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ORIGINAL STUDY

The addition of an anti-rotation screw to the dynamic hip screw

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The aim of this study is to assess if there is a difference in outcomes between a dynamic hip screw with or without an anti-rotation screw in the treatment of hip fractures.

All patients with an intracapsular hip fracture who underwent dynamic hip screw osteosynthesis between January 2010 and December 2013 in three Dutch hospitals were reviewed. Minimal follow-up was one year.

The study included a total of 364 patients. 24 patients were lost to follow-up and excluded. 297 (87.4%) were in the dynamic hip screw group and 43 (12.6%) in the dynamic hip with anti-rotation screw group. Direct comparison of patient characteristics of the two groups showed significant differences in age, sex, Garden classification and Pauwels classification.

Patients operated with a dynamic hip screw and anti-rotation screw are significantly younger and their fractures are significantly more dislocated and steeper. To draw conclusions about differences in outcome, a randomised clinical trial should be performed.

Keywords : Hip fracture ; DHS ; anti-rotation screw.

INTRODUCTION

Femoral neck fractures (or intracapsular hip fractures) are common injuries. Depending on patient and fracture characteristics, surgical treatment consists of (hemi-) arthroplasty or reduction and internal fixation. In a case of internal fixation, either three cannulated screws, or a Sliding Hip Screw/ Dynamic Hip Screw (DHS) can be used. Literature shows a reoperation rate of 10.0-48.8% after internal fixation *(3)*. A recent randomized controlled trial showed no difference in reoperation rates between three cannulated screws and DHS fixation *(6)*. To increase stability and prevent rotation of the femoral head, surgeons can place an anti-rotation screw (ARS) above the DHS, although its added value of an ARS is controversial. In a biomechanical cadaveric study by Bonnaire et al. the DHS with an ARS showed superior stability compared to the DHS without an ARS *(4)*. Other studies suggested that increasing the volume of implant within the femoral head by adding an ARS could result in more complications *(13)*.

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To our knowledge, only one small retrospective study by Makki et al. compared the clinical outcomes of DHS surgery with and without an ARS [9]. The conclusion was that adding an ARS to a DHS is associated with extra costs, prolonged operation time, and more intraoperative fluoroscopy but that there are no advantages regarding fracture union. Because of the small sample size (N=65) and the retrospective design, no firm conclusion could be drawn from this study. Due to the lack of strong evidence, it remains unclear whether the use of an ARS would favour uncomplicated fracture healing, and hence decrease the reoperation rate.

The aim of this study is to assess the difference in reoperation rates caused by avascular head necrosis, non-union or implant failure between DHS surgery with an ARS, and DHS surgery without an ARS. Our hypothesis is that the adding of an ARS to a DHS provides greater stability and prevents the rotation of the femoral head, leading to a reduced rate of reoperations.

PATIENTS AND METHODS

This study reviews intracapsular hip fracture patients between January 2010 and December 2013 where a DHS fixation was applied. The minimal follow-up was one year. The participating hospitals included one academic hospital and two teaching hospitals in the Netherlands. Inclusion criteria were : 18 years or older, an intracapsular hip fracture and operated with a DHS. Patients were excluded if : classified as multi-trauma patient (Injury Severity Score >15), missing operation report, and extracapsular fractures.

Patients were selected from a regional trauma registry, using the Abbreviated Injury Scale (AIS 98851812.3 ; score of intracapsular hip fracture). Sex, age, day of admission and the Injury Severity Score were retrieved from the regional trauma registry. Additional data was collected from the local hospital information system, including : ASA classification (American Society of Anesthesiologist physical status scoring system), type of osteosynthesis, operation time, time of surgery and post-operative complications (reoperations, wound infections and mortality) *(1)*. The preoperative and perioperative x-rays were reviewed to assess the fracture dislocation (Garden classification with Garden 1+2 defined as non-displaced and Garden 3+4 as displaced), the obliquity of the fracture (Pauwels classification), the fracture reduction and the implant position *(2,7)*. Fracture reduction was classified as adequate if the femoral neck angle was <10° varus or <15° valgus compared to the contralateral hip on an AP pelvis radiograph, and the displacement between fracture fragments on AP and lateral radiographs was < 3 mm *(5)*. Implant position was classified as adequate if the DHS on the AP and lateral view was respectively central and central, inferior and central or inferior and posterior in the femoral head, and the distance between the tip of the screw and the bone/cartilage interface was < 20 mm, and the DHS and the ARS were parallel (<5°) on AP and lateral view *(5)*.

The X-rays and medical charts of reoperated patients were reviewed to establish the reason for reoperation : avascular head necrosis (AVN), non-union or implant failure (dislocation of osteosynthesis or fracture). Removal of the implant because of possible irritation without failure was not considered as a reoperation.

All analyses were performed using IBM SPSS Statistics® version 22. Normally distributed continuous data is presented as mean and standard deviation, non-normally distributed continuous and ordinal data as median and interquartile range and categorical data as percentages. The Chi-square test or exact test was used for comparing categorical data, and comparison of continuous data was performed by the Student's t-test or a non-parametric test if the distribution was not normal.

A logistic regression was performed to examine the impact of the anti-rotation screw (independent variable) on the risk of reoperation (dependent variable). Differences were considered significant with a p-value lower than 0.05.

RESULTS

The study included a total of 364 patients that underwent DHS surgery, of whom 49 with an ARS and 315 without additional ARS. The mean

Table 1. — Patient baseline characteristics

N=340	DHS N=297	DHS + ARS N=43	P-value
Age in years (mean)	72.3	63.7	<0.01†
Male (%)	118 (39.7%)	25 (58.1%)	0.02*
ASA > 2	42 (14.1%)	3 (7.0%)	0.07*
DHS plate *2-hole plate* *4-hole plate*	 283 (95.3%) 14 (4.7%)	 42 (97.7%) 1 (2.3%)	0.47*
Garden classification *Non displaced(Garden 1+2)* *Displaced (Garden 3+4)*	 206 (70.1%) 88 (29.9%)	 16 (37.2%) 27 (62.8%)	<0.01*
Pauwels Classification *Type 1* *Type 2* *Type 3*	 65 (21.1%) 112 (38.1%) 117 (39.8%)	 4 (9.3%) 12 (27.9%) 27 (62.9%)	0.01*
Adequate reduction	222 (76.8%)	30 (69.8%)	0.31*
Adequate implant position	245 (83.9%)	34 (79.1%)	0.42*
Time to operation (hours)	17.9	15.4	0.17†
Time of surgery (minutes)	57	66	0.04†

† = Independent sample T-test. * = Chi-square test. DHS = Dynamic Hip Screw. ARS = Anti-rotation screw. ASA = American Society of Anesthesiologist physical status scoring system.

Table 2. — Failures specified for age and Garden Classification

Age in years	Garden Classification	Type of osteosynthesis	Number (N=337†)	Failures (%)	P-Value
< 65 year	1+2	DHS	45	6 (13,3%)	0.05*
	1+2	DHS + ARS	8	1 (12,5%)	
	3+4	DHS	46	11 (23,9%)	
	3+4	DHS + ARS	20	4 (20%)	
65 – 80 years	1+2	DHS	64	10 (15,6%)	0.03**
	1+2	DHS + ARS	3	1 (33,3%)	
	3+4	DHS	30	9 (30%)	
	3+4	DHS + ARS	7	4 (57,1%)	
> 80 years	1+2	DHS	97	6 (6,2%)	0.57**
	1+2	DHS + ARS	5	2 (40%)	
	3+4	DHS	12	2 (16,7%)	
	3+4	DHS + ARS	0	0	

† = 3 missing patients due to no pre-operative X-ray available. * = Chi-square test. ** = fisher's Exact Test. DHS: Dynamic Hip Screw. ARS : Anti-rotation screw.

age was 70.4 years (median 70, standard deviation 14.7), 57.7% was female and the median (IQR) ASA classification was 2 *(1-2)*. The follow-up in 24 patients did not take place in the operating hospital ;

Table 3. — Complications

N=340	DHS N=297	DHS + ARS N=43	P-value
Reoperations	45 (15.2%)	12 (30.2%)	0.04*
AVN	30 (10.1%)	5 (11.6%)	
Non-union	5 (1.7%)	2 (4.6%)	
Implant failure	10 (3.3%)	5 (11.6%)	
Removal of osteosynthesis without implant failure	20 (6.7%)	3 (7.0%)	0.95*
Wound infections	4 (1.4%)	2 (4.7%)	0.13*
Superficial	3 (1.0%)	1 (2.3%)	
Deep	1 (0.3%)	1 (2.3%)	
30-day post-operative mortality	18 (6.3%)	0 (0.0%)	0.10*

*Chi-square test. † Independent sample T-test. DHS : Dynamic Hip Screw. ARS : anti-rotation scre.

these patients were considered lost to follow-up and excluded from analysis. Lost to follow-up occurred in 18 patients (5.7%) of the DHS group and in 6 patients (12.2%) of the DHS + ARS group.

The DHS + ARS group was significantly younger and the fractures were more dislocated and steeper (Table 1).

Table 2 shows no difference in failure rate between DHS and DHS + ARS in the below-65 age group. In the 65-80 age group a significant difference in failure rate between DHS and DHS + ARS was present.

In the follow-up group of 340 patients, there were 57 reoperations (17%) : 35 avascular necrosis of the head, 7 non-unions and 15 implant failures (Table 3). A significant difference in reoperations (AVN, non-unions, implant failure) was found between the two groups. Comparing the causes of reoperation showed that only implant failure was significant (Table 3).

The DHS and the DHS + ARS groups showed significant differences in baseline characteristics. To account for these differences, a logistic regression was performed, where the reoperation was the dependent variable and the ARS was the independent variable. The impact of each baseline characteristic on the beta coefficient of the logistic regression analysis was examined. Garden classification, Pauwels classification and ASA classification caused a difference of over 10% in the beta coefficient. Due to the relatively high number of confounders, and low number of patients in the DHS + ARS group, no reliable logistic regression model could be performed.

DISCUSSION

This study shows that in a specific patient category an ARS is sometimes added to the DHS, and that no conclusion can be drawn from different reoperation rates between DHS surgery and DHS + ARS surgery. The hypothesis that a DHS combined with an ARS provides more stability, and therefore would result in fewer reoperations when compared to the fixation of only a DHS could not be confirmed. The decision to place an ARS remains up to the surgeon, based on his or her experience.

Direct comparison between the two groups (DHS versus DHS + ARS) showed that patients in the DHS + ARS group were significantly younger and more often male, with fractures that were significantly more dislocated and steeper.

Literature shows that a higher age, a displaced fracture, and a steeper fracture are associated with higher rates of reoperations *(8,11,14,16)*. Two meta-analyses (Bhandari et al. and Parker et al.) have shown that in patients with a dislocated fracture (hemi)-arthroplasty leads to fewer reoperations compared to internal fixation *(3,12)*. The NICE guidelines also recommend to perform replacement arthroplasty (hemiarthroplasty or total hip replacement) in patients with a displaced intracapsular fracture,

independent of the age of the patient *(10)* In our study, selection bias seems present in the choice of operation technique (confounding by indication), as surgeons tended to use an ARS in younger patients with more displaced and steeper fractures. An explanation for this selection bias might be that in younger patients surgeons find a higher risk of reoperation acceptable, given the benefits of a head-saving operation. In older patients surgeons do not accept this reoperation risk and are more willing to opt for a hemi-arthroplasty instead of a DHS.

Placing an additional ARS extended the operation time by an average of 9 minutes. The study by Makki et al *(9)* stated that due to the prolonged operation time and the cost of an ARS, placing an ARS was significantly more expensive. This conclusion cannot be drawn from our results. The study by Makki et al. had a small number of inclusions (N=65) and did not compare the baseline groups on Pauwels classification, reduction score and implant position. A possible explanation for a reoperation is an inadequate reduction or implant position. Avascular necrosis of the femoral head occurred in 35 patients, of whom 9 did not have an adequate reduction and 6 did not have an adequate implant position, but both findings were not significant (P = 0.73 and P = 0.88). 15 patients had a reoperation caused by implant failure, in three patients the reduction and implant scores were inadequate (not significant).

The 30-day post op mortality differed between the two groups : 6.3% in the DHS group versus 0% in the DHS + ARS group. A possible explanation for this difference might be the difference in age and comorbidity (ASA-classification) between the two groups.

To correct for the potential selection bias between the two groups, a logistic regression analysis was performed. Possible confounders for the reoperation rate were included (age, sex, ASA classification, Garden classification, Pauwels classification, implant position and reduction score). Due to the low event rate, no reliable model could be made to correct for all confounders. Increasing the number of patients would only correct the power but not the effect of confounding by indication. In all retrospective or prospective cohort studies this effect will be present ; as the placement of an ARS remains at the surgeon's discretion, based on his or her experience. The only way to correct for this confounder is performing a randomised clinical trial.

CONCLUSION

This study shows that patients undergoing DHS + ARS surgery and patients undergoing DHS surgery are different patient categories. The patients treated with a DHS+ARS are significantly younger and their fractures are significantly more dislocated and steeper. Direct comparison between these two patient groups was not possible due to confounding by indication. Correcting for this confounder is not possible in a retrospective cohort study ; this can only be done in a randomised clinical trial.

The hypothesis that a DHS combined with an ARS would provide greater stability and result in fewer reoperations when compared to the fixation of only a DHS cannot be confirmed on the basis of this study.

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