LEG LENGHTH DISCREPANCY, DISLOCATION RATE AND OFF-SET IN TOTAL HIP REPLACEMENT USING A SHORT MODULAR STEM: NAVIGATION VERSUS CONVENTIONAL FREE-HAND

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Abstract: The Authors present a match-paired study between computer assisted and free-hand techniques using a short modular femoral stem in total hip arthroplasty (Metha, B.Braun Aesculap, Tuttelingen; Germany). They assessed surgical time, clinical outcome, dislocation rate, limb length and off-set in 44 patients with ideal indication for this more conservative implants. Despite both longer surgical time and similar early outcomes, the results demonstrated how computer assisted techniques permits an easier way to manage limb length discrepancy and off-set restoring.
The Authors do believe navigated short modular stems as safe procedure towards a real less invasive surgery in hip arthroplasty

Introduction:

Interest in minimally invasive total hip replacement (THR) has increased throughout the orthopaedic community (1, 2). Most of the attention in this area has been directed toward reducing the surgical exposure by using dedicated instruments (3). One of the drivers of this change has been the more frequent use of joint replacements in young and active patients. In this group preserving bone stock becomes more important as the need for a revision procedure is increased (4). Recently, short femoral stems have become available for total hip replacement in these patients. These stems allow preservation of the femoral neck and have shown early positive results in selected cases (5, 6, 7). Stem modularity and navigation technology to support correct implant selection and alignment are some of the newer innovations in this area designed to optimize the accuracy of joint reconstruction using shorter femoral stems. Computer navigation allows the surgeon to evaluate intraoperatively limb length, medialization of the center of rotation and ROM (8, 9)

Leg length discrepancy following total hip replacement can be a significant problem and has been shown to contribute patient dissatisfaction (10, 11). Pain, instability, stiffness, neuropathy and heterotopic ossification are all described as a direct or indirect consequence of leg length discrepancy and incorrect femoral off-set (12).

Studies in the literature demonstrate substantial statistical improvement in the accuracy of acetabular cup placement using navigation compared with free-hand alignment methods. However, few studies have been published on the results of femoral stem placement using computer navigation and none evaluating the effect of navigation on leg length discrepancy (13, 14, 15, 16).

The Authors performed a matched paired study between 2 groups of modular short stem in hip arthroplasty: with (Ca-THR) o without the navigation support. They hypothesized that Ca-THR permits to achieve a better joint reconstruction with an effective control over the leg length discrepancy. Furthermore they compared the 2 groups according to hip function and number of post operative dislocations.

Materials and Methods:

Patients who underwent a total hip replacement (THR) using modular short stemmed femoral components between April 2006 and January 2008 were included in the study. All patients had a body mass index less than 35. Patients with hip dysplasia, limb length discrepancy greater than 2cm or a major deformity of the femoral head or neck were excluded because not ideal candidates for this implant.

Twenty-two patients who underwent a Ca-THR using a CT-free computer assisted alignment system (Orthopilot 3.1, Aesculap, Tuttelingen; Germany) were included in group A. Each patient in this group was matched with a patient who had undergone to a conventional free-hand THR (group B). Patients were matched for age (maximum difference ± 3 years), sex, arthritis level, pre-operative diagnosis and pre-operative limb length discrepancy (maximum difference ± 0.3cm). The length of involved limbs was less than or equal to that of the contralateral limb in all cases.
In both groups the same postero-lateral approach was made to the hip joint. The same prosthesis was used in all cases (Metha modular short stem and Plasma-Cup, B.Braun Aesculap, Tuttelingen; Germany). The duration of surgery was documented.

Pre-operative and post-operative measurements of limb length discrepancy and femoral off-set were made using digital radiographs as described by Woolson et al. (17) with IMPAX digital radiography software (Agfa-Gevaert, NV, USA) (fig 1a-1b). At latest follow-up the ability to re-create the femoral off-set was determined by the difference between the pre and post-operative femoral off-set measures (fig 2). All the radiographs were always taken with a standardized protocol using the same magnification. This protocol was rigidly adhered to during the study and radiographs were repeated if a mistake was detected. All radiographs were assessed by an independent radiologist blinded to the original procedure.

Post-operatively early weight bearing as tolerated was encouraged in all patients. All episodes of hip dislocation were documented. At a minimum follow-up of 3 months the clinical outcome was evaluated using the Harris Hip Score.

Statistical Analysis was carried out using SPSS for Windows Release 11.0 (SPSS Inc, Chicago, Ill, USA). Data were represented as a mean and standard deviation for continuous response variables and as percentages for discrete variables. Differences between the two groups were measured with an independent Student's T test or Mann-Whitney non-parametric test depending on the data distribution of the continuous variables.

Results:

No statistically significant differences in patient's demographics were seen. There were no significant differences in pre-operative limb length discrepancy between the 2 groups. The mean pre-operative leg length discrepancy was 0.9cm in group A and 1.1cm in group B (Table 1). In both groups the pre-operative diagnosis was primary hypertrophic osteoarthritis in 18 patients, avascular necrosis in 3 patients and post-traumatic osteoarthritis in one (Table 1). The mean follow-up was

10.8 and 11.6 months for group A and B respectively. The difference in length of follow-up was not for statistically significant.

No intraoperative complications were encountered in either group. In group A, a 32mm ceramic femoral head was used in 20 cases while a 28mm ceramic head was used in 2. In Group B, a 32mm ceramic femoral head was used in 19 cases while a 28mm ceramic head was used in 3 cases. In the computer-assisted group we noted marked variability in the femoral neck required in terms of inclination, version, and size to achieve anatomical best fit (Diagram 1, 2). Surgical time was statistically longer in group A with a mean of 102.6 minutes compared to 87.7 minutes in group B (Table 2).

In the computer-assisted group the mean post-operative leg length discrepancy was reduced to 0.4cm compared to 0.8cm in the free-hand group. This difference was statistically significant. No post-operative cases with leg length discrepancy greater of 1cm were seen in group A. In group B, a post-operative leg length discrepancy of greater of 1.0cm was seen in 2 patients (9%). In neither group did the post-operative leg length discrepancy exceed 2cm. even if in 3 (13.6%) cases in group B the discrepancy was increase of a mean values of 0.4 cm. At latest follow-up no sign of major subsidence was seen in any of the implants.

Recreation of the femoral offset was significantly better in the computer-assisted group. The difference between the pre-operative and post-operative femoral off-set was less in the computer-assisted group than the free-hand group (Table 2). This difference was statistically significant.

There were no statistically significant differences in the Harris Hip score between the two groups and all the patients were satisfied with the outcome. The mean Harris Hip score was 90.1 and 89 in groups A and B respectively. For patients with a shorter follow-up the final outcome was still improving (Table 2). No cases of hip dislocation were seen in group A. In the group B, 1 patient experienced a traumatic hip dislocation following a car accident 7 months after surgery. This patient subsequently had 2 further atraumatic dislocations but has no radiographic signs of implant loosening. A revision THR is planned for the near future.

Discussion:

Short stem prostheses represent an attractive alternative to resurfacing hip arthroplasty in the same selected cases (4,6). In combination with minimal invasive techniques these implants allow preservation of muscle and bone stock whilst avoiding a number of the complications associated with resurfacing implants (18). Using short stemmed femoral implants the femoral neck is partially maintained and the greater trochanter region remains untouched. In addition the femoral metaphysis is not filled by the implant maintaining some of the cancellous bone (4, 6, 8). Newer implants have incorporated modularity of the short femoral stem in an attempt to improve the restoration of hip anatomy and biomechanics and reduce the chances of mechanical failure. (8,9,19) (fig 3).

A significant problem with these short stemmed femoral implants has been lengthening of the operated leg. Lazovic in 2006 has shown that even with navigation support using this implant can lead to elongation of leg length by 1cm to 1.5cm (9). This problem is also seen with resurfacing procedures and has led us to avoid this technique in 'longer hips'

Multiple studies have shown that better implant placement of the acetabular cup and femoral stem can be achieved using navigation in THR (13, 14, 15, 16). Navigation of short stemmed femoral implants is mainly based on the restoration of the hip anatomy with little regard for stem positioning (8, 9). The navigation can evaluate intra-operatively the best modular neck and head size to achieve the desired femoral off-set, leg-length and range of motion. In our study the computer navigation support allowed for better exploitation of the different modular neck options to achieve the best anatomical fit.

We performed a matched paired study comparing 22 computer-assisted to traditional free-hand THR using the same modular short stemmed femoral component. Strict criteria including diagnosis, age and sex, body-mass index and shortening were used to match the two groups. At a minimum follow-up of 3 months after surgical intervention our results demonstrated that computer navigation achieved statistically significant better results both in correcting limb length discrepancy and in restoring the original off-set.

We recognise that our study does have some limitations. It was a retrospective analysis and the patients were not randomised. The follow-up was short and the number of cases in each group was small. As a result we may not detect a clinical difference between the 2 groups and conclusions regarding an improvement in the dislocation risk with this technique cannot be stated conclusively. However, we note that no cases of primary atraumatic dislocation were seen in either group including those patients with longer follow-up.

Our results demonstrated that using computer navigation in THR with modular short stemmed femoral components can enhance the ability to correct limb length discrepancy and to restore the original femoral off-set. The Authors believe that given the correct indications navigated short stemmed femoral prosthesis represent a minimally invasive THR option which can restore normal joint biomechanics with results at least similar to other more traditional techniques.

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	Group A (CAS-THR) 13♀, 9♂	Group B (THR) 13♀, 9♂
Age (years)	M:60.4 STD: 5.2 R: 47-68	M: 60.8 STD: 4.8 R: 48-69
Follow-up (months)	M: 10.8 STD: 6.08 R: 3-19	M: 11.6 STD: 6.08 R: 4-20
Pre-op discepancy (mm)	M: 11.2 STD: 4.4 R: 0-20	M: 10.4 STD: 3.9 R: 3-19
Pre-op HHS score	M: 43.95 STD: 3.31 R: 39-50	M: 43.4 STD: 2.98 R: 38-51
Pre-op diagnosis	18 hyperthophic osteoarthritis 3 avascular necrosis 1 post-traumatic osteoarthritis	18 hyperthophic osteoarthritis 3 avascular necrosis 1 post-traumatic osteoarthritis

Table 1. Patient demographic data, 22 cases are considered. Data are reported as mean value (M), standard deviation (STD) and range (R).

	Group A (Bi-UKR) 14♀, 8♂	Group B (TKR) 14♀, 8♂	p
Surgical time (minutes)	102.5 min (range: 123-86) S.D. 12.2	87.7 min (range: 68-105) S.D. 11.7	0.0001
Post-op HHS score	M: 90.1 STD: 6.0 R: 78-99	M: 89 STD:6.5 R: 80-100	0.5
Post-op discepancy (mm)	M: 4.1 STD: 1.7 R: 0-7	M: 7.9 STD: 2.8 R: 3-14	>0.0001
Post-op off-set *(difference in mmm between the pre and post values)*	M: 2.8 STD: 0.5 R: 0-6	M: 5.1 STD: 1.9 R: 2-9	0.0002

Table 2. Post-operative results for the two groups, 22 cases are considered. Data are reported as mean value (M), standard deviation (STD) and range (R).

Diagramm 1

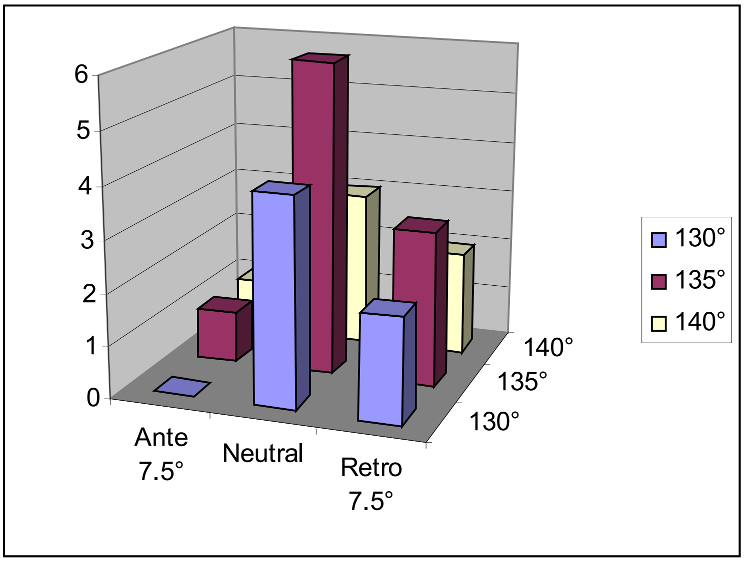
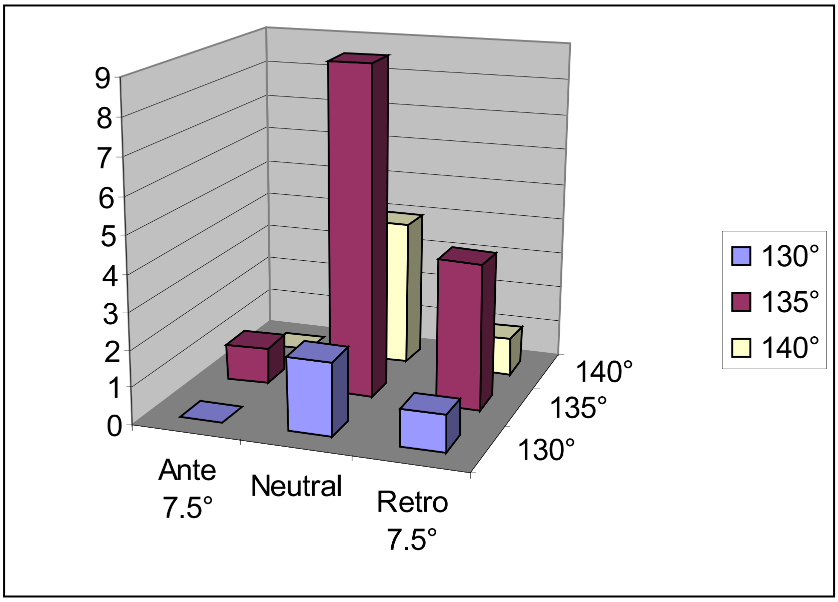


Diagram 2



Legends:

Diagram 1: Modularity in the CA group with a wider choice of solutions

Diagram 2: Modurarity in the free-hand group

Fig 1a-1b: Preoperative pelvis radiograph of a 63 years old woman previously operated on the right side with the relative pre-operative planning

Fig 2: Follow-up pelvis radiograph after the implantation of a navigated Metha.

Fig 3: Screenshot showing the multiple choices in modularity of the necks and different head sizes to cope with the best joint reconstruction