DISPLACED INTRACAPSULAR NECK OF FEMUR FRACTURES: DISLOCATION RATE AFTER TOTAL HIP ARTHROPLASTY

BY

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Declaration

I, **Sibasthiaan Shituleni**, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Abbreviations

THA - Total Hip Arthroplasty

ORIF - Open Reduction and Internal Fixation

TFL - Tensor fascia lata

FAITH - Fixation Using alternative Implants for the Treatment of Hip Fractures

HEALTH - Hip Fracture Evaluation with Alternative of Total Hip Arthroplasty versus hemi-arthroplasty

ALTR - Adverse Local Tissue Reactions

ALVAL - Aseptic Lymphocytic Vasculitis-Associated Lesions

Chapter 1: Literature Review

Objectives

The objectives of this literature review are to critically review the evolution of neck of femur fracture management, incidence of dislocation and the risk factors associated with dislocation. We will review the biomechanical aspects of THA and how larger femoral head sizes enhance stability following THA and reduce the risk of dislocation.

Literature search methods

We conducted the literature search scanning the English literature using PubMed and Google scholar.

Specific search terms for this literature review were as follow:

- Management of hip fractures
- Neck of femur fractures
- Management of neck of femur fractures
- Total Hip Arthroplasty for hip fractures
- Hip Arthroplasty registries
- Dislocation rate of Total Hip Arthroplasty
- Risks factors associated with dislocation of Total Hip Arthroplasty

We reviewed all relevant full-text journal articles, books, government and

Arthroplasty registry publications found on this search. Citations of the relevant articles were reviewed as well and follow up searches done on authors of referenced articles. One Author was contacted for comments on the published article and permission obtained for the use of some of the figures.

Search results that yielded from this literature review were satisfactory and enabled the researchers to have a broad overview of the published literature of the subject.

Literature Review

Neck of femur fractures are common and frequently lead to significant morbidity and mortality worldwide. The number of people with Hip fractures is predicted to be 6.3 million worldwide by 2050 (1). Mortality rate for hip fractures ranges from 14% to 36% at 1 year (2).

Management of Neck of Femur Fractures

Neck of femur fractures are becoming increasingly common (3,4). This is due to the increase in the number of aging population. These fractures are more common in the female gender (3). While fractures of the neck of femur are relatively uncommon in the young, high energy (motor vehicle accidents, high-height falls or industrial accidents) is the main mechanism of injury in young patients. The fractures in the young are often comminuted. The mechanism of injury is low energy (as a result of poor bone quality) in the elderly population.

Challenges encountered in the management of these patient groups are the nature of the fracture in young patients. They are commonly comminuted and associated with multiple other injuries. Elderly populations commonly have multiple co-morbidities and often pre-existing hip arthrosis (1,5). Neck of femur fractures are classified as undisplaced or displaced.

Management of neck of femur fractures is determined by various factors. These are patient related and depend on fracture characteristics. Some of these factors are premorbid ambulatory status, patient cognitive status, medical comorbidities and fracture displacement.

The optimal treatment of neck of femur fractures has evolved over the years, but remains controversial. Options for management include non-operative treatment, percutaneous fixation, closed reduction and internal fixation, open reduction and internal fixation and arthroplasty (either hemi-arthroplasty or total hip arthroplasty). Recent literature supports Total Hip Arthroplasty over fixation and hemi-arthroplasty due to equal mortality, reduced complication and better functional outcomes (4,6-9). Potential adverse outcomes following treatment by open reduction and internal fixation are non-unions, osteonecrosis with subsequent avascular necrosis of the femoral head, varus malreduction and fixation implant cut-outs, leading to acetabular erosion and bone loss. The number of THAs is projected to increase 170% by 2030 (10). A comparison made between Fixation, Hemi-arthroplasty and THA revealed similar cost for treatment after 2 years of follow up (6).

In a multicenter prospective randomized trial, Rogmark et al, reported a 6% failure rate for total hip arthroplasty compared to 43% for open reduction and internal fixation (8). The dislocation rate in the same study was 8% (4.2% recurrent dislocations) with 13% mortality at one year. In comparison to previous studies, dislocation rate following total hip arthroplasty in displaced hip fracture is less than 10% (8,11-13). This makes THA for displaced neck of femur fractures a viable option.

Hip joint preservation and avoidance of complications of THA are regarded as advantages by some surgeons. On the other hand, some surgeons favour THA as a treatment modality due to quicker rehabilitation and avoiding all complications associated with fracture union and femoral head vascularity (14).

Dislocation of THA

Dislocation is one of the most common orthopaedic complications following primary total hip arthroplasty (15) and it can lead to substantial morbidity and medical costs. It is one of the primary reasons for revision THA (16). It is reported in the literature that the annual dislocation following primary THA ranges between 2% to 20% dislocation rate for THA performed for fractured neck of femurs (9,12). Dislocated THA have worse outcomes in comparison to THA that are not dislocated with a survivorship studies showing reporting around 50% survival rate in dislocated THA(17). It is reported in the literature that over half of

all the dislocation after THA occurs in the first 3 months after surgery and more than 75% in the first year (18).

THA is one of the most successful operations in Orthopaedic Surgery (19), but due to the high incidence of dislocation reported in the literature (ranging from 2% to 20%), a large number of surgeons are reluctant to perform THA (9,20,21). Is it justifiable to do THA for fractured neck of femur?

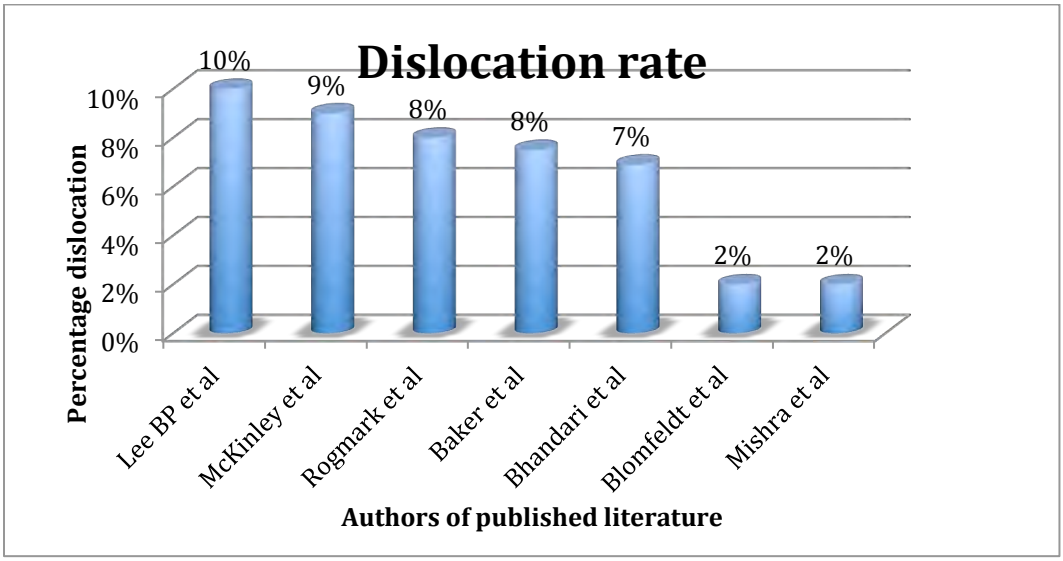
Johansson et al. (22) reported a 22% re-operation in patients treated with THA while Ravikumar reported a 20% failure rate (23). The failures included reoperations such as relocation of a dislocated THA, revision THA and removal of internal fixation devices. Naeder et al. and Rogmark et al. reported a 10% re-operation rate whereas Keating et al reported a 9% and Blomfeldt et al on 4% (6-8,24). These studies primarily compared the outcomes of different treatment modalities in neck of femur fractures such as Internal Fixation, Hemi-Arthroplasty and THA. Overall functional outcomes for the THA group were better compared with internal fixation and hemi-arthroplasty (25). The cost of internal fixation for neck of femur fractures is lower at the index surgery, but the overall cost of THA is equal or lower if patients are re-operated. Puolakka et al reported a 44% reoperation rate for the internal fixation group, highest rate reported in comparison of treatment modalities (26).

Only a few studies looked at dislocation rate in isolation.

Lee et al reported a 10% dislocation rate for THA performed for neck of femur fractures. Mckinley et al reported 9%, Rogmark et al 8%, Baker et al 7.5% and

Bhandari 6.9% (4,8,9,27). The lowest reported dislocation rates are by Blomfeldt and Mishra (7,20) who reported a 2% dislocation rate.

Figure1: Dislocation after THA



Etiological and Risk factors of dislocation in THA

Dislocation following THA is defined as the loss of articulation between the acetabular cup and femoral head implants. This is due to the failure of the biomechanics of the implanted components and the soft tissue restrains. Factors leading to dislocation are either patient-related (age, neuromuscular disorders, mental impairment) or surgical risk factors (Femoral head size, Surgical approach, component positioning, impingement and liner profile among others). Higher dislocation rates have been reported in elderly patients, patients with muscular dystrophy and dementia (28). Patient age and sex are important factors. The Swedish hip registry reported on high failure rate and increased risk

of dislocation in elderly patients (29). All the patients included in the comparison studies of Internal Fixation, Hemi-Arthroplasty and THA were over the age of 60 years (7,8,22,23). Lee et al found that elderly patients had higher failure rates (21). Female patients are reported to have a lower risk of dislocation (30). Other researchers, including Meek et al reported high incidence of dislocation within the first 3 months and an overall high dislocation rate within the first year following THA (18,28,31). Johanson et al reported a 32% dislocation in patients with mental impairment with displaced neck of femur fractures treated with THA (22). Jameson et al reported on decreased incidence of dislocation with the increase in femoral head sizes of over 240 000 THA from the National Joint Registry for England and Wales (32). Berry et al reported that smaller femoral head sizes are associated with high dislocation rate (15). Hailer et al showed that posterior approaches has higher dislocation rate, with a RR of 1.3 (CI 1.1 – 1.7). Sariali et al demonstrated in their study to determine the accuracy of reconstruction of the hip using computerised three-dimensional pre-operative planning and a cementless modular neck that inaccurately positioned components led to higher failure rate and revision due to dislocation (33). Lachiewicz et al reported on low early and late dislocation rates with larger femoral head sizes with highly cross-linked polyethylene in high-risk patient for primary THA (34). Polyethylene crosslinking reduces the wear rate. **Hedlundh** et al in a study conducted to assess surgeon experience found that inexperienced young surgeons and trainees had a higher dislocation rate (35). The use of modern implants has eliminated most of the risks associated with implant designs. Careful pre-

operative assessment of patient risk factors, correct decision making for the choice of treatment of neck of femur fractures, appropriate implant choice, optimal surgical approach and soft tissue tensioning will aid in lowering the incidence of dislocation.

Biomechanics in THA

Biomechanics for THA is complex. It affects joints center, neck angle, offset, lever arms, impingement and hip range of motion. Loosening and dislocation can be affected by prosthesis designs and surgical technique. Various surgical approaches can be used for total hip arthroplasty. Namely anterior, antero-lateral, lateral, posterior and minimally invasive approaches. A specific approach might be an option of the surgeon's preference, familiarity and experience of the approach. The posterior approach is reported to have a higher dislocation rate compared to transgluteal and anterolateral approach (36). Properly performed surgery with meticulous soft tissue tensioning and capsular repair minimizes the risk of dislocation in posterior surgical approach.

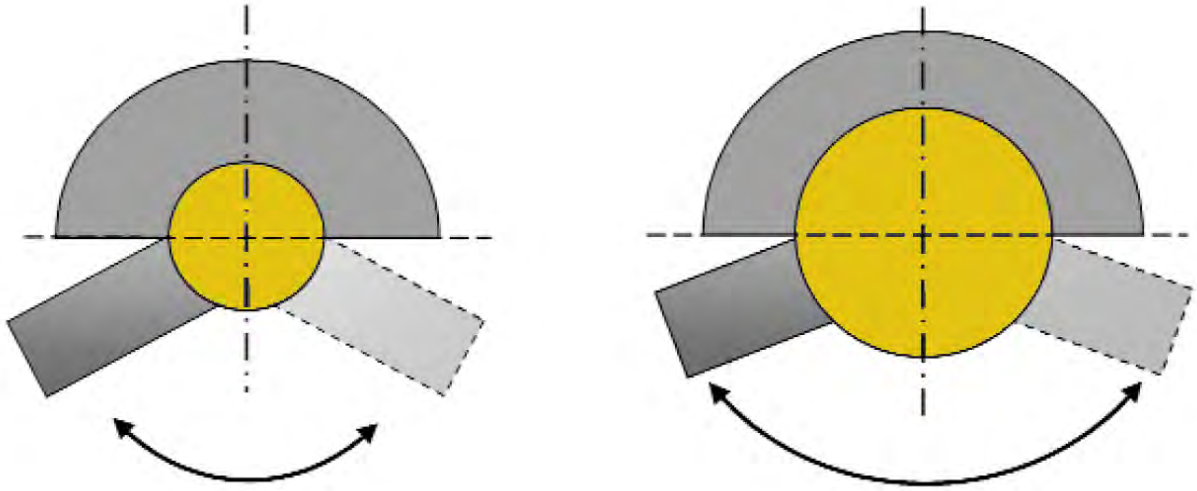
Prosthesis design influences range of motion. Femoral components vary widely. They are made of different material, shape, diameter, surface coating and lengths. All femoral heads have a modular or monobloc articulating femoral head. The head sizes vary from 22 mm to 60 mm. Acetabular components have different fixation mechanisms with either a hemispherical or conical shape.

Figure 2. Different femoral component designs with varying head sizes

Legend: *The design of the prosthesis has changed over the years.*

Femoral head size has a direct relation to the hip range of motion. Increasing the head size from smaller to larger diameter heads results in an increase of the range of motion of the hip joint. Larger heads have a higher friction moment, despite the advantage of an increased jumping distance that lower impingement and risk of dislocation. Larger heads need a higher joint separation to relocate once dislocated, thus increasing the force required to relocate.

Figure 3. The relation of femoral head size and range of motion before impingement.



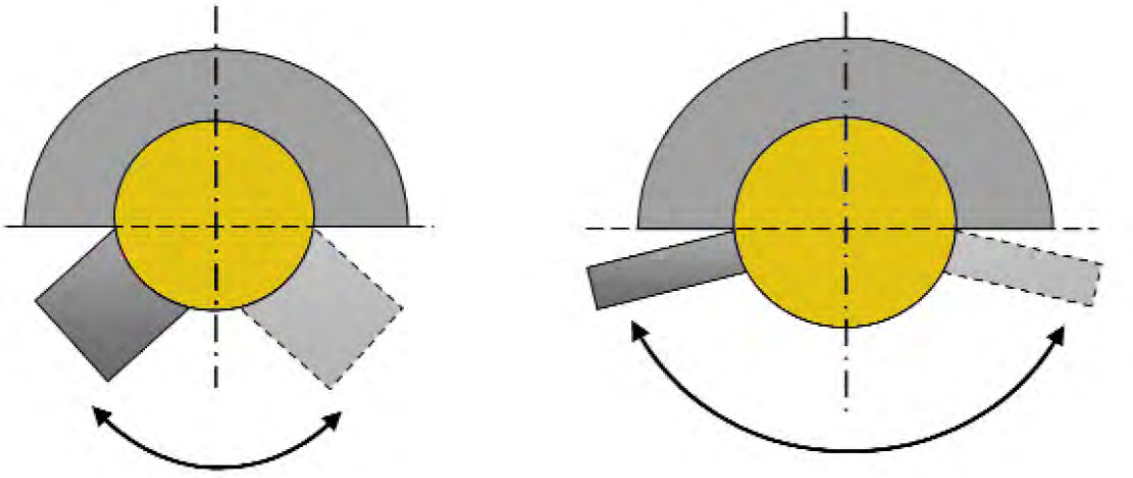
Legend: *Range of motion is significantly increased with larger femoral head sizes*.

All these are technical aspects, but how large should femoral heads be? Clinical results from published literature demonstrate decrease in dislocation rate with the increase of femoral head diameter. For 28 mm diameter femoral heads the dislocation rate ranges from 0.6% to 3.6% (31), but even higher for 22 mm diameter femoral heads that range from 3.8% (31) to 18.8% (37). Lower rates are reported for the 32 mm diameter femoral heads, 0.5% and 0.0% for 38 mm diameter (38).

Disadvantages of a larger femoral head size are increased wear in metal on polyethylene bearings. Metal-on-metal THA result in increased ion levels. Concerns have been raised about the adverse local tissue reactions (ALTR) and aseptic lymphocytic vasculitis-associated lesions (ALVAL) with larger femoral head sizes.

Stem taper geometry is important for range of motion. Thicker tapers impinge earlier with the acetabular cup.

Figure 4. The effect of taper size on range of motion before component impingement

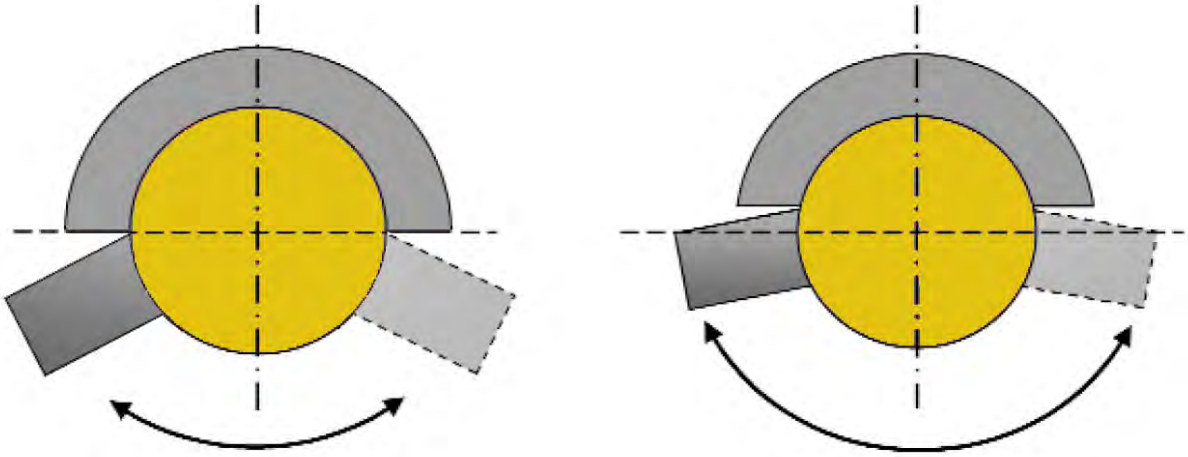


Legend: *Smaller tapered stems have an increased range of motion*.

Acetabular cup design also influences range of motion. The position of the plane of the cup and cup sphericity are vital. The cup is either hemispheric or sub hemispheric. In a hemispheric cup the center of rotation is in the middle of the

entrance plane and impinges when the taper or the neck of the prosthesis comes in contact with the cup (39).

Figure 5. Hemispheric and a sub-hemispheric cup



Legend: *Sub-hemispheric cups have increased range of motion*.

There is increased range of motion in sub-hemispheric cup before impingement, but this adversely decreases the bearing surface. The decreased bearing surface decreases the jumping distance and predisposes patient to the risk of dislocation. Early impingement due to decreased range of motion increases the risk of biomechanical failure of the implanted components and with that increasing the risk of revision due to dislocation.

Implants in THA are either cemented or uncemented. The acetabular cup may be fixed additionally with screws or pegs. There are various reasons for the choice of implant fixation. These depend on surgeon preference, patient age, bone quality etc.

Cementing technique is crucial for successful THA. These techniques have been improved over the past years. Thorough cementing technique will reduce the risk of revision due to dislocation.

Cemented Arthroplasty statistically shows the best overall results (40). But this is different with the recent increase in THA in younger and active patients. Cemented THA in this patient group has poorer results, hence the recommendations for uncemented or hybrid THA for this patient group.

Soft tissue tensioning in THA is important for joint stability. Some studies have shown that surgical approach influences the incidence of dislocation following THA (31). However there is no functional difference following different surgical approaches (41). It is vital to reproduce the anatomical joint center and offset to achieve optimal biomechanical circumstances during loading.

Component positioning is an important factor in determining the outcomes of THA. A poorly positioned acetabular cup increases the risk of dislocation by

reducing the jumping distance (33). It also increases wear and friction with resultant metallosis or pseudo-tumors and subsequent loosening.

Femoral implant designs have improved with shorter stems resulting in bone preservation but a disadvantage of rotation into varus with the lever arm of the joint exceeding the loading capacity of the proximal femur.

Hip Arthroplasty Registries

The number of patients needing hip replacements is increasing steadily. A system to capture all data is essential. Countries such as Sweden, Denmark, Norway, Finland, Australia and New Zealand have hip and knee arthroplasty registries. This phenomenon is growing across the globe. These countries have collected data for over 10 years and collecting data of more than 90% of the patients. The minimum required data collected includes patient demographics, surgeon details, hospital information, basic surgical data, date of surgery, diagnosis, treatment codes, laterality and implant information.

These registries have become important over the years and provide crucial data for outcome studies. With the adoption of these registries by more countries, this can only provide better research answers and address the problems of controversies relating to the optimal treatment of neck of femur fractures.

The major advantages of a joint arthroplasty registry are:

- Effective implant monitoring. This enables early recognition of implant failure.
- Monitoring implant and surgical technique performance.

- Identifying trends.
- Provides research data. This will help with identifying patient risk factors and association with adverse outcomes.

Ongoing Research

Larger randomized trials are required to address the ongoing controversies regarding the treatment of neck of femur fractures. Two large studies are underway currently (FAITH and HEALTH). The FAITH trial (Fixation Using alternative Implants for the Treatment of Hip Fractures) compares sliding hip screws and cancellous screws on revision surgery rates for the treatment of femoral neck fractures. The HEALTH trial (Hip Fracture Evaluation with Alternative of Total Hip Arthroplasty versus hemi-arthroplasty) compares THA and hemi-arthroplasty. Once these studies are completed, it will provide adequate answers on the optimal treatment of neck of femur fractures.

Summary

The literature shows that neck of femur fracture management has progressed over the past years. Optimal management of these fractures remains controversial. There is no consensus on the optimal management of displaced neck of femur fractures. Numerous adverse events following THA are described in the literature. Dislocation is a severe and serious complication. It can be costly

for the patient and pose surgical challenges for the surgeon. Careful perioperative risk assessment, patient selection and surgical execution are key to minimize the risk of dislocation following THA for displaced neck of femur fractures. With the improvement in implant choices THA is a good surgical procedure with good clinical outcomes and improved quality of life. Increased femoral head size has shown a decreased incidence of dislocation.

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Chapter 2 – Manuscript

Title: Displaced intracapsular neck of femur fractures: Dislocation Rate after Total Hip Arthroplasty

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Abstract

Background

Dislocation is one of the most common orthopaedic complications after primary total hip arthroplasty (THA). The reported dislocation rate in elective THR is 5–8%. This number increases up to 22% for THA done for neck of femur fractures. Larger femoral head sizes increase the head-neck ratio and range of motion before impingement, therefore reducing the dislocation rate. Due to the reported increase in dislocation for trauma, some surgeons prefer to do a hemi-arthroplasty or open reduction and internal fixation (ORIF).

Methods

A retrospective review of all THA done for neck of femur fractures during 2006–2012 was undertaken at a large referral hospital. Records were reviewed for patient related and surgical risk factors. We excluded all pathological fractures, extra-capsular fractures and failed ORIF.

Results

A total of 96 cases were identified as suitable for analysis. Average age at surgery was 73.2 years (range 30–81). Delay to surgery was 5.3 days (range 1–63). Average follow up period was 18.3 months (range 3 months-4.3years). Four patients (4.3%) had a confirmed dislocation. The four patients who had confirmed dislocation had the following characteristics, 28 mm femoral head size, age over 60 years, 2 posterior approaches and 3 females, although not statistically significant.

Conclusion

The outcomes of THR in patients with neck of femur fractures can be favorable and provide good long-term prosthesis survival. We report on low dislocation rate post total hip replacement for intra-capsular neck of femur fractures.

Key words

Neck of femur fractures, total hip replacement, dislocation rate, risk factors, South Africa

Introduction

Primary total hip replacement is suggested for treatment of displaced neck of femur fractures in patients with pre-existing arthrosis of the hip or if they expect a high level of activity. Dislocation is one of the most common orthopaedic complications after primary total hip arthroplasty (1). Dislocation is associated with high morbidity and increased cost for the patient. Dislocated THA have worse outcomes compared to THA that do not dislocate. Two-year survival rate for the dislocated THA is slightly over 50% (2).

Improved surgical techniques and the evolution of an implant design have lowered the dislocation rate after hip arthroplasty surgery for treatment of fractured neck of femur to approximately 1-5%. In a multicenter prospective randomized trial, Rogmark et al. reported a 6% failure rate for total hip arthroplasty and a 43% failure rate for open reduction and internal fixation (3). Dislocation rate for total hip arthroplasty was 8% (4.2% recurrent dislocations) in the same study with similar 1-year mortality of 13% between the THA and Internal Fixation groups. A compared with previous studies revealed that dislocation rate following total hip arthroplasty in displaced hip fracture is less than 10% (4-6).

The treatment of displaced neck of femur fractures has evolved, but remains controversial. Options for treatment include non-operative, percutaneous fixation, closed reduction and internal fixation, open reduction and internal fixation and arthroplasty (either hemi-arthroplasty or total hip arthroplasty).

Hip joint preservation and avoidance of complications of THA are regarded as advantages by some surgeons. On the other hand, some surgeons favour THA as a treatment modality due to quicker rehabilitation and avoiding all complications associated with fracture union and femoral head vascularity (7).

For patients with appropriate indications for THA for treatment of acute neck of femur fracture, THA can provide good outcomes, lower cost and long-term survival of the prosthesis(8). Total hip arthroplasty for treatment of neck of femur fracture has low failure rate compared to open reduction and internal fixation. In THA, functional recovery of the patients was good. It had lower revision rates, but dislocation rates have been high, ranging between 6-22% (9).

Various factors influence the risk of dislocation after THA. These are patient related factors, such as age, sex, diagnosis, alcoholism, dementia, neuromuscular and cognitive disorders, psychosis, or surgical risk factors such as surgical approach, component positioning, soft tissue tension, head size, impingement and liner profile (10-12). Femoral head sizes of larger diameters increase the head-neck. Range of motion is increased before impingement, therefore reducing the dislocation rate. They have a higher friction moment,

despite the advantage of an increased jumping distance that lower impingement and risk of dislocation.

Table 1. Factors influencing the risk of dislocation following THA

Patient Factors	**Surgical factures**
1. Age 2. Sex 3. Diagnosis 4. Alcoholism 5. Dementia 6. Neuromuscular disorders 7. Psychosis and cognitive disorders	1. Surgical Approach 2. Component Positioning 3. Soft Tissue Tension 4. Femoral Head Size 5. Impingement 6. Liner Profile

For 28 mm diameter femoral heads the dislocation rate ranges from 0.6% to 3.6% (13), but even higher for 22 mm diameter femoral heads that range from 3.8% (13) to 18.8% (14). Lower rates are reported for the 32 mm diameter femoral heads, 0.5% and 0.0% for 38 mm diameter (15). In a recent study, Femoral heads with bigger than 36 mm resulted in drastic decrease in the dislocation rate following THA when compared to head sizes less than 36 mm (16).

Rationale and Problem identification

THA performed for neck of femur fracture has a higher risk of dislocation than THA done for hip arthrosis. Larger femoral head sizes have a lower incidence of dislocation. However, the dislocation rate is not known in South Africa. Furthermore the factors that may be associated with an increased risk of dislocation in the South African context are not known.

Aims and objectives

The aim of this study was to determine the prevalence and risk factors of dislocation following total hip arthroplasty for treatment of acute neck of femur fractures at our Level 1 Hospital during the period of 2006-2012. In order to achieve this aim, the objectives of the study were:

- To estimate the number of dislocations following total hip arthroplasty during the period 2006 – 2012
- To investigate the association between femoral head size and the risk of dislocation after THA.

Methods

Design

This study was a retrospective review of records of patients who had a total hip arthroplasty for neck of femur fractures during the period 2006 – 2012.

Setting

The study was conducted at a Level 1 University Hospital.

Inclusion and exclusion criteria

All total hip arthroplasties for fractured neck of femur during 2006-2012 were included. Patients that did not have a minimum of 1 year follow up were contacted to confirm if they have dislocated. All the patients with pathological fractures, extra-capsular fractures, failed open reduction and internal fixation and patients with less than 3 months follow up were excluded from this study.

Measurements

A list of patients' names was obtained from the Arthroplasty registry. We reviewed the information in the patients' medical records and radiographs. Hip dislocation was the end point of the review .We counted the total number of patients with confirmed dislocations. Femoral head sizes were recorded.

Ethics and informed consent

This study was approved by the University of Cape Town Human Research Ethics Committee (HREC REF: 632/2012).

Statistical analysis

All numerical data were tested for Normality using the Shapiro Wilks test. For normally distributed data, means and standard deviations were described. Where data were skewed, medians and interquartile ranges (IQR) were described. For categorical data, frequencies and proportions were described. The dislocations were counted and expressed as a proportion of total number of participants. For risk factors, binary logistic regression, with dislocation (yes/no) as the outcome was used to report odds ratios, 95% confidence intervals and p-values. Multivariate analysis was attempted although the low sample size and low number of dislocations was a limiting factor.

Results

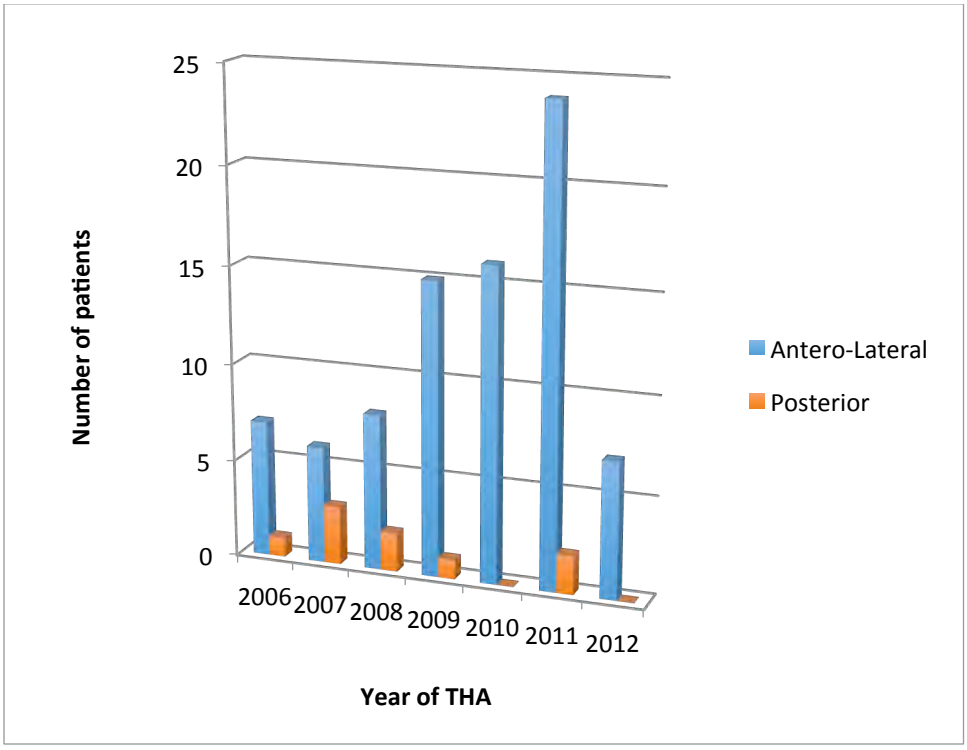
A total of one-hundred and seven patients treated with THA for neck of femur fracture were identified. Fifteen (14%) patients were unsuitable for analysis. A total of ninety-two patients were included in this study. The median age at the

time of surgery was 64.4 years (IQR 57.9 – 72.0). The male to female ratio of patients included in the study was 37(40.2%): 55(59.8%). The median delay to surgery for THA was 3 days (IQR 2 – 6) days. One patient who had 63 days delay for THA was admitted to a different hospital prior to transfer to our unit. The median follow up period was 18.3 months (Range: 3 - 51.6) (Table 1).

Table 2: Demographic characteristics

		Frequency (%)
Gender	Female	55(59.8)
	Males	37(40.2)
Side of operation	Right	44 (47.8)
	Left	48 (52.2)
Delay to surgery (days)	Median =3	
	IQR = 2 to 6	
Age at time of surgery (years)	Median = 64.4	
	IQR = 57.9 to 72.0	
Follow Up (months)	Mean = 18.3	18,3 (3-51.6)
	Range = 3.0 – 51.6	
Implant articulation	Hard-on-soft bearing couples	Metal on Polyethylene 76
		Ceramic on Polyethylene 0
	Hard-on-hard bearing couples	Metal on metal 6
		Ceramic on ceramic 10

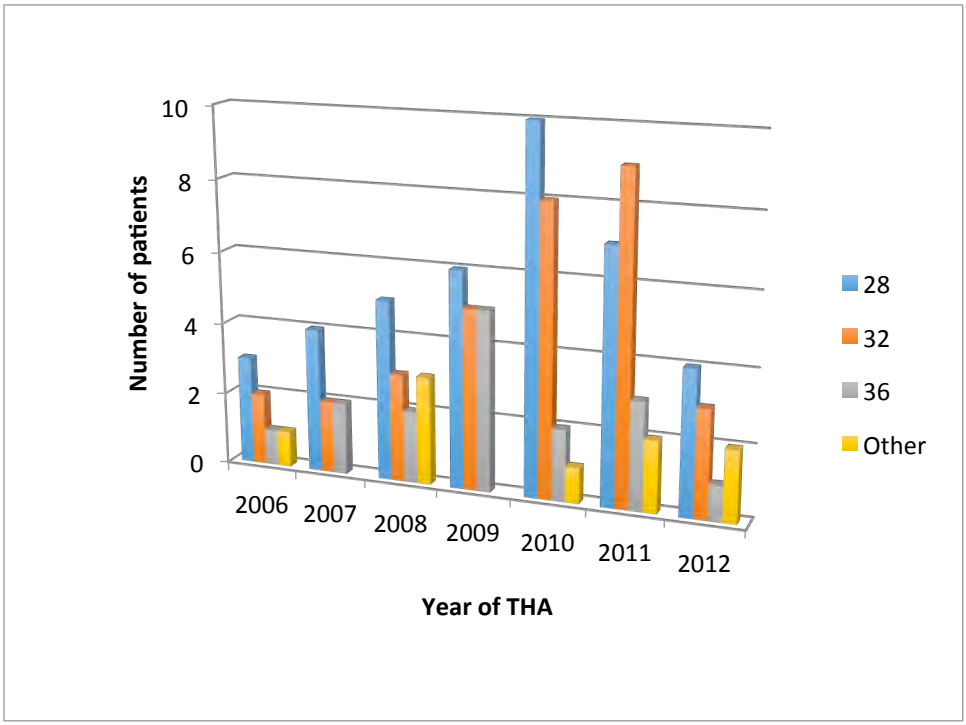
Figure 6: Preferred surgical approach



Legend: *Surgical exposure of the hip for THA can be done through anterior approach, antero-lateral approach, direct lateral approach and posterior approach.*

The most preferred surgical approach for THA was anterolateral, with 83(90.2%) patients. The posterior approach was occasionally utilized, with only 9(9.8%) patient operated through this approach.

Figure 7: Most frequently used head sizes



Legend: *Femoral head sizes vary between 22 mm and 60 mm. The size of the head implanted is dependent on the size of the acetabular cup. This varies between patients.*

The most frequently used head sizes were 28 mm and 32 mm; with 9(42.4%) patients having the 28 mm femoral head implanted, 32(34.8%) the 32 mm, 16(17.4%) 36 mm while 5(5.4%) patients had larger than 36 mm femoral heads.

A total of 16(17.4%) THA were hard-on-hard coupling (6(6.5%) metal-on-metal and 10(10.9%) ceramic-on-ceramic), whereas the rest (76(82.6%)) were metal on polyethylene.

Prevalence of dislocations

Four patients (4.3%) had confirmed dislocations within the first year following THA. The dislocations occurred after days 19, 39, 94 and 249 after discharge from hospital. The dislocations were verified through a review of patient records, radiographs and interviews with patients. There were no recurrent dislocations following reduction in the 3 patients and revision for the one patient. No other adverse events were recorded during follow up of these patients.

Table 3. Patient characteristics with hips dislocation following THA for NOF fracture.

Patient	Head size (mm)	Age (Years)	Sex (F:M)	1st dislocations (No. of days after surgery)	Surgical Approach	Revision? (Yes/No)
1	28	69	F	19	Anterolateral	No
2	28	61	M	249	Posterior	No
3	28	63	F	94	Anterolateral	Yes
4	28	74	F	39	Posterior	No

Risk factors associated with dislocation

All four hips that dislocated following THA for fractured neck of femur had a 28-mm articulation. Their median age was 63 years, 3 were female and 1 of the patients had a revision. With respect to surgical approach, 2 of the patients had anterolateral approaches while the other 2 had posterior approaches.

Being female was significantly associated with reduced risk of dislocation on multivariate analysis (OR = 0.01; 95%CI 0.001 – 0.87, p = 0.044). Bigger head sizes were associated with reduced risk for dislocation, although this did not reach statistical significance (OR = 0.27; 95%CI 0.06 – 1.19, p = 0.083). There was no association between either age or delay to surgery and risk of dislocation (Table 3). Due to the small number of the dislocations that occurred, and the small sample size, these results need to be treated with caution.

Table 4: Head size and dislocation

	Univariate analysis		Multivariate Analysis	
	OR (95%CI)	P-value	OR (95%CI)	P-value
Age	1.03 (0.93 – 1.14)	0.547	1.15 (0.88 – 1.51)	0.299
Gender (female vs male)	0.57 (0.08 – 4.25)	0.582	0.01 (0.001 – 0.87)	0.044
Delay	0.78 (0.44 – 1.37)	0.385	0.58 (0.23 – 1.48)	0.256
Head size (bigger vs small)	0.57 (0.29 – 1.12)	0.105	0.27 (0.06 – 1.19)	0.083

Discussion

Literature review showed only a few papers had analyzed the treatment of neck of femur fractures with THA and risk factors associated with dislocation. There is strong support in the literature to treat displaced intracapsular neck of femur fractures with THA (17). Hemi-arthroplasty provides superior outcomes compared to fixation, but THA has been shown to have advantages over both hemi-arthroplasty and fixation (17,18). Bhandari et al in their systemic review and analysis showed that though THA may increase surgical mortality, it reduces the need for re-operation (17).

Due to the reported high dislocation rate and cost associated with THA some surgeons avoid performing THA, there is no consensus for the treatment of displaced intracapsular neck of femur fractures. There are two large multicenter randomized trials underway currently (FAITH and HEALTH) (26). The FAITH trial (Fixation Using alternative Implants for the Treatment of Hip Fractures) compares sliding hip screws and cancellous screws on revision surgery rates for the treatment of femoral neck fractures. The HEALTH trial (Hip Fracture Evaluation with Alternative of Total Hip Arthroplasty versus hemi-arthroplasty) compares THA and hemi-arthroplasty. Once these studies are completed, it will provide answer to the current controversy of optimal treatment of neck of femur fractures.

Internal fixation for fractured neck of femur fracture may carry significant complications such as osteonecrosis, leading to avascular necrosis, implant failure and non-union (17). The benefit of THA for displaced neck of femur fractures outweighs the risk of dislocation following THA.

A total of 92 patients were included in this study. 15 patients were excluded due to inadequate recording keeping of pre operative assessment, incomplete surgery data records, pathological fracture and previous ORIF. The median age at the time of surgery was 64 years. The study included 55 (59.8%) females and 37 (40.2%) males. Hailer at al showed that age did not influence the risk of revision due to dislocation, however, they reported that female patients had a lower risk of dislocation (19). Rogmark et al as well as Lee et al reported on higher dislocation rate in elderly patient (3, 14, 21). The average follow up in this study was 18.3 months with a minimum of 3 months follow up. Previous authors reported high incidence of dislocation within the first 3 months and an overall high dislocation rate within the first year following THA (10,11,13). Most studies showed a varying follow ups, slightly longer. This is probably due to follow up protocols of different units, and some patients discharged earlier if no concerns. The minimum follow ups are similar to most studies. Socio-economic situations might force some patients not to follow up if they have no complaints.

In this study, four patients (4.3%) had confirmed dislocation. This is lower than that reported by many previous researchers. For example Bhandari et al (6.9%), Keating et (8.6%), Baker et al (7.5%), McKinley et al (9%), Rogmark et al. (8%) and Lee et al. (10%) all found higher rates of dislocation (3,17,18,20-22). However, one study, Blomfeldt et al reported a low (2%) dislocation rate, compared to our results (23).

Three of the four patients had successful closed reduction and had no further complications reported. One patient required revision surgery and change of component orientation. All four dislocations had smaller femoral head sizes (28 mm), which is consistent with what has been reported previously. In particular, Berry et al reported on a higher dislocation rate in patients that had smaller femoral head size and posterior approach (13). Hailer et al reported higher dislocation rates with minimally invasive procedures compared to anterolateral approach (19). Greater tuberosity non-unions are associated with higher dislocation rates (24). Eftekhar NS et al reported on the association of surgeon experience and dislocation rates (25). Younger surgeons and trainees had a slightly higher incidence of dislocation compared to experienced surgeons. Although the sample size was not enough to allow a multivariate regression, one possible explanation for this is that the jumping distance is decreased in smaller head diameters, predisposing patients to dislocation. Two patients (50%) had posterior approach. The male to female ratio was 1:3 for the dislocations. Although all the patients in our study were older than 60 years, we were unable

to test the statistical significance of age as a risk factor for dislocation due to the small sample size.

All 4 dislocations were within the first year of the index THA. There are no reported reasons to the exact cause for early dislocations. This is likely due to the time required for the healing of the capsule and soft tissues.

Limitations of the study

The major weakness of our study is that it was not randomized. We recruited a small cohort of retrospective THA, although this was over significant period of time, the population group presenting with neck of femur fractures that is suitable for THA is smaller. Younger patients are treated by reduction and fixation, whereas most of the elderly who are not independently mobile, with multiple comorbidities and cognitive impairment are treated with hemi-arthroplasty.

We were unable to report on factors such as cognitive status, neuromuscular disorders, soft tissue tensioning and impingement for the patients that dislocated. This is mainly due to the lack of appropriate record keeping.

Implant neck geometries were not recorded to determine the head/neck ratio. These are factors that may affect the dislocation risk independently.

Conclusion

Our early dislocation rate of 4.3% is within the published results and shows that primary THA is an acceptable and safe option for displaced intracapsular neck of

femur fractures in active patients. Larger femoral head sizes may have a lower dislocation rate. More rigorous, better-designed studies are needed to investigate risk factors for dislocation in our setting.

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