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Acetabular PE wear measurement (linear head penetration) using Roman V1.70

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The principles of measuring linear head penetration to quantify polyethylene wear are well described in the literature (e.g. Geerdink et al. 2008). This basic instruction focuses on the practical issues of using Roman V1.70, a donationware image analysis software developed and made available by Mr Frank Cook at The Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry, UK (f.kok@keele.ac.uk).

1 Load image into Roman

Roman accepts most image format except DICOM. DICOM must be converted, preferably in a lossless image format like TIFF (e.g. by using the freeware Irfanview). Original resolution, no/low compression image formats are preferred to preserve accuracy. Complete AP x-rays (left & right leg) shall be used at min. 5MPix.

2 Calibrate image

Zoom onto femoral head. ("Zoom function").
High zoom improves accuracy.

Click a min. of three, best five or more points on the edge of the femoral head ("Insert objects")
Points must be put onto spherical part of head! Some heads are flanged. Set points far apart for better interpolation.

Select the points which should form the circle around the head ("Scroll/**Sel**/Del")

Create circle from the point selection ("Fit objects to image"). The circle center is automatically drawn.

Draw a ruler from one edge of the circle to the other passing the center point (Menu "Insert object")

Set the length of the ruler to head diameter (e.g. 28mm) (Menu "Calibrate").

The image is now calibrated

Ruler & circle can now be selected (Menu "Scroll/**Sel**/Del") and deleted (Menu "Scroll/Sel/**Del**").

It is recommended to change the point & line colour for the cup (Menu "Object properties").

3 Identify head center

The head center has been identified during the calibration process. When lost repeat w/o calibration.

4 Identify cup/insert center

Make sure that point/line colour is changed from head identification (Menu "Object properties").

Zoom onto cup. ("Zoom function")
High zoom improves accuracy.

Click a min. of three, best five or more points on the edge of the cup ("Insert objects")
Attention: Points must be put onto hemispherical part concentric with PE insert! Some cups are flanged. Avoid proximity of spikes or screws. Set points far apart for better interpolation.

Select the points which should form the circle around the head ("Scroll/**Sel**/Del")

Create circle from the point selection ("Fit objects to image"). The circle center is automatically drawn.

5 Measure head penetration distance ("wear")

Zoom onto points marking head and cup center. ("Zoom function")
High zoom improves accuracy.

The distance between the head and cup center is measured with the ruler (Menu "Insert object").
Head penetration is usually small and measures a few pixels only. One can alternatively count the pixels and calculate the distance using image resolution, calibration and trigonometry.

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6 Measure angle of head penetration distance ("wear angle")

Use coordinate system suggested.

Draw line marking the cup inclination ("Insert objects")

Select cup inclination line and wear ruler ("Scroll/**Sel**/Del") and measure angle ("Calculate").
The software only measures the nearest angle between two lines. Thus this angle may have to be converted into the coordinate system.

7 Paired vs single image analysis

For paired analysis trigonometric calculations between both observations need to be performed.

General tips:

Accuracy and inter- and intra-observer reliability is increased when the head and cup center are determined at least three times and the average position is chosen for measurement.

All results are printed into a spreadsheet which can be saved. Also the image and all drawings can be saved for review or changing.

It is helpful to use two distinct colors to distinguish the head (e.g. red) and the cup (e.g. blue).

References:

Geerdink CH, Grimm B, Vencken W, Heyligers IC, Tonino AJ. The determination of linear and angular penetration of the femoral head into the acetabular component as an assessment of wear in total hip replacement: A COMPARISON OF FOUR COMPUTER-ASSISTED METHODS. J Bone Joint Surg Br. 2008 Jul;90(7):839-46.

http://www.keele.ac.uk/depts/rjah/downloads/roman.zip

http://www.irfanview.de/

Disclaimer:

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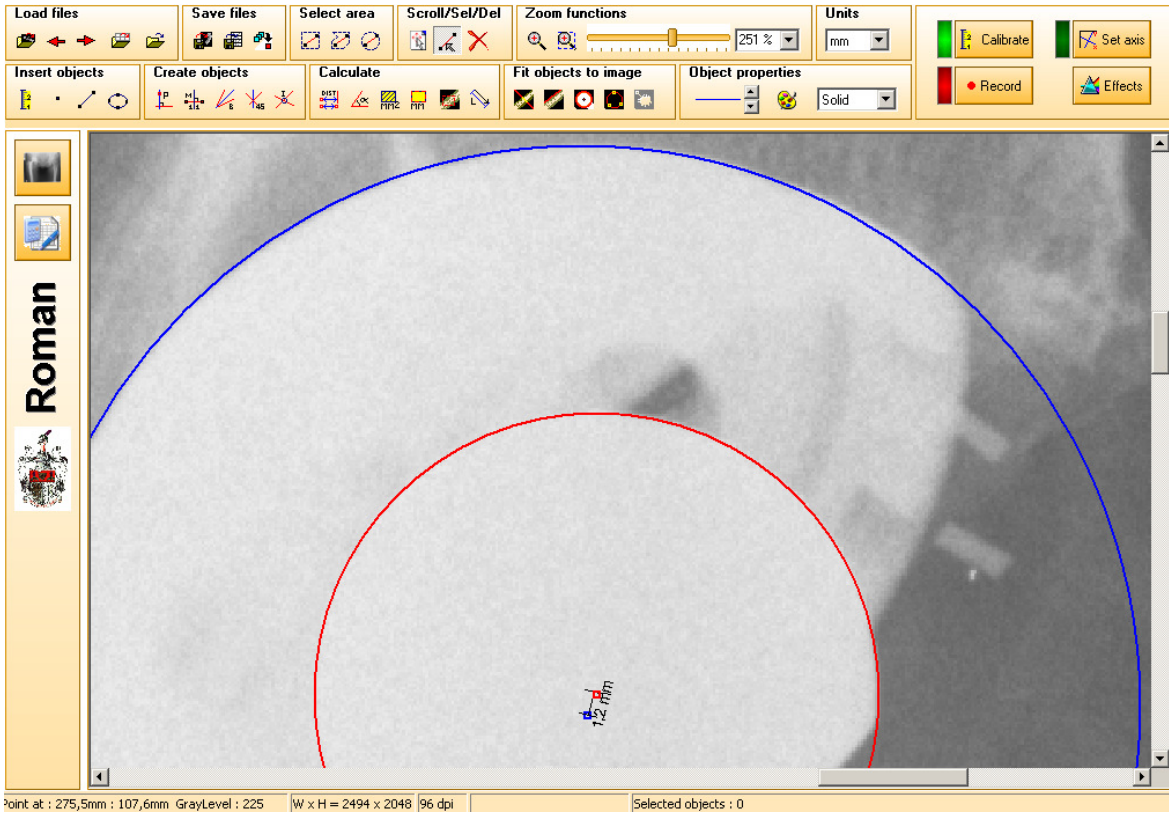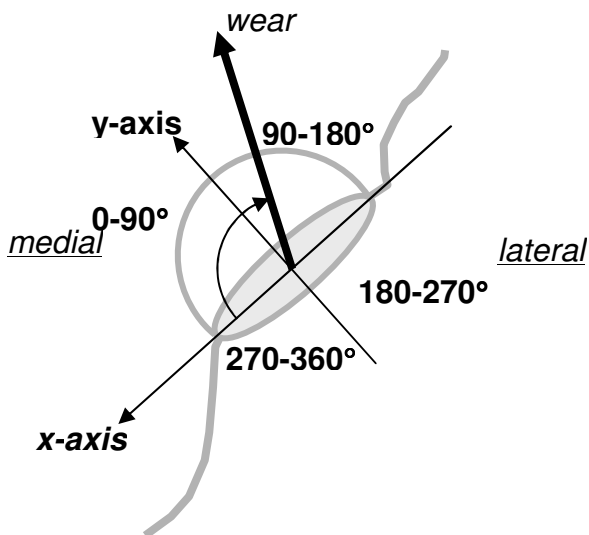**Figure 1:** *Snapshot of Roman software with a typical measurement of head penetration*

Figure 2: *Suggested coordinate system making paired analysis more simple and avoiding negative wear confuision.*

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Figure 3: *Principles of single versus paired image analysis..*

	Baseline	Final follow-up	Total wear
Single image analysis			
Paired image analysis			

Calculating the resultant wear in paired analysis:

The resultant wear vector of paired image analysis is calculated using simple trigonometry. An excel sheet containing the formula for calculating the resultant wear penetration length and wear angle can be downloaded from:

http://orthocamp.nl/ahorse/RomanPairedAnalysis.xls

This Manual is available for download on:
http://orthocamp.nl/ahorse/WearRomanManual.pdf