: 329
Calibrated [Oversize:113%]

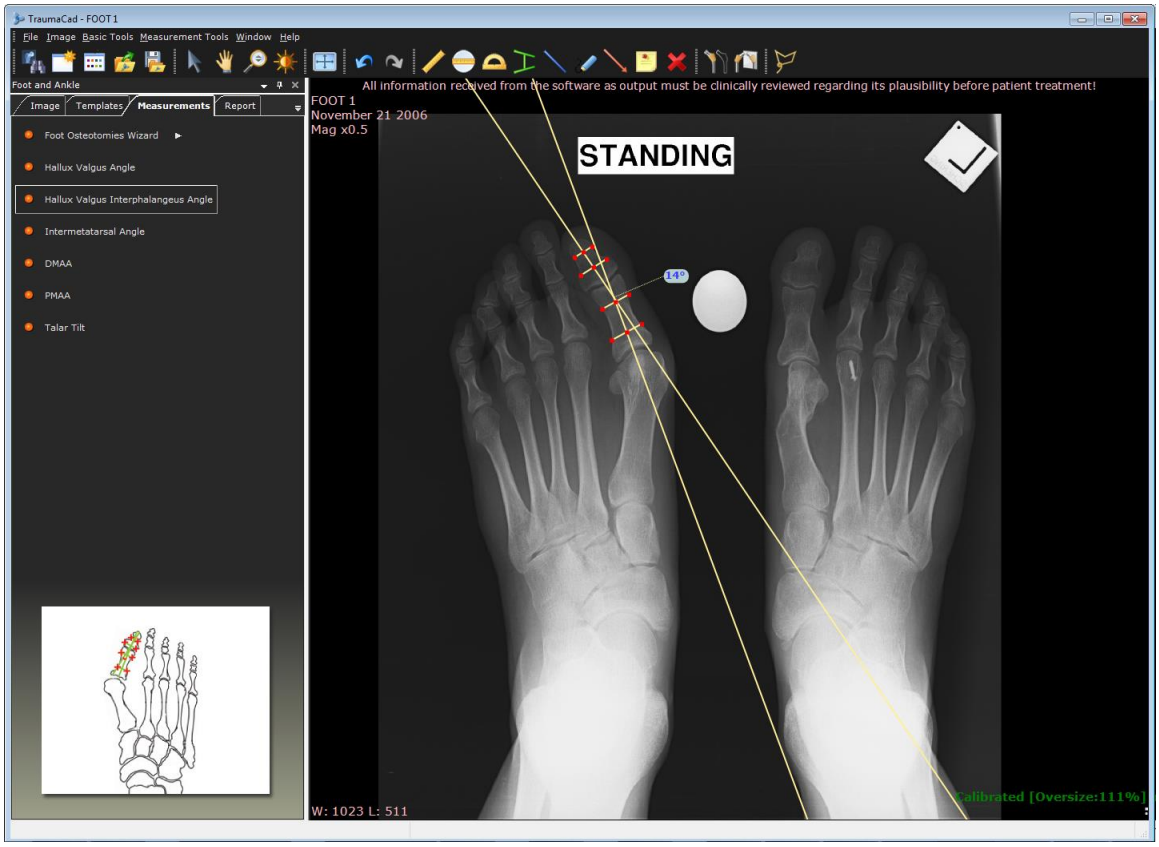
Hallux Valgus Angle

This tool measures the angle between the longitudinal axes of the metatarsus and the proximal phalanx of the big toe.



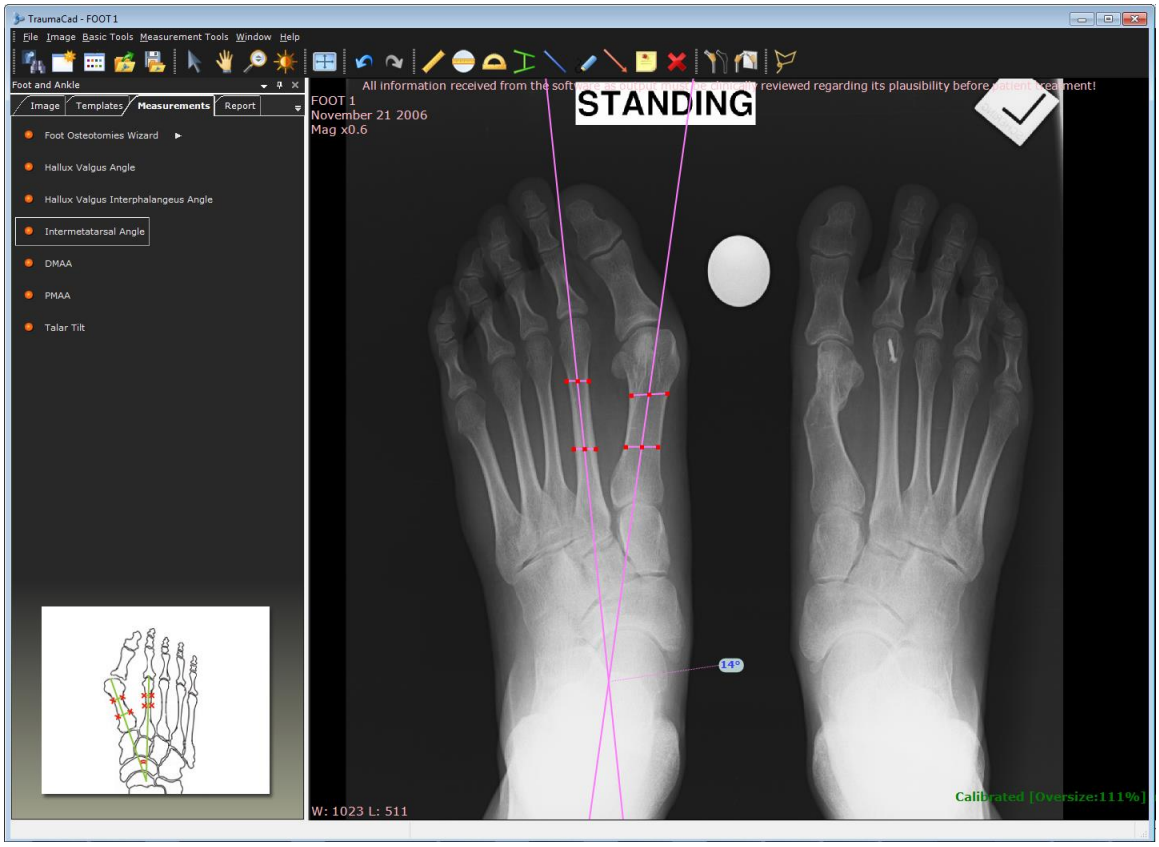
Hallux Valgus Interphalangeus Angle

This measurement tool measures the angle between the longitudinal axes of the proximal phalanx and the distal phalanx of the big toe.



Intermetatarsal Angle

This measurement tool measures the angle between the longitudinal axes of the first and second metatarsal bones.

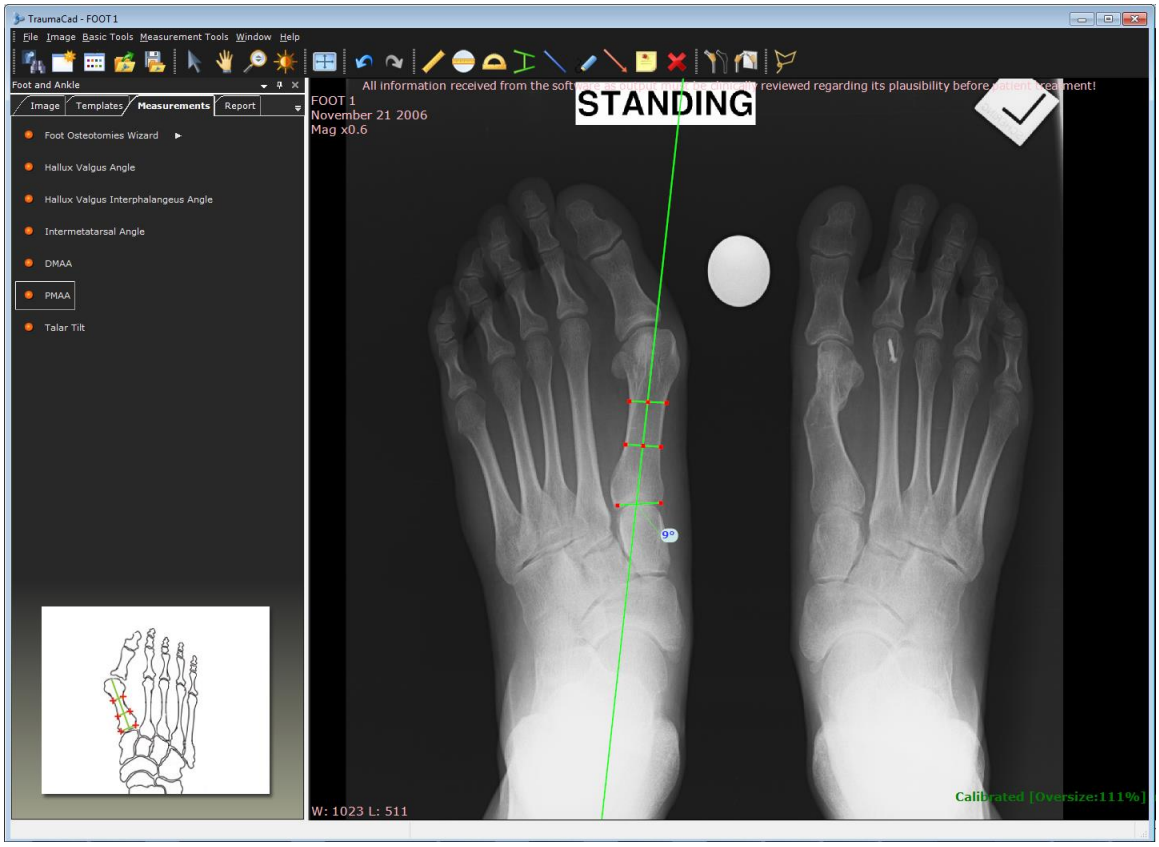


DMAA - Distal Metatarsal Articular Angle

This measurement tool measures the complement angle to 90° of an angle between the longitudinal axes of the first metatarsus to its distal articular surface.

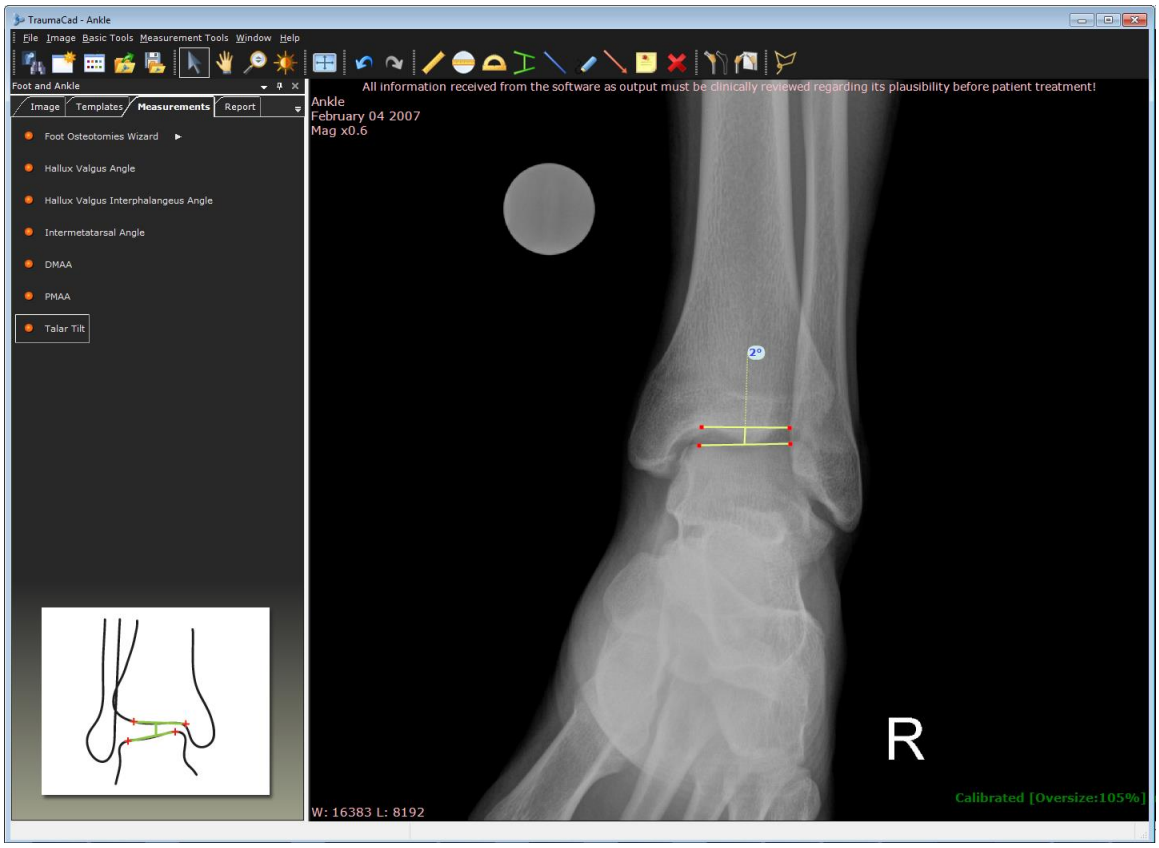
PMAA - Proximal Metatarsal Articular Angle

This measurement tool measures the complement angle to 90° of an angle between the longitudinal axes of the first metatarsus to its proximal articular surface.



Talar Tilt

This tool measures the angle between the ankle articular surfaces of the tibia and talus.



UPPER LIMB MEASUREMENTS

The following upper limb measurements can be made using TraumaCad measurements tools:

- **Center Line Finder**, below
- **Simple Line**, below
- **Joint Line**, below

Center Line Finder

The tool appears on the image. This tool works as described in the *Center Line Finder* section on page 96.

Simple Line

The tool appears on the image. This tool works as described in the *Simple Line* section on page 97.

Joint Line

The tool appears on the image. This tool works as described in the *Joint Line* section on page 99.

CORA TOOLS

Center Line Finder

The tool appears on the image. This tool works as described in the *Center Line Finder* section on page 96.

Joint Line

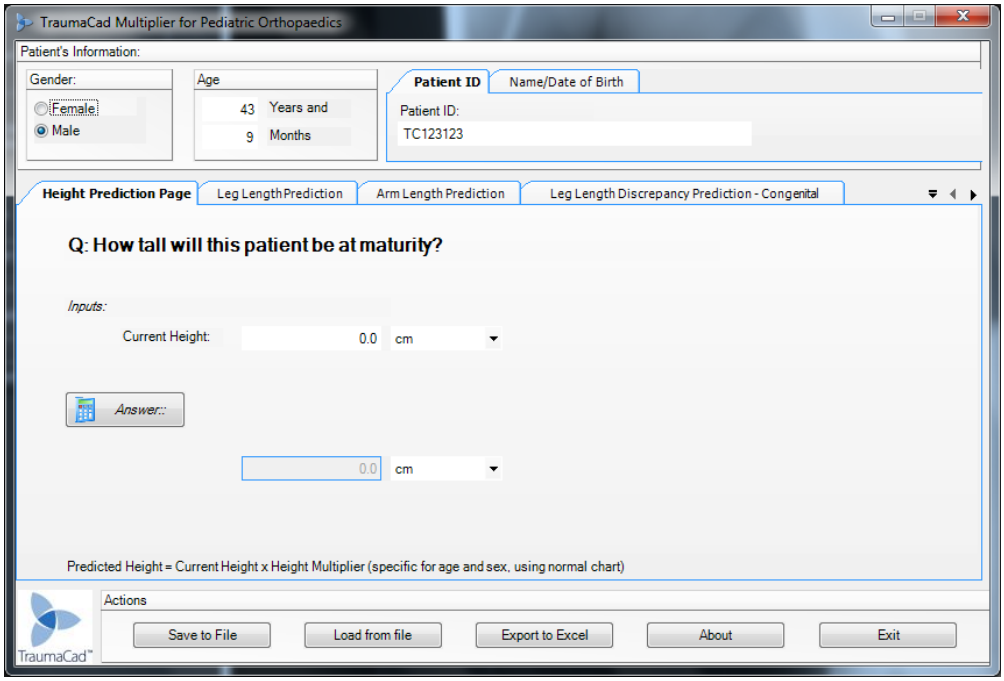
The tool appears on the image. This tool works as described in the *Joint Line* section on page 99.

GROWTH CALCULATOR

CDC Growth Charts

The growth charts consist of a series of percentile curves that illustrate the distribution of selected body measurements in children in the United States.

- **To access the Growth Calculator:**
  From the Measurement Tools menu, or the Pediatric Measurements tab, select Growth Calculator



The Growth Calculator includes 11 tabs, each one provides different options for predicting the growth of a particular anatomy in pediatric orthopedics, as described below. You can navigate through the different tabs by using the arrow button on the right side of the tabs. Begin by entering descriptive information about the patient, such as the patient's name, gender, date of birth and patient ID in the respective fields at the top of the window. Then, select the appropriate tab in the window, enter the required information and click **Answer**.

The following buttons are available at the bottom of the window:

Save to File:	Saves Growth Calculator data to an *.XML file
Load from File:	Imports previously saved Growth Calculator data from an *.XML file
Export to Excel:	Saves Growth Calculator data to a *.CSV file
About:	Displays Growth Calculator version information
Exit:	Closes the Growth Calculator

Height Prediction Page

Purpose: Predicts the height of this patient at maturity.

Formula: Predicted Height = Current Height x Height Multiplier (specific for age and sex, using a normal chart)

Leg Length Prediction Page

Purpose: Predicts leg length at maturity.

Formula: Predicted length at maturity = Current Length x Multiplier (specific for age and sex, using a lower limb chart)

Growth remaining = Current length - predicted length

Arm Length Prediction Page

Purpose: Predicts the length of an arm at maturity.

Formula: Predicted length at maturity = Current Length x Multiplier (specific for age and sex)

Growth remaining = Current length - predicted length

Leg Length Discrepancy Prediction - Congenital Page

Purpose: Predicts the leg length discrepancy at maturity for this patient with congenital LLD. (Congenital = congenital femoral deficiency, fibular hemimelia, tibial hemimelia, hemihypertrophy, hemiatrophy, posteromedial bow of tibia)

Formula: Predicted length discrepancy at maturity = Current Length Discrepancy x Multiplier (specific for age and sex, using a lower limb chart)

Leg Length Discrepancy Prediction - Developmental Page

Purpose: Predicts the leg length discrepancy at maturity for this patient with developmental LLD. (Developmental = Ollier's, polio, growth arrest, also works for congenital discrepancies after lengthening)

Formulas: Predicted length discrepancy at maturity = current difference + [1- (short leg current - short leg previous)/ (long leg current - long leg previous)] x Long leg current (Multiplier (specific for age and sex using a lower limb chart) -1)

Inhibition = 1- (short leg current - short leg previous)/ (long leg current - long leg previous)

Arm Length Discrepancy Prediction - Congenital Page

Purpose: Predicts arm length discrepancy at maturity for this patient with congenital LLD. (Congenital = hemihypertrophy, hemiatrophy)

Formula: Predicted length discrepancy at maturity = Current Length Discrepancy x Multiplier (specific for age and sex, using an upper limb chart)

Arm Length Discrepancy Prediction - Developmental Page

Purpose: Predicts arm length discrepancy at maturity for this patient with developmental LLD. (Developmental = Ollier's, polio, growth arrest, also works for congenital discrepancies after lengthening)

Formulas: Predicted length discrepancy at maturity = current difference + [1- (short arm current - short arm previous)/ (long arm current - long arm previous)] x Long arm current (Multiplier [specific for age and sex using upper limb chart] -1)

Inhibition = 1- (short arm current - short arm previous)/ (long arm current - long arm previous)

Timing of Epiphyseodesis at the Knee Page

Purpose: Suggests the timing for epiphyseodesis around the knee of a long limb to equalize the limb length discrepancy at maturity.

Formulas: Multiplier at correct age for epiphyseodesis = [current long leg length x current multiplier specific for age and sex using lower limb chart]/ (current long leg length x current multiplier specific for age and sex using lower limb chart) - desired correction / kappa

Kappa should be calculated for three scenarios: distal femur = 0.71,
Proximal tibia = 0.57, both distal femur and proximal tibia = 0.67.

The resultant Multiplier at age correct for epiphyseodesis must be *translated* back to a chronologic age using the lower extremity Multiplier chart specific for age and sex.

Timing of Stapling for Hemi-epiphyseodesis Page

Purpose: Suggests the timing for hemi-epiphyseodesis around the knee to correct angular deformities, if the staple will not be removed.

Formulas: Multiplier at correct age for hemi-epiphyseodesis = [current bone length x current multiplier specific for age and sex using lower limb chart] / ([current bone length x current multiplier specific for age and sex using lower limb chart] - [(width of the growth plate x desired correction/57) / kappa].

Kappa should be calculated for one of two scenarios: distal femur = 0.71, proximal tibia = 0.57.

The resultant Multiplier at age correct for hemi-epiphyseodesis must be *translated* back to a chronologic age using the lower extremity Multiplier chart specific for age and sex.

Timing of Staple Removal for Hemi-epiphyseodesis Page

Purpose: Suggests the timing for removing a staple inserted for hemi-epiphyseodesis around the knee to correct angular deformities, assuming that the stapling was done well prior to skeletal maturity.

Formulas: Multiplier at correct age for removal of hemi-epiphyseodesis staple = [current bone length x current multiplier specific for age and sex using lower limb chart] / ([current bone leg length + [(width of the growth plate x desired correction/57)/ kappa]

Kappa should be calculated for one of two scenarios: distal femur = 0.71, Proximal tibia = 0.57.

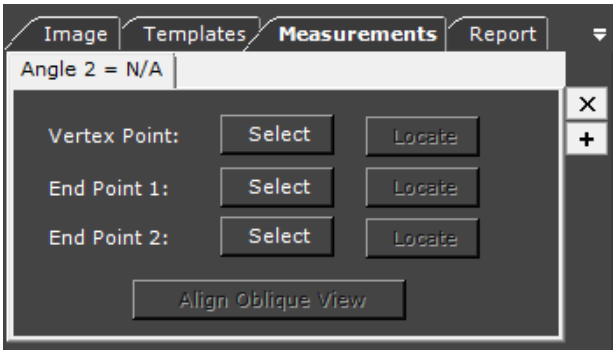
The resultant Multiplier at age for removal of hemi-epiphyseodesis staple must be *translated* back to a chronologic age using the lower extremity Multiplier chart specific for age and sex.

3D TOOLS

3D Angle

The **3D Angle** tool is used to determine the measurement of a 3D angle, including its two endpoints and vertex. This tool enables you to calculate the angle between any three points on the body of the patient.

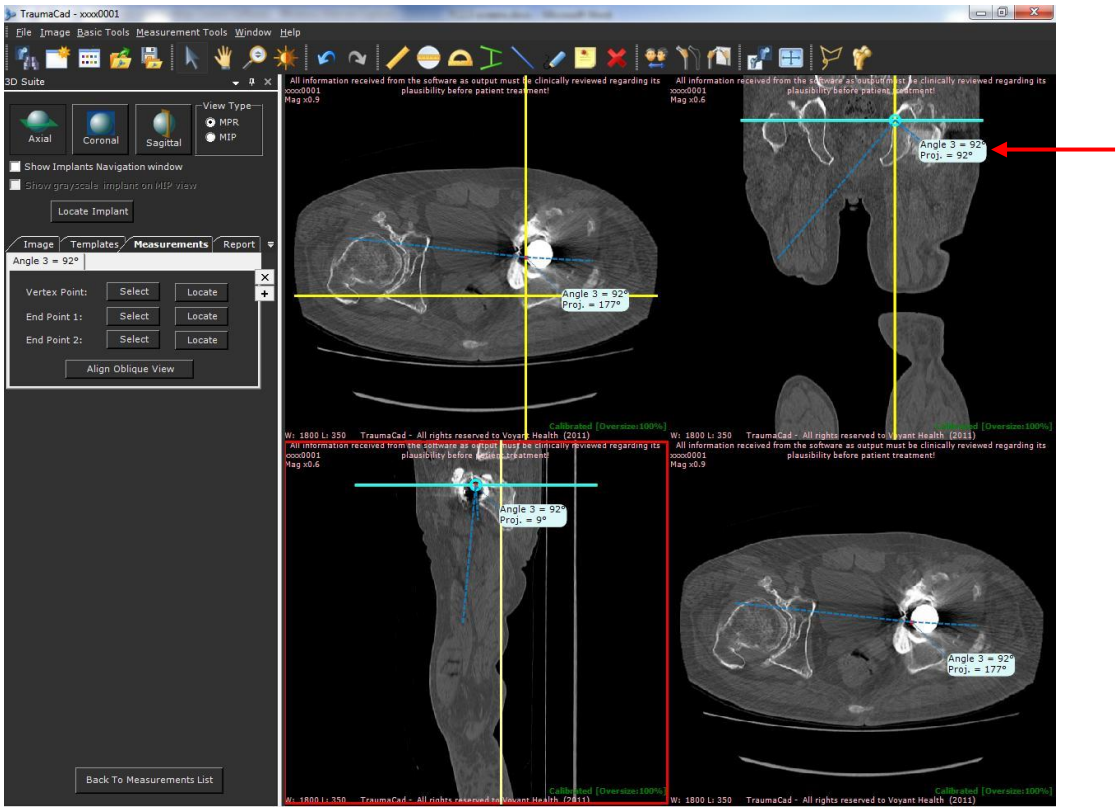
In the 3D procedure, select the **Measurements** tab to display the 3D Angle option:



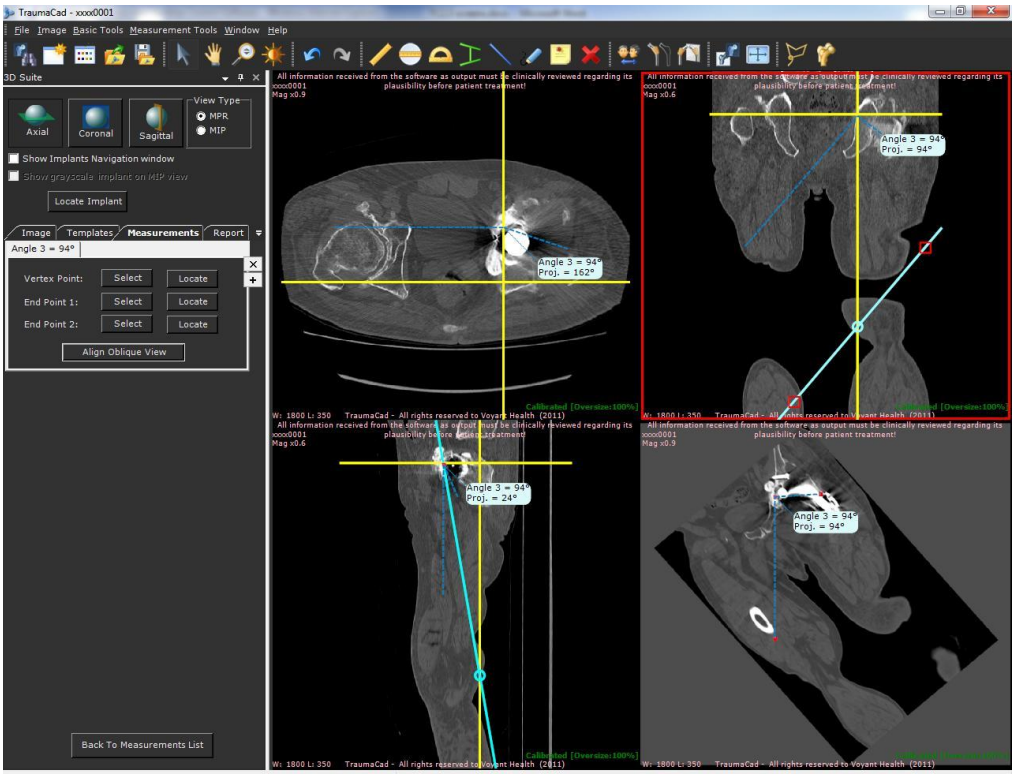
To set a point for the 3D angle, click its **Select** button and then click an image to set the point in that frame. The three points defining the 3D angle can be placed on different image frames, and do not have to be placed on a single image. Use the mouse wheel to scroll through the different frames of the same 3D image. When doing so, be sure to scroll before clicking a **Select** button. Repeat this process to set the other two points in the image.

Click the **Locate** button to locate its associated point on an image frame. The associated point is shown in all views. The locate mechanism scrolls on all views to the frame where the point is located. The located point is always shown red.

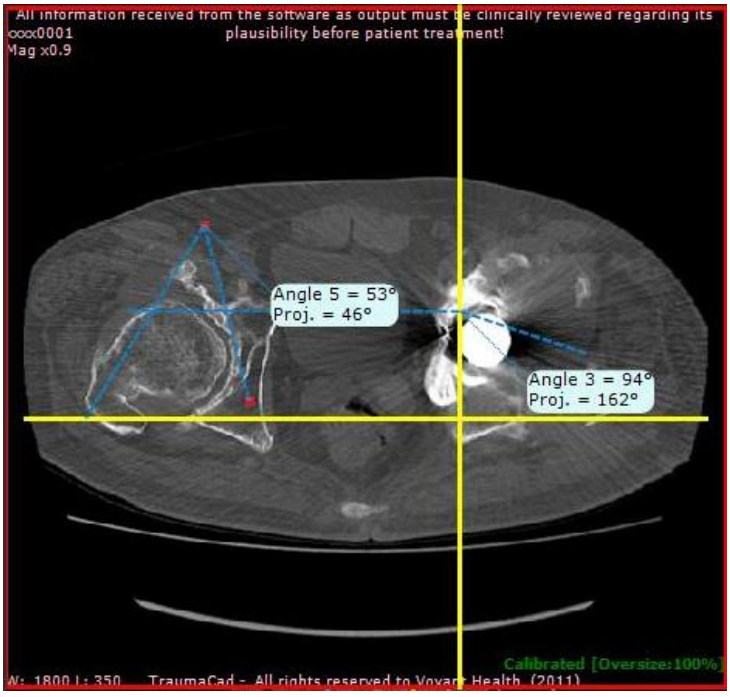
For each 3D angle, the measurement shows the value of the angle in the 3D volume, as well as its projected angle on that frame. The projection is the projected angle on a specific plane, meaning how the angle displays in the current frame view. For example, in the example below, the projection in the upper-right frame is almost identical to the actual 3D angle (in this case, 92°).



When working in MPR mode, you can change the bottom-right view to an oblique one, which enables you to rotate the frame to show any plane in the 3D image volume. Click **Align Oblique View** to show the exact view that contains all three points of the 3D angle. Note that for the resulting oblique view, the actual angle and its projection have the same value, as they are both on the same plane.



You can define as many angles as needed. To do so, click the button to show another angle on the same image, as shown below:



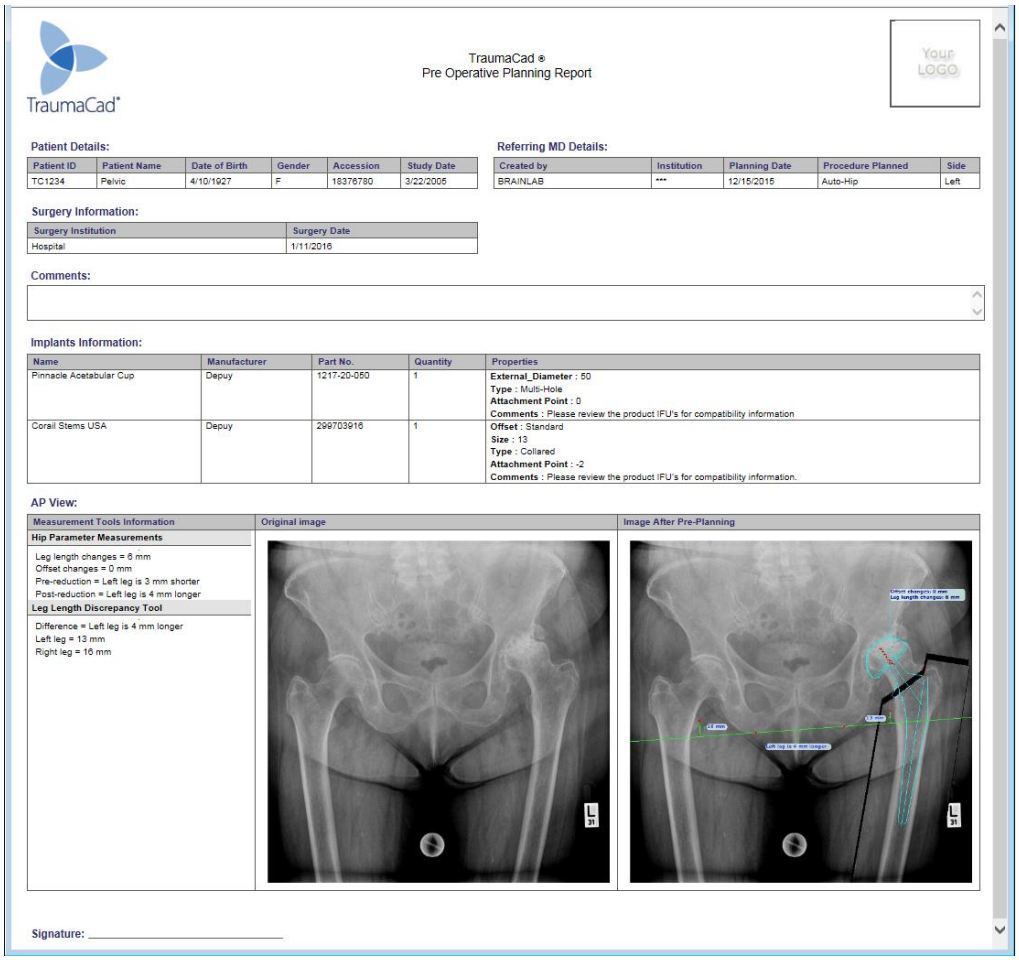
PREPARING REPORTS

Once the planning is completed, you can go to the Report tab to preview the image that will be saved or committed back to the PACS system. TraumaCad HTML report includes the following information: patient details; Referring MD details; Surgery Information – institution and date; the selected implants information and any measurements taken; and the original and planned images.

An example of an HTML report is shown below. It can be printed, committed to PACS, saved locally or uploaded to Quentry for future reference.

Warning! Be sure to save the patient's case in order not to lose patient data. See page 21 for details.

Warning! The material generated by the program is two dimensional. Before performing a procedure, confirm that the actual bone matches the image produced by the software.



TraumaCad

TraumaCad ®
Pre Operative Planning Report

Your LOGO

Patient Details:

Patient ID	Patient Name	Date of Birth	Gender	Accession	Study Date
TC1234	Pelvic	4/10/1927	F	18376780	3/22/2005

Referring MD Details:

Created by	Institution	Planning Date	Procedure Planned	Side
BRAINLAB	***	12/15/2015	Auto-Hip	Left

Surgery Information:

Surgery Institution	Surgery Date
Hospital	1/11/2016

Comments:

Implants Information:

Name	Manufacturer	Part No.	Quantity	Properties
Pinnacle Acetabular Cup	Depuy	1217-20-050	1	**External_Diameter** : 50 **Type** : Multi-Hole **Attachment Point** : 0 **Comments** : Please review the product IFU's for compatibility information
Corail Stems USA	Depuy	299703916	1	**Offset** : Standard **Size** : 13 **Type** : Collared **Attachment Point** : -2 **Comments** : Please review the product IFU's for compatibility information.

AP View:

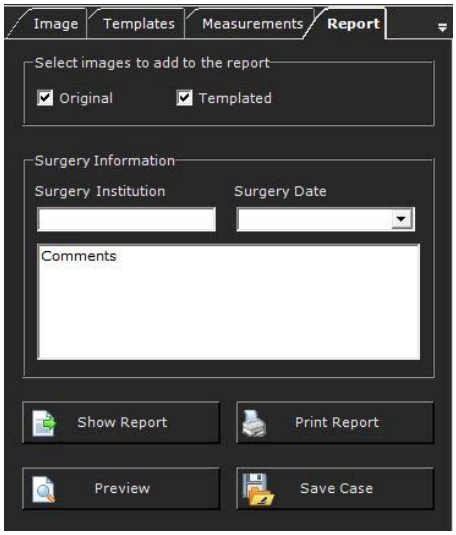
Measurement Tools Information	Original image	Image After Pre-Planning
Hip Parameter Measurements Leg length changes = 6 mm Offset changes = 0 mm Pre-reduction = Left leg is 3 mm shorter Post-reduction = Left leg is 4 mm longer **Leg Length Discrepancy Tool** Difference = Left leg is 4 mm longer Left leg = 13 mm Right leg = 16 mm		

Signature: _____

GENERATING REPORTS

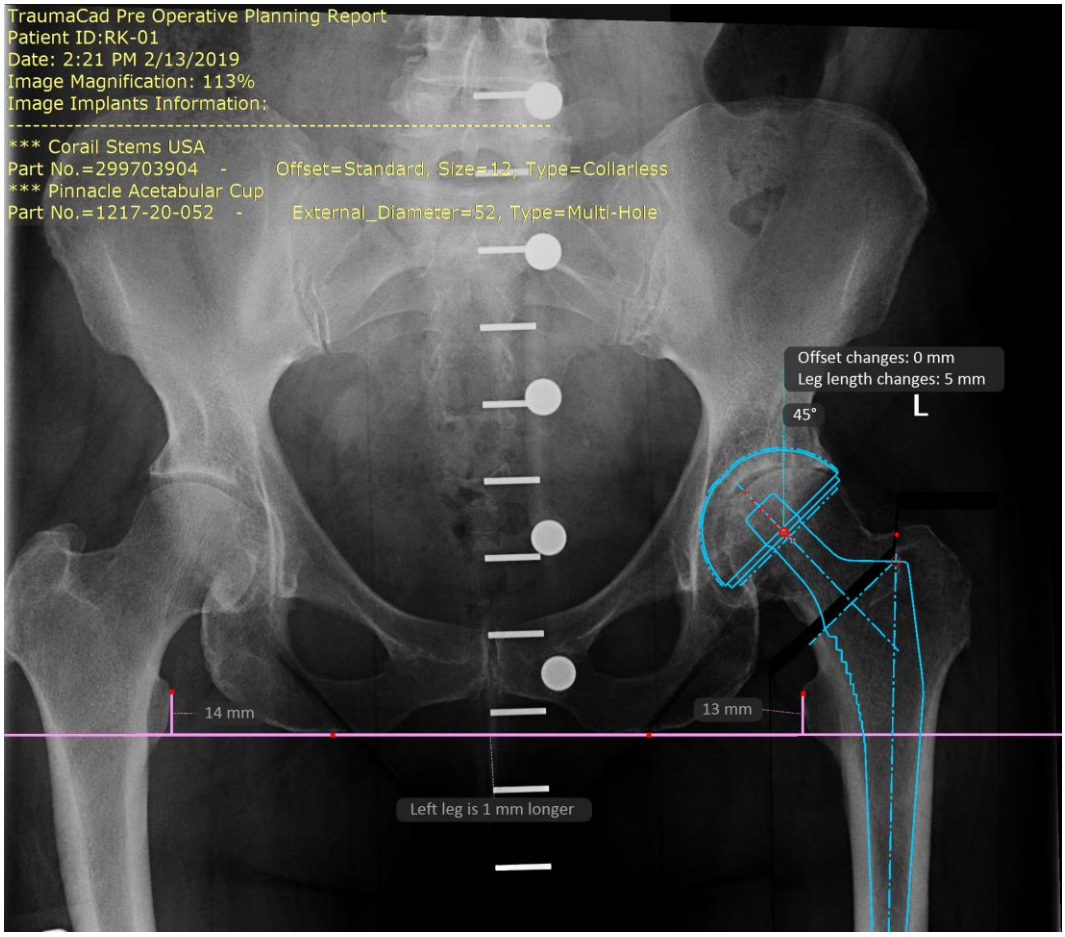
▶ **To generate a report:**

1. Select the **Report** tab. The following is then displayed:



The following options are provided:

- **Original Image:** Specifies that the original images are included in the report.
- **Templated Image:** Specifies that the images after templating are included in the report.
- **Surgery Information:** Specifies the surgery institution and the date the surgery will be performed, and adds specific user comments to the report.
- **Show Report:** Displays an HTML report. You should save this report or print it before opening another case study.
- **Print Report:** Prints the report.
- **Preview:** Previews the image to be stored, as shown below:



Note: the text annotation saved on the planned image can be customized.
To change the data displayed on the image go **File menu** ➔ **Settings** ➔ **Save Case**.
To change the font preferences go to **File menu** ➔ **Settings** ➔ **Text**.

- **Save Case:** Saving a case enables you to store all its images, templates, measurements and case information and later reopen it in TraumaCad. This option opens a window in which you can select to save this case by choosing any of the following options:
  - Upload to Quentry.
    - Use JPEG Lossy Compression: When this option is selected, the DICOM files in the ***.tcc** file sent to Quentry are compressed using JPEG Lossy compression.
  - Commit to PACS.
    - Include the report while saving to PACS.
  - Save Locally:
    - Save locally in the **My TraumaCad Cases** folder.
    - Save to an external device drive that you select, such as a memory stick.
  - Select the location for the annotation on the image.

APP. A - INSTALLING TRAUMACAD

Installation of TraumaCad must be performed on a computer that is connected to the web. If a web connection is not available for a certain computer, an alternative activation can be completed using a license file. For additional information, contact Brainlab support.

After installation and the first launch, TraumaCad does not need to be connected to the web.

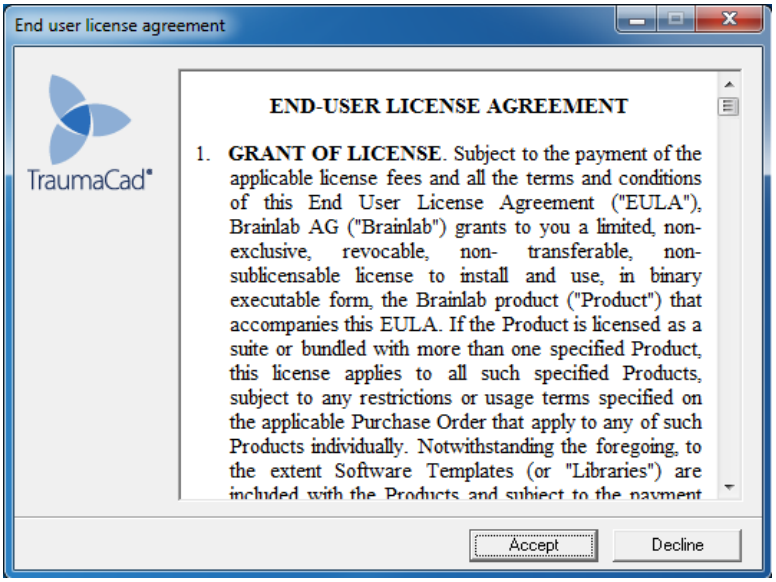
Note: For standalone versions of TraumaCad, the PACS configuration must first be set up in order to specify the connection properties between TraumaCad and the PACS system. Typically, this only needs to be performed once by a system administrator after the initial installation of TraumaCad. The system administrator should make sure to enter the relevant connection properties in the PACS system so that it recognizes TraumaCad. For more information, see page 177.

HOW TO INSTALL TRAUMACAD

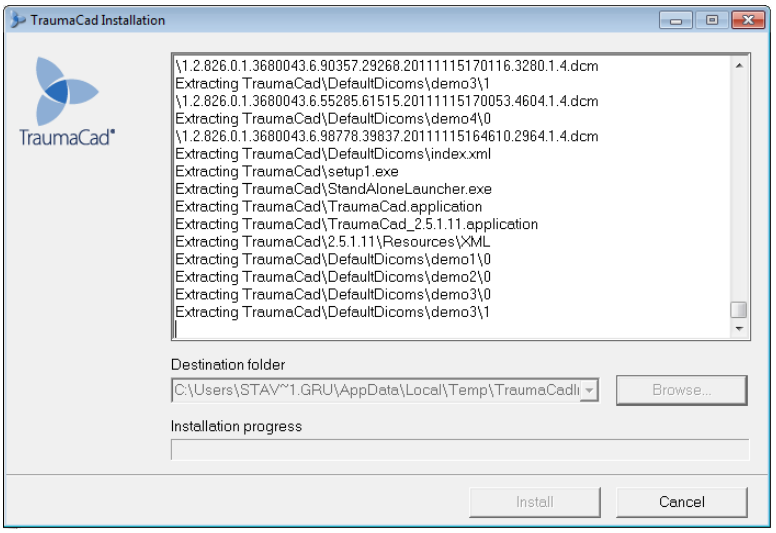
The TraumaCad installation program will check if Windows .Net is installed on your computer. If it is not, it will download and install it. You are then required to restart your computer.

- **To install TraumaCad:**

1. The License Agreement window is displayed. Read the agreement and click **Accept**.

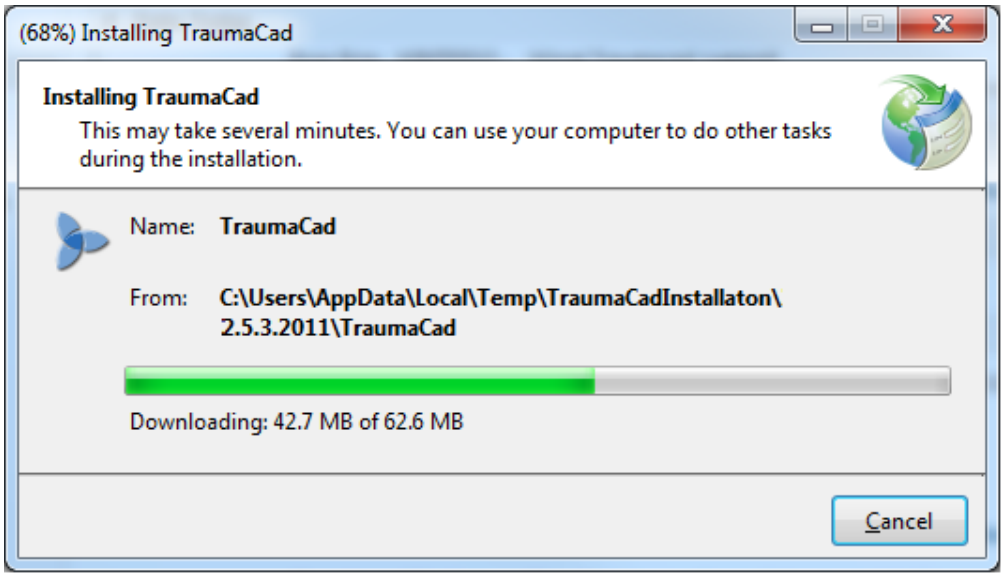


The following window is displayed:

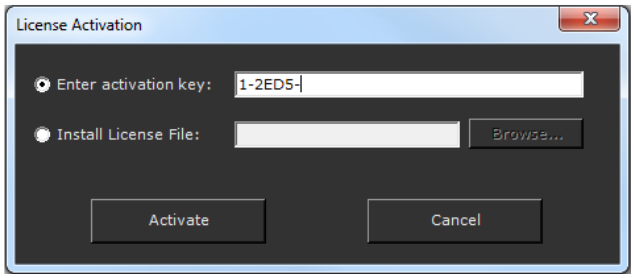


When the following window is displayed, click **Install**.

A progress window is displayed, showing the progress of the download:



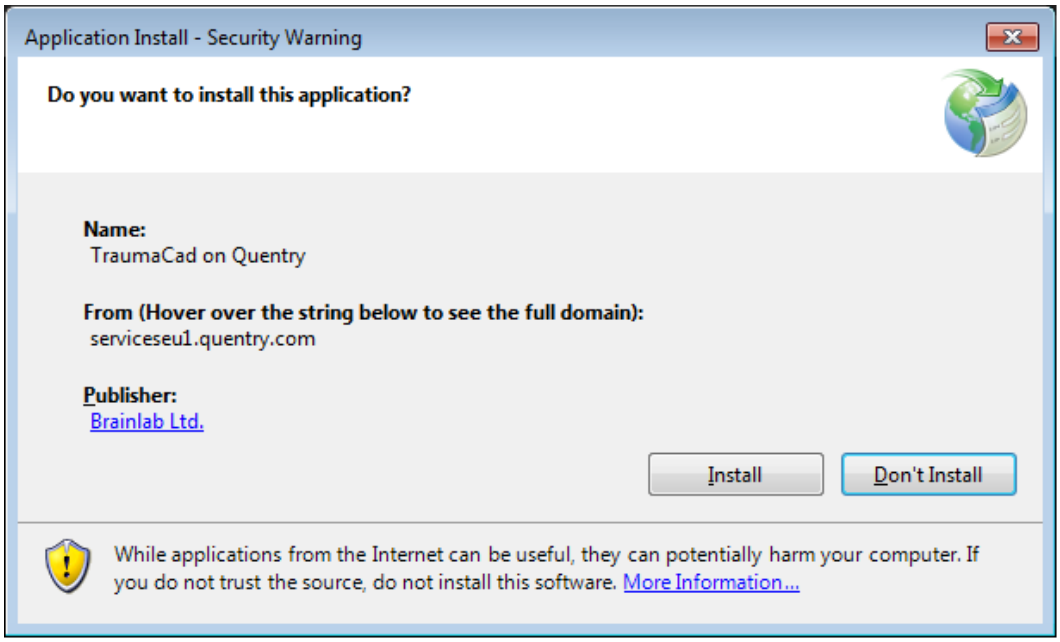
2. At the end of the installation process, the *License Activation* window is displayed:



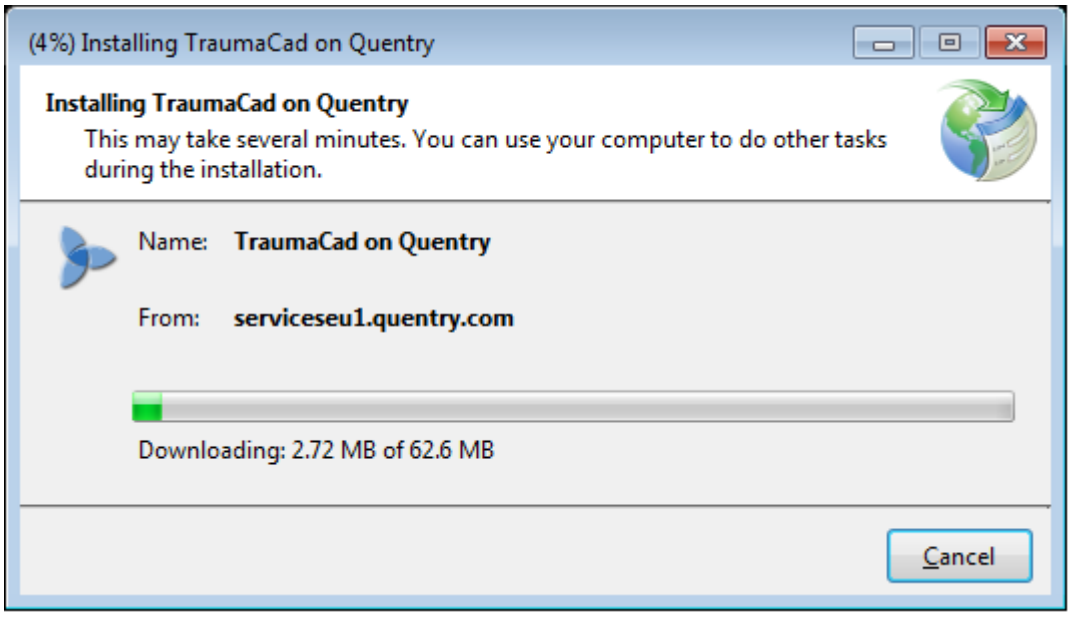
3. Enter a valid activation key and click **Activate**.

INSTALLING FROM THE WEB

If you are installing via the web, launch Internet Explorer and then enter the URL of the organization's server that runs TraumaCad Server. The following security warning is displayed:



Click **Install**. A progress window is displayed, showing the progress of the download:



At the end of the installation process, TraumaCad launches automatically.

APP. B - STANDALONE USAGE

This appendix describes several procedures that may be required in standalone mode, as follows:

- **Importing Images**, page 36
- **Capturing Images From the Screen**, page 37
- **Setting the PACS Configuration (Optional)**, page 177

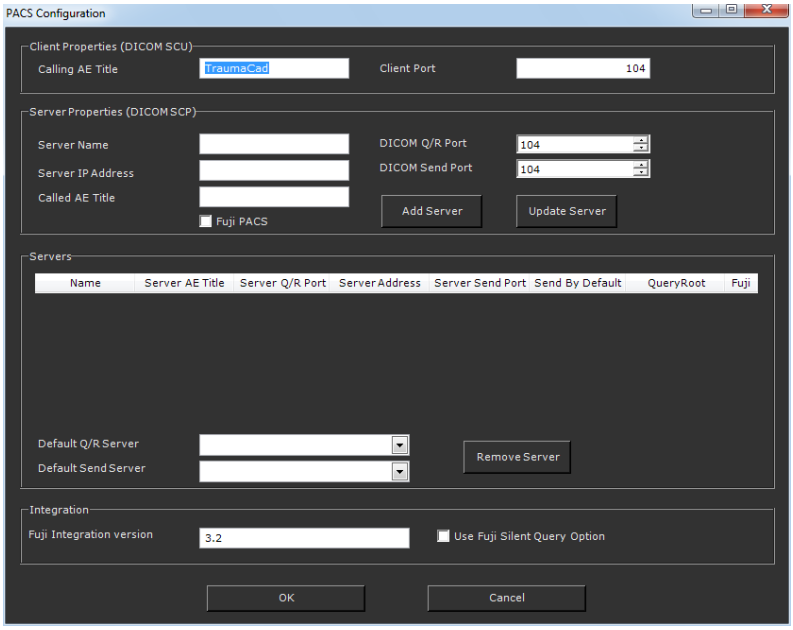
SETTING THE PACS CONFIGURATION (OPTIONAL)

This optional step only applies to standalone versions of TraumaCad. It enables you to specify the connection properties between TraumaCad and the PACS system. Typically, this only needs to be performed once by a system administrator after the initial installation of TraumaCad. The system administrator should make sure to enter the relevant connection properties in the PACS system so that it recognizes TraumaCad.

Note: Client/server versions of TraumaCad can skip this step since it is performed on the server, as described in the *TraumaCad Administrator's Guide*.

▶ **To set up the PACS Configuration:**

1. In the menu bar, select **File ➔ PACS Configuration**. The *PACS Configuration* window is displayed:



2. Enter the relevant PACS connection information into the appropriate fields. This information should be available to your network administrator.
3. Click **OK** to save to apply these settings.

APP. C - MANAGING IMPLANT TEMPLATES

TraumaCad provides a large library of digital templates for a wide variety of orthopedic surgical procedures.

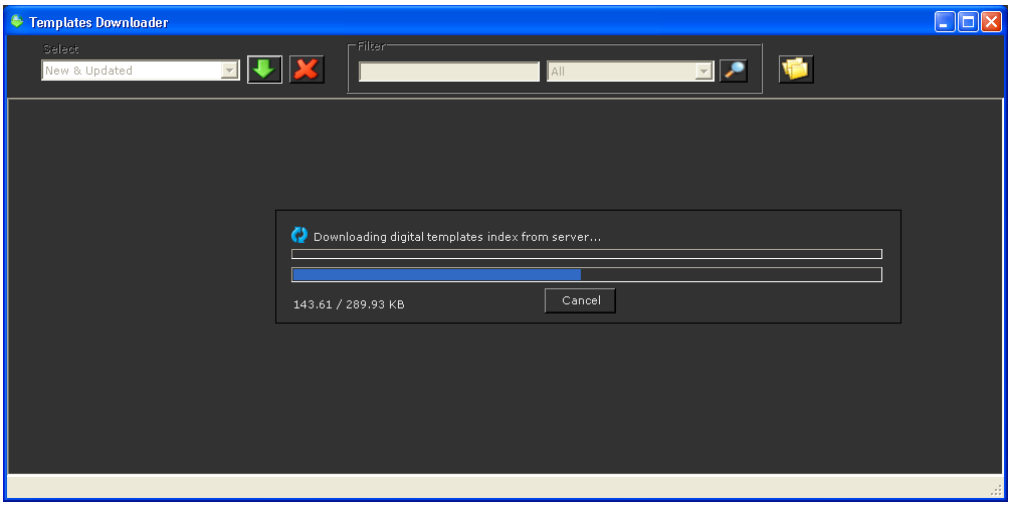
For the client/server and TraumaCad Web versions of TraumaCad, these implant images are automatically imported and updated on your computer from the TraumaCad server.

For the standalone version of TraumaCad, select **File** > **Download Templates** in the menu bar to download templates of implants from Brainlab's global repository to your computer.

Each implant is provided in a variety of sizes and properties and each such group is called an implant *template*. Several implanting scenarios can be recorded and compared to find the optimal implant procedure. Once an implant is chosen, it can easily be scaled and manipulated.

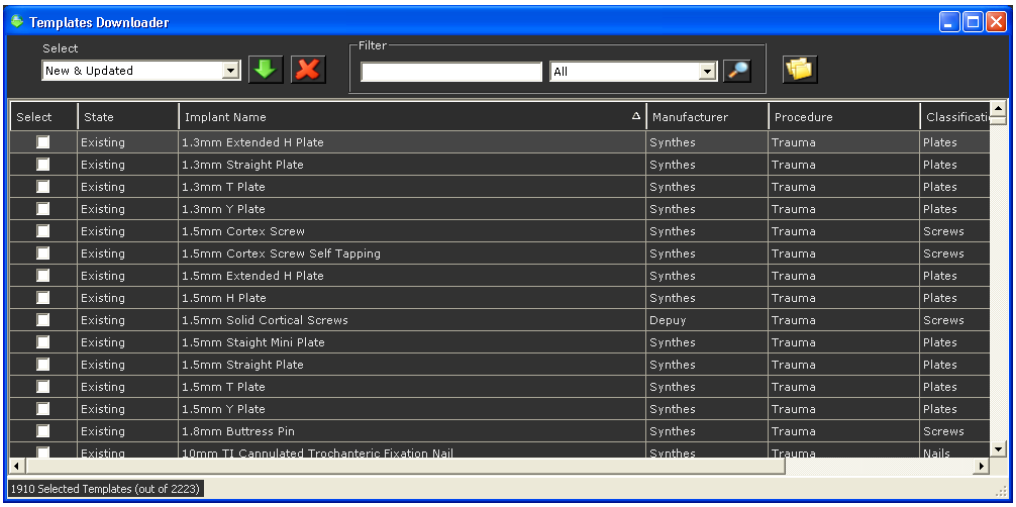
IMPORTING IMPLANT TEMPLATES

Before TraumaCad is used for the first time, the implant templates should be imported. This procedure should also be performed from time to time to update the template library.



TEMPLATES MANAGER

After the Templates Downloader is launched, it assesses the locally stored templates and the latest templates on the Brainlab server.



The *Templates Downloader* window lists the templates stored locally and those on Brainlab's TraumaCad server. Each row in the table represents one implant template. Each row contains the following fields:

- **State:** Displays the current state of the implant template on the TraumaCad client. The **State** is determined by comparing the TraumaCad client's list of templates to the list stored on the TraumaCad server.

- **Implant Name:** The name of the implant template.
- **Manufacturer:** The manufacturer of the implant template.
- **Procedure:** The TraumaCad procedure for which the implant template can be used.
- **Classification:** The implant template type, as defined on the TraumaCad server.
- **Version No.:** The version number of the implant template on the TraumaCad server.
- **Last Modified:** The date the implant template was last changed on the TraumaCad server.

In the **Select** dropdown list, you can specify whether you want to choose all or some implant templates. Whichever option you select automatically checks the checkboxes of the corresponding implant templates in the table. The available options are:

- **New & Updated:** Selects implant templates that are either new to or that have been updated on the TraumaCad server. This is the default.
- **New:** Selects implant templates that exist on the TraumaCad server, but that do not exist on the local TraumaCad client.
- **Updated:** Selects implant templates that have been updated on the TraumaCad server. A newer version of this template exists on the server.
- **Existing:** Selects implant templates that currently exist on the TraumaCad client. This means that the latest version of the template already exists on the local client.
- **All:** Selects all implant templates in the table.
- **None:** Selects no implant templates in the table.

You can also select a specific implant template(s) by selecting its respective checkbox in the **Select** column of the table.

▶ **To download templates to the local client:**

1. Select the required templates by clicking the checkbox to the left of the template name or by selecting the relevant option in the **Select** dropdown list.
2. Click the **Download Selected Templates** button to start downloading the selected templates.

Searching for Templates

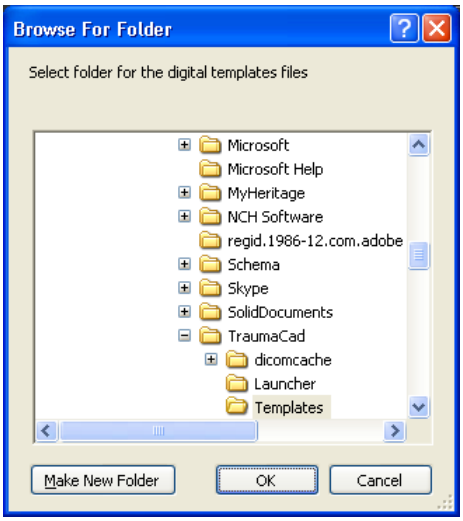
You can search for specific templates (meaning, filter the list of templates) by entering text, such as the template name or part of the name in the **Filter** area and clicking the **Search Templates** button to its right. You should then select one of the options from the dropdown menu in the right field in the **Filter** area to specify whether this text appears anywhere in the template information, in the **State** column, **Implant Name** column, **Manufacturer** column, **Procedure** column, **Classification** column or **Version No:** column.

Remove Selected Templates

Select the required templates by clicking the checkbox to the left of the template name and then click the **Remove Selected Templates** button to delete the implant template from the local TraumaCad client.

Change Templates Folder

By default, templates are stored locally in your drive (typically the C drive) under C:\Documents and Settings\All Users\Application Data\TraumaCad\Templates. To change the folder in which they are stored, click the **Change Templates Folders** button to display the *Browse For Folder* window in which you can select a different location for template storage.



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