

Optimization of Cup Positioning in THA

Comparison between conventionally instrumented and computer assisted implanted cups by using the OrthoPilot® Navigation System

Ottersbach Andreas MD, Haaker Rolf PhD

Department of Orthopaedic Surgery, St. Vincenz-Hospital, 33034 Brakel, Germany

AIM:

The goal of the current study was to determine the accuracy of free hand and computer assisted cup positioning.

MATERIAL AND METHODS:

We analysed the positions of 50 conventional implanted and 50 navigated implanted cups and compared the results. The patients for each group were chosen randomized.

	Manual Group	Navigated Group
Number of patients	50	50
Mean age	60.3 years (39 ... 88)	59.2 (27 ... 80)
Right side	21	24
Left side	29	26
Female	28	33
Male	22	27
Cementless cup	45	46
Cemented PE cups	5	4

We used a kinematics based, image free navigation system (OrthoPilot by BJBraun Aesculap). All surgeries were carried out by a constant group of surgeons between October 2002 and November 2004.

To ensure the accuracy and the comparability of the measurements for cup inclination and cup anteversion on the post op X-rays there was used a special measuring device which was developed by the author (some kind of water-level). This pelvis scale has 3 legs. They are positioned on both ASIS and the symphysis of the patient's pelvis. By tilting the OR-table the anterior pelvis plane can be positioned in parallel to the floor.

This procedure ensures that the central X-ray beam always hits the anterior pelvis plane orthogonally. The central beam was focussed directly on the femur head.

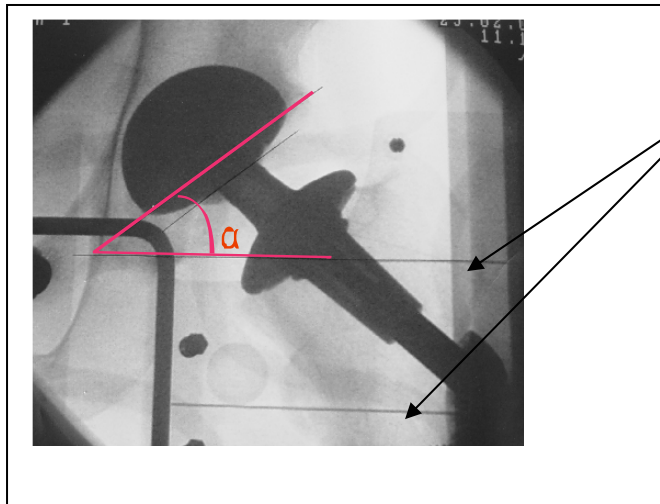


Picture 1: "Pelvis scale after Ottersbach" enables aligning the anterior pelvis plane in parallel to the floor and orthogonally to the X-ray beam by tilting the OR table.



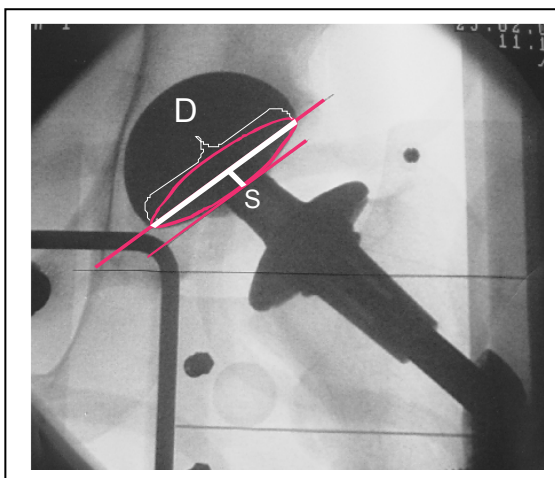
Picture 2: post-op X-Ray in neutral pelvis position (in parallel to floor) with “Pelvis scale after Ottersbach”

We calculated the cup anteversion and inclination.



Horizontal reference lines (X-Ray markers) to determine cup inclination angle α

Picture 3: Standardized X-ray, post-op, inclination



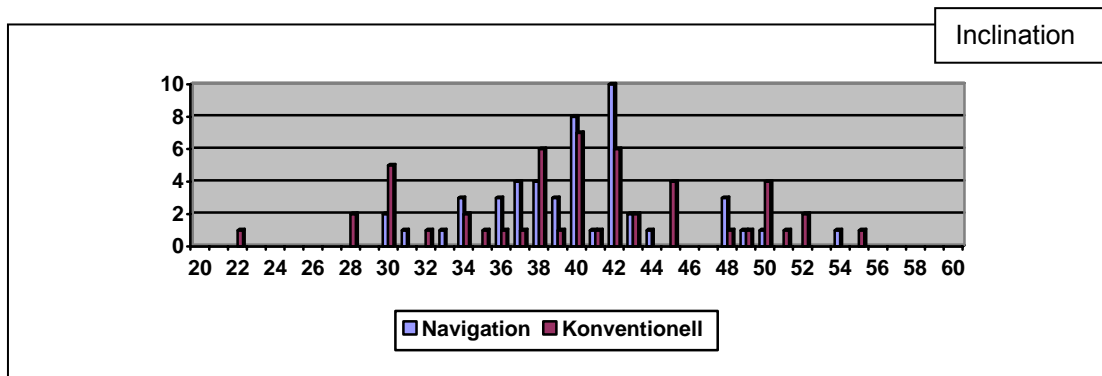
Determination of longitudinal and transversal cup diameters and computation of anteversion modified after Petterson:

$$\text{Anteversion} = \arcsin \frac{S}{D/2}$$

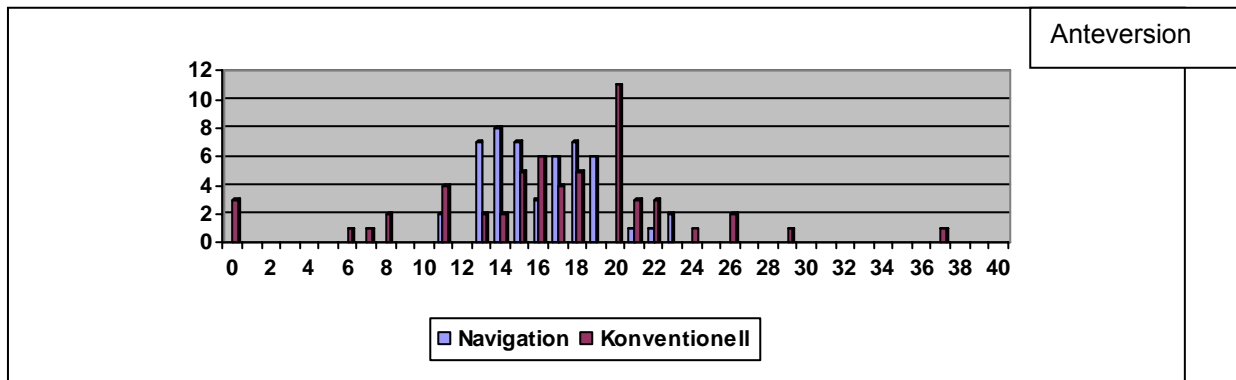
Picture 4: Standardized X-ray, post-op, anteversion

RESULTS:

	Manual Group	Navigated Group
Inclination		
mean	40.3°	40.1°
standard deviation	7.4	5.0
confidence area (95%)	2.0	1.3
Anteversio		
mean	16°	16.3°
standard deviation	6.9	2.8
confidence area (95%)	1.9	0.7



Picture 5



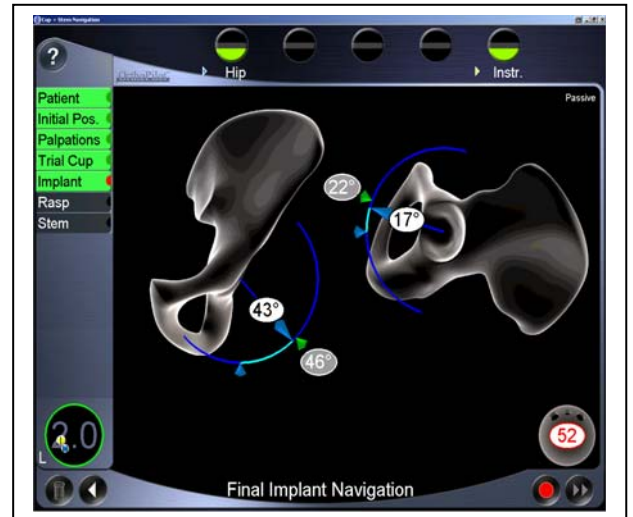
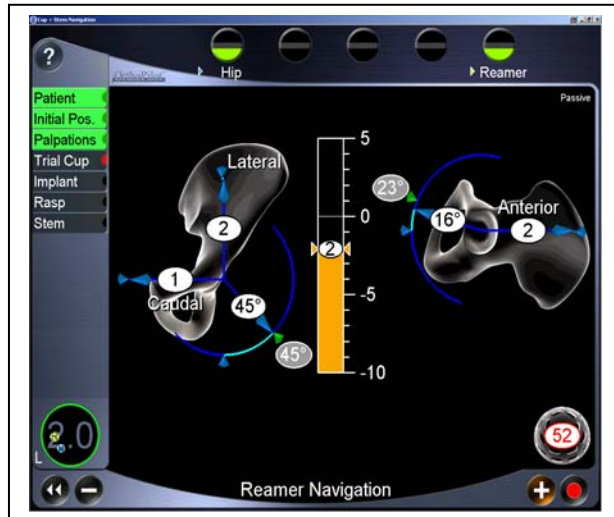
Picture 6

With regard to cup inclination and particularly to cup anteversion, the distribution of the measured angles was significantly broader in the free hand implanted group. In the navigated group we found no outliers (what is the definition of outlier?). In the navigated group the standard deviation for cup inclination was 5.0 and for cup anteversion 2.8. In the conventionally implanted group the standard deviation for cup inclination was 7.4 and for cup anteversion 6.9. It must be pointed out that the standard deviation for the anteversion without navigation help, was more than 2.5 times higher than with navigation. Furthermore the confidence areas are narrower for OrthoPilot technology.

Accuracy of OrthoPilot system:

Differences of OrthoPilot measurements (stored in the computer) and the measurements found by application of the above described reproducible conventional X-Ray method:

	Anteversio	Inclination
Mean of deviation	2.373	0.275
confidence area (95%)	1.611	2.213



Picture 7 + 8: information on OrthoPilot system during reaming and cup implantation

CONCLUSION AND DISCUSSION:

During conventional THA particularly the anteversion can intraoperatively not exactly be assessed since the individual position of the patient's pelvis can not be assessed by the surgeon without any aid.

The study showed that with the help of a computer based navigation system the cup inclination and anteversion can be positioned more exactly.

We did not see any luxations in the computer navigated collective till now.

Two early luxations were recorded in the conventional operated collective. In addition, the medial wall of the pelvis was perforated in two cases, when reaming without navigation help. Results of clinical long-term studies to clarify longevity of the computer navigated implanted cups have to be watched.

Keywords:

conventional total hip arthroplasty, computer-assisted surgery, kinematic navigation- system, cup position.