A Clinical Review of Patients who Underwent Arthroplasty for the Treatment of a Neck of Femur Fracture at Chris Hani Baragwanath Academic Hospital

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Medicine

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Declaration

I Joseph Daniel Wessels declare that this research report in the format of a "submissible" paper is my own, unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Orthopaedic Surgery at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

……

(Signature of candidate)

3rd day of January 2022 in Johannesburg

Dedication

To my wife Erica

For always being at my side

Presentations and publications arising from the research project

Presented at the Wits Orthopaedic Surgery Research Day – 10 November 2021

Acknowledgements

I wish to thank Prof Chris Frey and Dr Brenda Milner for all their guidance and assistance. This research report would not have been possible without their participation.

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Nomenclature

AA	Anterior approach
AAOS	American Academy of Orthopaedic Surgeons
ACCI	Age-adjusted Charlson co-morbidity index
AO	Arbeitsgemeinschaft für Osteosynthesefragen
ASA	American Society of Anesthesiologists
BMI	Body mass index
CCI	Charlson co-morbidity index
CEO	Chief Executive Officer
CHBAH	Chris Hani Baragwanath Academic Hospital
DVT	Deep vein thrombosis
FAITH	Fracture Fixation in the Operative Management of Hip Fractures
HA	Hemiarthroplasty
HIV	Human Immunodeficiency Virus
HHS	Harris hip score
LA	Lateral approach
NICE	National Institute for Health and Care Excellence
NOF	Neck of femur
OTA	Orthopaedic Trauma Association
PA	Posterior approach
QoL	Quality of Life
RCT	Randomised control trial
SA	South Africa

SF-36	36-Item Short Form Survey
THA	Total hip arthroplasty
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation

“Submissible” format of a paper

A Clinical Review of Patients who Underwent Arthroplasty for the Treatment of a Neck of Femur Fracture at Chris Hani Baragwanath Academic Hospital

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Abstract

Background: Intracapsular neck of femur fractures are common in the elderly and are associated with significant morbidity and mortality. Little is known about the outcome of intracapsular neck of femur fractures in South Africa. The aim of this study was to determine the outcome of patients who underwent arthroplasty for the treatment of a neck of femur fracture at Chris Hani Baragwanath Academic Hospital.

Methods: A retrospective, descriptive review was done on 114 patients who underwent arthroplasty for the treatment of a neck of femur fracture from 01 January 2013 to 30 April 2017 at Chris Hani Baragwanath Academic Hospital. Primary outcome measures included mortality and morbidity. Secondary outcome measures included patient based outcome scores, as well as clinician based outcome measures.

Results: The mean age of the patients was 66.6 years (range 50 to 92 years). The majority of patients were female (n = 65; 59.1%). Most patients underwent an uncemented total hip arthroplasty (n = 80; 72.7%). The posterior approach was the most frequently used approach (n = 74; 67.3%). There was one (0.9%) in-hospital mortality and 19 (17.3%) patients had morbidities. Iatrogenic intra-operative peri-prosthetic fracture was the most frequently encountered complication, occurring in 14 (12.7%) patients. This did not alter the outcome.

Conclusion: Our results show that patients have a favourable outcome when arthroplasty is used for the treatment of neck of femur fractures even though our management protocol differs from the recommended guidelines. Furthermore, our results indicate a low rate of morbidity with only one mortality.

Introduction

The older people become, the more osteoporotic deficiency fractures occur and these most commonly involve the spine, hip and wrist. [1] In 2010 there was an estimated 2.7 million hip fractures that occurred worldwide. [2] Hip fractures are primarily a disease in the elderly with the majority of these fractures occurring in elderly women. [3,4] Due to improved healthcare, better nutrition and advances in the management of medical conditions that frequently affect the elderly, a substantial increase in life expectancy has occurred. [5] As a result of this growing elderly population, the incidence of hip fractures is rising and it is estimated that in 2050 there will be approximately 6.3 million hip fractures worldwide. [6]

Hip fracture incidence in South Africa (SA) is lower than more developed countries such as the United Kingdom (UK) and the United States of America (USA). Hip fracture incidence in the UK is 250 per 100 000 [7] and 195 per 100 000 in the USA, [8] compared to 68.6 per 100 000 in SA. [4]. This is likely due to a lower life expectancy in SA. [9] SA is also home to a diverse, multi-ethnic population with a higher incidence of hip fractures in the White and Indian populations compared to the African and Coloured populations. [4]

Arthroplasty is the gold standard treatment for intracapsular neck of femur fractures (NOF) as recommended by the National Institute for Health and Care Excellence (NICE) guidelines, as well as by the American Academy of Orthopaedic Surgeons (AAOS). [10–12] This is largely due to the unacceptably high rate of biological fracture fixation failure. [13,14]

NOF fractures are associated with significant mortality and morbidity rates. [15,16] This is due to a comparatively high rate of co-morbidities in these patients which raises the American Society of Anesthesiologists (ASA) score. [17] A score of more than three is associated with higher mortality and complications. [18,19] There is an in-hospital mortality rate of 7–14% and this rises to a one year mortality rate of 14–36%. [15] The global one year mortality rate is 22%, with SA having a higher rate at 33.5%. [20,21] Patients who survive are also likely to have a functional deficit and a decreased quality of life (QoL). [16]

The aim of this study was to determine the outcome of patients who underwent arthroplasty for the treatment of a NOF fracture at Chris Hani Baragwanath Academic Hospital (CHBAH). The primary outcome measures were mortality and morbidity. Secondary outcome measures included patient based outcome scores by use of the 36 Item Short Form

Survey (SF-36), as well as clinician based outcome measures which included ASA scores, Sernbo Scores, fracture classification and factors related to the surgery. [13,17,22]

Methods

This retrospective, descriptive study was conducted on 114 consecutive patients who sustained a NOF fracture that required arthroplasty from 01 January 2013 to 30 April 2017. Once ethical and institutional approval was obtained, data were retrospectively collected from theatre records, patient records, weekly mortality and morbidity presentations, and the CHBAH Arthroplasty Patient Database. Mortality data were sought from the Department of Home Affairs with the patients' South African Identification numbers however, the relevant data could not be obtained.

The inclusion criteria for the study were all patients who underwent arthroplasty for an intracapsular NOF fracture which was defined as all AOT Classification 31B fractures according to the Arbeitsgemeinschaft für Osteosynthesefragen Foundation/Orthopaedic Trauma Association (AO/OTA) Fracture and Dislocation Classification Compendium. [23] As the nature and personality of NOF fractures are different in the young compared to the elderly, only patients who were 50 years or older were included. Exclusion criteria were patients who suffered from a condition that predicted an early death, as well as incomplete patient records.

Data collected fell into six domains, namely: Generic patient data, medical data, fracture factors, recorded outcome measures, details regarding the surgery, as well as any adverse events or mortality. Patient generic data included: age, sex and the body mass index (BMI) of the patient. For the patients whose weight and height were not noted pre-operatively, the post-operative weight and height were recorded once they were mobilised. Medical data collected were the ASA score, Sernbo score, walking status and any co-morbidities the patient may have been suffering from. [13,17] With regards to the fracture sustained, the degree of displacement was classified according to Garden's Classification. [24] The fracture geometry was classified according to the Pauwels Classification. [25] In terms of the surgery, the procedure performed (total hip arthroplasty (THA) or hemiarthroplasty (HA)), the approach

used (Lateral Hardinge type or posterior approach), stem cementation, the time to surgery and the duration of the surgery were all recorded.

The Arthroplasty Unit at CHBAH is headed by three consultants, who are the primary surgeons. Two of them utilise a posterior approach and the third uses a lateral approach. In addition to this, trainee surgeons also perform surgery under the supervision of one of the primary surgeons.

Each patient was assigned a study number to maintain anonymity and data were captured on an Apple Numbers © spreadsheet. Categorical variables were reported using frequencies and percentages. Continuous variables were reported using means and standard deviations, or medians and interquartile ranges depending on the distribution of the data. Normality of the data was determined using the Shapiro-Wilk test. Generic, medical, fracture and surgical variables, outcome measures and their relationship with adverse events were calculated using a Chi^2 or a Fisher's Exact test depending on the data distribution and sample size in each group. Relationships between generic, medical, fracture and surgical variables, adverse events and continuous data (age and BMI) were calculated using a Student's T-test. A p - value ≤ 0.05 was considered statistically significant.

Results

The study population included 114 patients who sustained an intracapsular NOF fracture between 01 January 2013 until 30 April 2017. Four of these patients were not fit for surgery and were managed non-operatively with a period of immobilisation and subsequent mobilisation to a wheelchair. The remaining 110 patients all underwent arthroplasty for the treatment of their NOF fractures.

Table I summarises the characteristics of the 110 patients who underwent arthroplasty. The majority of patients were female (n = 65; 59.1%). The female patients were older with a mean age of 68.4 years (SD 10.2; range 50 to 89 years) and a median age of 69.0 years (IQR 60 to 76 years). This contrasts with the males who had a mean age of 64.0 years (SD 9.7; range 50 to 92 years) and a median age of 63.0 years (IQR 56 to 70 years; p = 0.024). The female

patients had an increased BMI compared to the males. The mean BMI of the female patients was 29.0 kg/m^2 (SD 5.4; range 19 to 42kg/m^2) and in the male patients it was 25.8 kg/m^2 (SD 4.7; range 17 to 37kg/m^2; $p = 0.001$).

Table I: Generic Patient Characteristics

Characteristic (n =110)	
Age in years (mean, SD, range) Age in years (median, IQR)	66.6 (10.8, 50–92) 67.5 (59.3–74.8)
Sex Female Male	 65 (59.1%) 45 (40.9%)
BMI in kg/m^2 (mean, SD, range)	27.7 (5.25, 17–42)

Table II summarises the medical and fracture characteristics of the patients. With regards to the medical characteristics of the patients, 90 patients (81.8%) had one or more co-morbidities and 20 patients (18.2%) did not have any co-morbidities. The three most encountered co-morbidities were cardiac (n = 47), diabetes mellitus (n = 15) and neurological (n = 8). With regards to the human immunodeficiency virus (HIV) status of patients, 11 (10.0%) patients were confirmed positive.

Table II: Medical and Fracture Characteristics

Characteristic (n = 110)	**Frequency**
Number of Co-morbidities 0 1 2 3	 20 (18.2%) 59 (53.6%) 25 (22.7%) 6 (5.5%)
Walking ability Community Home	 80 (72.7%) 30 (27.3%)
Garden Classification (displaced or un-displaced) I/II III/IV	 2 (1.8%) 108 (98.2%)

Pauwels Classification	
1 (< 30 degrees)	2 (1.8%)
2 (30–50 degrees)	53 (48.2%)
3 (> 50 degrees)	55 (50.0%)

The majority of patients had an ASA score of III (n = 52; 47.3%), followed by ASA II (n = 32; 29.1%), ASA I (n = 21; 19.1%) and ASA IV (n = 5; 4.6%) (see Figure 1). There were no patients classified as ASA V or VI. In terms of walking ability, 80 patients (72.7%) were community walkers, while 30 patients (27.3%) were home walkers. Figure 2 summarises the Sernbo Score of the patients. The majority of patients (n = 80; 72.7%) were low risk with a score of 15 or higher, with the remainder (n = 30; 27.3%) being high risk, with a score of less than 15.

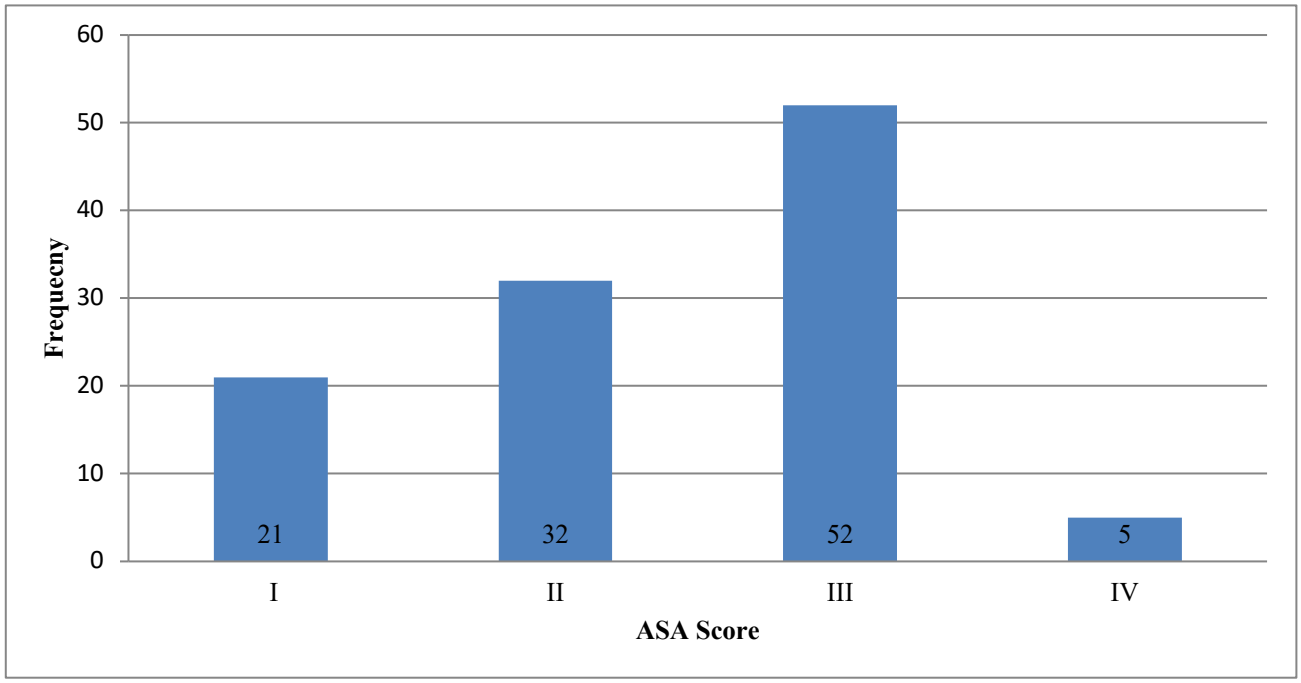

Figure 1: ASA Score of Patients

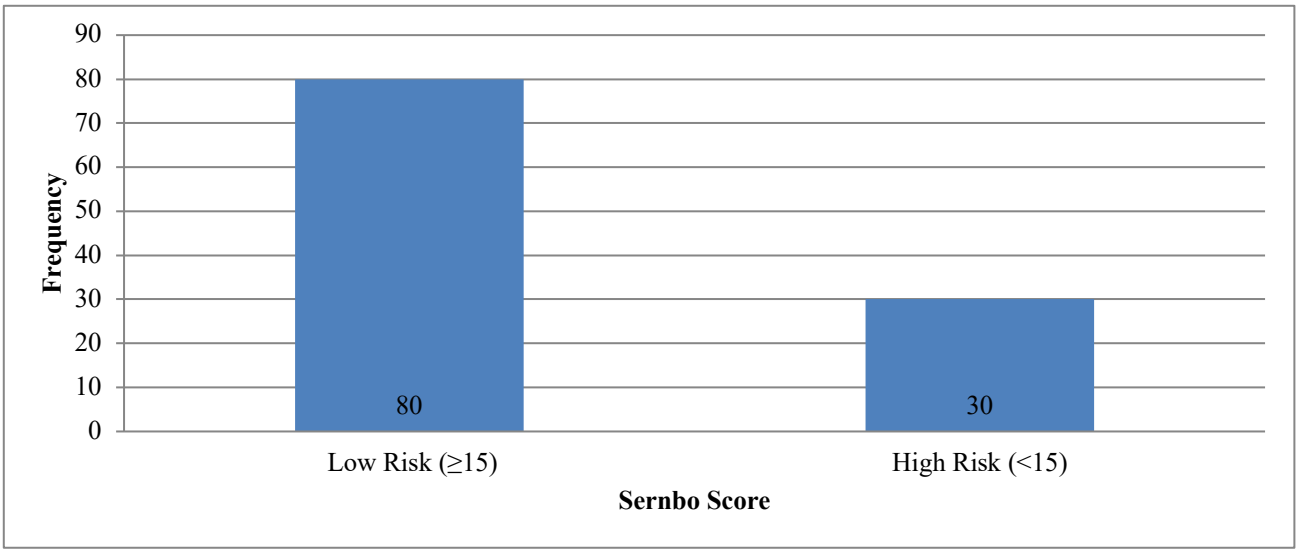

Figure 2: Sernbo Score of Patients

Most fractures encountered were displaced (n = 108; 98.2%), that is to say Garden III or IV fractures, respectively. [24] Only two (1.8%) patients sustained an un-displaced fracture (Garden I or II). With regards to Pauwels classification, 55 patients (50.0%) sustained a Type III, 53 (48.2%) patients sustained a Type II and two patients (1.8%) sustained a Type I fracture.

Table III summarises the characteristics related to the procedure. All 110 patients underwent arthroplasty for the treatment of their NOF fractures. Most of the cases were performed by one of the three primary surgeons (n = 88; 80.0%) and the remainder by trainee surgeons under supervision (n = 22; 20.0%). The patients waited a mean of 3.2 days (range 2 to 11 days) to undergo the surgery. The mean duration of the anaesthesia and surgical procedure was 2.0 hours (range 1.5 to 2.4 hours). Of these patients, 80 (72.7%) underwent THA and 30 (27.3%) underwent HA. HA patients were older, with a mean age of 71.4 years (SD 11.2; range 50 to 92 years), compared to a mean age of 64.8 years (SD 9.2; range 18 to 42 years) in the THA patients ($p = 0.006$). In terms of the ASA score, ASA I and II patients were more likely to undergo THA compared to ASA III and IV patients. Out of the 110 patients, 49 (44.5%) ASA I or II patients underwent THA compared to four (3.6%) who underwent HA, and 31 (28.2%) ASA III and IV patients underwent THA and 26 (23.6%) HA ($p < 0.001$). All 80 (72.7%) patients who underwent THA were community walkers whereas all 30 (27.3%) of the patients who underwent HA were home walkers ($p < 0.001$). Furthermore, the 30 patients

who underwent HA had a Sernbo score of less than 15 and all THA patients had a Sernbo score more than 15 ($p < 0.001$).

Table III: Procedure Characteristics

Characteristic (n = 110)	**Frequency**
Procedure	
THA	80 (72.7%)
HA	30 (27.3%)
Approach	
Lateral approach	36 (32.7%)
Posterior approach	74 (67.3%)
Articulation	
Conventional THA	73 (66.3%)
Dual mobility THA	7 (6.4%)
Bipolar HA	29 (26.4%)
Monoblock HA	1 (0.9%)
Bearing surface in THA	
Metal on polyethylene	54 (49.1%)
Ceramic on polyethylene	26 (23.6%)
Cemented stem	
No	107 (97.3%)
Yes	3 (2.7%)
Adverse events	
Dislocation	2 (1.8%)
Intra-operative peri-prosthetic femur fracture	14 (12.7%)
Post-operative peri-prosthetic femur fracture	3 (2.7%)
Infection	2 (1.8%)
Symptomatic DVT	1 (0.9%)
In hospital mortality	1 (0.9%)

In terms of the surgical approach used, 74 (67.3%) of the procedures were done using a posterior approach, while 36 (32.7%) were done using a lateral approach. THA consists of the replacement of the acetabulum as well as the femoral head. Most THA articulations were conventional (n =73; 66.4%) and 7 (6.4%) were dual mobility. A metal on polyethylene bearing surface was used in most cases of THA (54; 49.1%), while a ceramic on polyethylene

bearing surface was used in 26 (23.6%) of the cases. HA entails replacing only the femoral head. The implant may be monoblock or bipolar. Out of the 30 HAs, 29 (26.4%) were bipolar articulations and one (0.9%) was monoblock. Out of the 110 procedures performed, 107 (97.3%) of the stems were uncemented while three (2.7%) were cemented. The three (2.7%) cemented cases were HAs ($p < 0.001$). There were no cemented cups in the THAs. In terms of the patient related outcomes recorded post-operatively, not all the patients had them documented but the mean scores of the eight domains of the SF-36 are summarised in Figure 3.

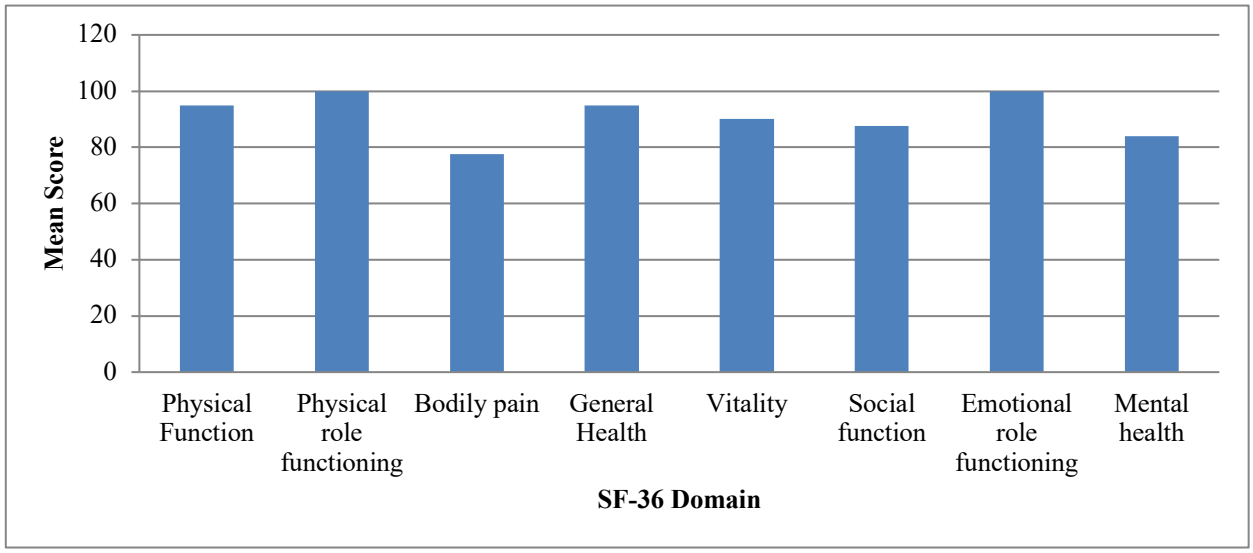

Figure 3: SF-36 Domain Scores of Patients

There was one (0.9%) in-hospital mortality recorded due to a nosocomial lower respiratory tract infection. Out of the 110 patients, 22 complications occurred in 19 patients, making a complication rate of 17.3% (see Table III). Eight (7.3%) patients required re-operation with two (1.8%) of these patients requiring a second re-operation. Table IV summarises the patient characteristics by complication. In patients who suffered complications and those who did not, there was no statistical significance with regards to age, BMI, sex, ASA score, Sernbo score, number of co-morbidities, walking ability, displacement of the fracture (according to Garden's classification), procedure or surgical approach.

Table IV: Patient Characteristics by Complication

Characteristic (n =110)	**Patients that had a complication (n =19)**	**Patients that had no complications (n =91)**	**p-value**	**Test Used**
Age in years (mean, SD, range)	63.7 (9.0, 50–76)	67.2 (10.4, 50–92)	0.139	Student's t
Sex Female Male	 12 (10.9%) 7 (6.4%)	 53 (48.2%) 38 (34.5%)	0.692	Chi^2
BMI in kg/m^2 (mean, SD, range)	29.0 (5.4, 21–38)	27.4 (5.3, 17–42)	0.271	Student's t
ASA Score I/II III/IV	 12 (10.9%) 7 (6.4%)	 41 (37.3%) 50 (45.4%)	0.151	Chi^2
Co-morbidities 0 >1	 6 (5.5%) 13 (11.8%)	 14 (12.7%) 77 (70.0%)	0.096	Chi^2
Walking ability Community Home	 15 (13.6%) 4 (3.7%)	 65 (59.1%) 26 (23.6%)	0.584	Fisher's exact
Sernbo Score Low risk (≥15) High risk (<15)	 15 (13.6%) 4 (3.7%)	 65 (59.1%) 26 (23.6%)	0.584	Fisher's exact
Garden classification I/II III/IV	 1 (0.9%) 18 (16.4%)	 1 (0.9%) 90 (81.8%)	0.317	Fisher's exact
Procedure THA HA	 15 (13.6%) 4 (3.7%)	 64 (59.1%) 26 (23.6%)	0.584	Fisher's exact
Approach Lateral approach Posterior approach	 8 (7.3%) 11 (10.0%)	 28(25.4%) 63 (57.3%)	0.338	Chi^2
Cemented stem No Yes	 19 (17.3%) 0 (0.0%)	 88 (80.0%) 3 (2.7%)	1.000	Fisher's exact

An iatrogenic intra-operative peri-prosthetic femur fracture was the most frequently encountered complication due to osteoporotic bone, occurring in 14 (12.7%) patients. All were Vancouver A2 fractures and were managed intra-operatively with cerclage wiring. [26] The surgical outcome was not altered and none of the patients required re-operation. The mean age of these patients was 61.8 years (SD 9.74; range 50 to 76 years) and their mean BMI was 28.9kg/m^2 (SD 5.74; range 21 to 38kg/m^2). Of the 14 patients, nine were male and five were female. In terms of the medical status of the patients, four patients had no co-morbidities while ten had one or more. With regards to the ASA score of the patients, eight had a score of II or III and six had a score of III or IV. In the group that had fractures, ten (9.1%) patients had a Sernbo score of 15 or more and four (3.6%) had a score less than 15. In the group that had no fracture, 70 (63.6%) had a score of 15 or more and 26 (23.7%) had a score less than 15 ($p = 1.00$). THA was performed in 10 patients and HA in four. All 14 patients had an uncemented stem. A lateral approach was utilised in eight (7.3%) patients and a posterior approach in six (5.5%) patients. In the patients who did not sustain a fracture, a lateral approach was used in 28 (25.5%) patients and a posterior approach in 68 (61.8%) ($p = 0.037$).

Post-operative peri-prosthetic femur fractures occurred in three (2.7%) patients. In terms of timing, one patient sustained the peri-prosthetic femur fracture one month after the initial surgery. The other two sustained their peri-prosthetic femur fractures at one and two years, respectively. One patient sustained a Vancouver B1 fracture which was managed with open reduction and internal fixation with a locking plate and cerclage wiring. [26] The other two patients sustained Vancouver B3 fractures both of which required revision THA. [26] All three cases initially underwent an uncemented THA via a posterior approach. Two patients were male and one was female with ages of 72, 66 and 69 years, respectively. All three patients were community walkers with a Sernbo score of more than 15. Only one patient had co-morbidities in the form of hypertension and diabetes mellitus. The BMI of the three patients was 30, 22 and 28kg/m^2, respectively. Their ASA gradings were I, II and III, respectively and Sernbo scores were all 15 or more. One of the three patients further complicated with deep infection two months after the revision surgery. This was managed with debridement and a Girdlestone procedure. The patient went on to develop a nosocomial lower respiratory tract infection post-operatively and demised in hospital 107 days after her index surgery.

Two out of the 110 patients suffered dislocations making a dislocation rate of 1.8%. The patients dislocated at one month and two years, respectively. Both patients had an increased BMI. The first case was a 59 year old male with a BMI of 33kg/m^2, diabetes mellitus with an ASA score of III, and the second case was a 72 year old female with a BMI of 35 kg/m^2, with diabetes mellitus and an ASA score of II. Both patients were community walkers with Sernbo scores above 15. With regards to the procedure, both cases underwent an uncemented THA through a posterior approach. Both patients were managed with a closed reduction under anaesthesia, a short period of bed rest, followed by early mobilisation and physiotherapy. The first patient went on to suffer a second dislocation with implant failure which necessitated a revision THA.

Two (1.8%) infective complications were encountered, occurring at one and two months post-operatively, respectively. The first patient was discussed earlier. The second patient suffered a late deep infection which required a one stage revision. The patient was a 66 year old hypertensive, non-diabetic female, with a BMI of 30kg/m^2, an ASA score of II and a community walker with a Sernbo score of more than 15. The index procedure was an uncemented THA performed through a posterior approach.

Discussion

In our series there was a high rate of intra-operative peri-prosthetic fractures (n = 14; 12.7%). Bellova *et al.* [27] reported a rate of 7.1%, and similarly Kuo *et al.* [28] reported a rate of 8.6% in patients who underwent uncemented HA. Taylor *et al.* [29] showed that the rate of intra-operative peri-prosthetic fractures is significantly higher when an uncemented stem is used. Bellova *et al.* [27] reported that an uncemented stem was not a significant risk factor however, they did find that the likelihood of an intra-operative peri-prosthetic fracture was higher with an uncemented stem (OR 5.018; 95% CI .674–37.384). All patients in our population who sustained intra-operative peri-prosthetic fractures had an uncemented stem, but the relationship was not statistically significant. Interestingly, patients who underwent their procedure through a lateral approach were more likely to have an intra-operative peri-prosthetic fracture. It is important to note that only one surgeon in the unit performs a lateral approach, so it may be likely that this is due to surgical technique rather than the approach used. In a retrospective review of cementless primary THAs, Miettinen *et al.* [30] found that a lateral approach was a risk factor for intra-operative peri-prosthetic fracture. They theorised

that the gluteus medius muscle may direct the broach and final implant in a medial and anterior direction. [30] This causes increased stress in the medial cortex, which may lead to a fracture of the calcar of the femur. [30] In a meta-analysis by van der Sijp *et al.,* [31] the authors compared posterior, lateral and anterior approaches and reported no difference in the number of peri-prosthetic fractures. The high rate seen in our patients may also be due to a decreased quality of bone in the patients who sustained the intra-operative peri-prosthetic fractures. Due to resource constraints, it is not possible to perform dual x-ray absorptiometry on all our patients to diagnose osteoporosis. We rely on surrogate measures such as the Singh Index and the canal bone ratio to identify patients with potentially lower bone mineral density (BMD). [32,33]

In contrast to the high rate of intra-operative peri-prosthetic fractures, we found a lower rate of post-operative peri-prosthetic fractures (n = 3; 2.7%). Song *et al.* [34] reported on peri-prosthetic fractures in cemented and uncemented stems. They found a significantly higher rate that required re-operation in the uncemented group (3.0%) compared to the cemented group (0.6%). Langslet *et al.*, [35] in their randomised control trial (RCT), reported a rate of 7.4% and 0.9% in the uncemented and cemented groups, respectively. Despite performing predominantly uncemented stems, we did not have a high rate of peri-prosthetic fractures. This may be related to the predominantly African ethnicity of our patients and the quality of their bone. A study conducted in SA by Schnitlzer [36] evaluated bone quality in the South African population and found improved hip BMD, a higher bone turnover and sturdier trabeculae in the African population. More recently in 2014, another study in SA showed a higher proximal femoral BMD in elderly African women compared to elderly White women. [37] Our patients had a higher BMI compared to other studies, this was especially true in the female patients. [21,38] The higher BMI observed in our patients may also be contributory as it has been shown that adipose tissue can secrete oestrogen, the so called ‘third ovary” as coined by Schnitzler *et al.* [36,39]

In our group of patients, two (1.8%) patients suffered a dislocation and both were THAs performed through a posterior approach. One of the two patients dislocated a second time which necessitated revision surgery. Of note is that both patients were obese with a BMI more than 30kg/m^2. Obesity is an accepted risk factor for dislocation in primary THA. [40] This association is not as strong in arthroplasty (THA and HA) performed for NOF fractures. [41,42] In SA, Shituleni and Maqungo [43] conducted a retrospective review on patients who

underwent THA for a NOF fracture and found a dislocation rate of 4.3%. Rogmark *et al.,* [14] in their RCT, reported a dislocation rate of 8.9% (twelve THAs and five HAs) and a recurrent dislocation rate of 5.2% (six THAs and four HAs). In a meta-analysis by van der Sijp *et al.* [31], the authors compared three HA approaches and found the posterior approach had the highest risk of dislocation, followed by the lateral and the anterior approach, respectively. [31]. A systemic review done by Stirton *et al.* [44] reported that there was no increased risk of THA dislocation through a posterior approach, provided that capsular repair was performed [44]. When AAOS evaluated the evidence, they reported that there is moderate evidence for increased dislocation with a posterior approach [11]. It is commonly believed that THA carries a higher risk of dislocation compared to HA. In Lewis *et al.'s* [45] analysis, THA was associated with a higher risk of dislocation compared to HA. Interestingly, when a sub-analysis was done with patients whose follow-up period was longer than four years, the difference in dislocation rate was no longer significant. This suggests that dislocation occurs later in HA patients.

We reported a low rate of post-operative infective complications (n = 2: 1.8%). De Jong *et al.* [46], in their retrospective review of patients who underwent a HA, reported 10% of patients having a surgical site infection and 4.9% having a deep infection within the first 90 days post-operatively. They reported reoperation as a risk factor, which was the case with one of our patients. Pollman *et al.* [47] recently reported a 2.4% rate of early surgical site infections which rose to 3.2% at one year follow-up in HA patients.

Deep vein thrombosis (DVT) was an uncommon complication in our population, with only one (0.9%) case being detected. Patients are mobilised on day one and all receive low molecular weight heparin thromboprophylaxis. Despite this, it is likely that a DVT complication is underdiagnosed in our setting. Fu *et al.* [48] reported that 56% of NOF fracture patients had DVTs post-operatively on ultrasound, and 24% had symptomatic DVTs.

In terms of overall complications, there was no statistical significance with regards to age, BMI, sex, ASA score, Sernbo score, number of co-morbidities, walking ability, displacement of the fracture (according to Garden's classification), procedure or surgical approach. We were only able to retrieve SF-36 scores for 22 of our patients as it is likely that not all the patients were able to perform them. We used the licenced Rand Health Care Survey (copyright 2012). Due to the lack of a WiFi network at our institution, the tests were done on

the iPad (Apple) RAND Cooperation iStore App. [22] The available scores indicate that patients respond favourably to arthroplasty for the treatment of NOF fractures.

In our study, a low in-hospital mortality rate (0.9%) was found with one patient demising of a nosocomial respiratory tract infection at 107 days post-operatively after first sustaining a post-operative peri-prosthetic femur fracture and then subsequently a deep infection after revision surgery. It is likely that many patients may have demised outside of the hospital. The data were sought at the Department of Home Affairs of SA however, the data was unattainable. As a result, it was not possible to quantify an overall mortality rate in our study group. Weller *et al.* [49] reported an in-hospital mortality rate of 7%. In SA, Du Toit *et al.* [50] reported a 30 day mortality rate of 12.5%, a 90 day mortality rate of 22.7%, a six month mortality rate of 27.9% and a one year mortality rate of 34.3% in patients who underwent HA for the treatment of a NOF fracture. In another study conducted in SA by Paruk *et al.*, [21] the authors reported a 30 day mortality rate of 13.0% , a 90 day mortality rate of 26.0% and a six month mortality rate of 33.5%.

The majority of the patients included in our study were female (n = 65). This is in keeping with the local SA literature. Du Toit and van der Merwe [50], and Dela *et al.* [4] reported that 69% of their patients were female while Paruk *et al.* [21] reported a similar value of 72%. With a median age of 67.5 years, our patient population was younger than those reported in other studies. Dela *et al.* [4] reported a median age of 77 years, Du Toit *et al.* [50] reported a median age of 78 years, and Paruk *et al.* [21] reported a median age of 74 years. A possible explanation for the lower median age of our patients may be related to their ethnicity. Our study was conducted in a region that is mostly African. Dela *et al.* [4] further analysed ages across different ethnic groups and showed that the median age of the African patients who sustained hip fractures was 67 years. In their study, female patients were older than the males which was also the case with our population (69.0 *versus* 63.0 years).

Patients who sustain NOF fractures are likely to have one or more co-morbidities which may or may not be controlled. Most of the patients in our population had one or more co-morbidities and fell into the ASA III category. González Quevedo *et al.* [18] showed that patients who were ASA III or less had a higher two year survival rate than those above ASA III. Donegan *et al.* [19] showed that patients who had an ASA score of III or IV had a higher rate of complications. These relationships were not seen in our group of patients.

Patients in our study with an ASA score of I or II were more likely to undergo THA. In addition to this, all patients who underwent THA were community walkers with a Sernbo score more than 15 while all patients who underwent HA were home walkers with a Sernbo score less than 15. The HA patients were also older. This is to say that THA was performed for fitter, more active patients and HA for lower demand, frail patients which is consistent with the NICE Guidelines and AAOS recommendations. [10,11] Lewis *et al.* [45] conducted a systemic review and meta-analysis on THA *versus* HA for displaced NOF fractures. They reported improved functional outcomes in THA patients. [45]

In our series, most patients were younger and had an increased BMI compared to the local and international literature. Most patients had one or more co-morbidities with an ASA score of III. We performed more THAs compared to HAs, with the majority of cases being performed via a posterior approach with an uncemented stem. Despite a different treatment protocol from the accepted guidelines, we report low mortality and morbidity and a favourable outcome in our population. This suggests that the nature of patients who sustain intracapsular NOF fractures in the SA population differs from international populations.

We suggest that larger scale studies be conducted in the South African population to determine the outcome of patients who sustain NOF fractures as the nature of our patients differs to international populations. In addition, more research should be performed on the use of a posterior approach and/or an uncemented stem for the management of NOF fractures in the South African population as we reported low dislocation and peri-prosthetic fracture rates, respectively.

Conclusion

Our results show that patients have a favourable outcome when arthroplasty is used for the treatment of NOF fractures even though our management protocol differs from the recommended guidelines. Furthermore, our results indicate a low rate of morbidity with only one mortality.

Ethics statement

All procedures done were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki

Declaration of 1975, as revised in 2008. Ethical clearance was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand: Clearance Certificate Number M170413 . Permission has been granted by the Chief Executive Officer (CEO) of CHBAH . The author/s declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.

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Appendices

Appendix A: Ethics Clearance Certificate

R14/49 Dr Joseph Wessels

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170413

NAME: (Principal Investigator)	Dr Joseph Wessels
DEPARTMENT:	Orthopaedic Surgery Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Retrospective Review of Patients who Underwent Arthroplasty for Neck of Femur Fractures at Chris Hani Baragwanath Academic Hospital
DATE CONSIDERED:	05/05/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof Chris Frey
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	14/06/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004,10th floor, Senate House/3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review April and will therefore be due in the month of April each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

Date 14/06/2017

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix B: Hospital CEO Clearance

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 28 Feb 2017

TITLE OF PROJECT: retrospective review of patients who underwent arthroplasty for neck of femur fractures at Chris Hani Baragwanath Academic Hospital

UNIVERSITY: Witwatersrand

Principal Investigator: J Wessels

Department: Orthopaedics

Supervisor (If relevant): C Frey

Permission Head Department (where research conducted): Yes

Date of start of proposed study: March 2017
Date of completion of data collection: Dec 2018

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Hospital. The CEO /management of Chris Hani Baragwanath Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Human Research Ethics Committee of the University of the Witwatersrand.
- the Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- the MAC will be informed of any serious adverse events as soon as they occur
- permission is granted for the duration of the Ethics Committee approval.

.....
Recommended
(On behalf of the MAC)
Date: 28 February 2017

.....
Approved/Not Approved
Hospital Management
Date 02/03/17

Appendix C: South African Orthopaedic Journal Guidelines

Abstract

A structured abstract (maximum of 350 words), summarising the most important points in the article is required.

The abstract consisting of four paragraphs with the subheadings:

- Background (must include the aim of the study)
- Patients and methods
- Results
- Conclusion

References should be avoided. Avoid uncommon abbreviations. If essential they must be defined at their first mention in the abstract itself

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using standard searchable terms. These keywords will be used for indexing purposes.

Level of evidence

Level 1 to 5.

Please follow the level of evidence guidelines provided by the Oxford Centre for Evidence-Based Medicine (OCEBM); version 2.1.

Available from: OCEBM Levels of Evidence Working Group. "The Oxford Levels of Evidence 2".Oxford Centre for Evidence-Based Medicine. http://www.cebm.net/index.aspx?o=5653

Introduction

The introduction should contextualise the study by providing the background to the research; explain the problem that is to be addressed and provide the rationale for the study.

Briefly outline the relevance if the study in respect to the current literature. Avoid a detailed literature survey or a summary of the results.

The last sentence should outline the research question or hypothesis.

Patients (or Materials) and Methods

State the methods, outcome measures, and selection criteria. The following aspects needs to be described:

- The study design and research methodology.
- Whether randomization (with methods) was applied.
- If case controlled, how the controls were selected.
- The time period under review.
- Number of patients/subjects under investigation and why this number was chosen.
- Inclusion and exclusion criteria.
- Case and outcome definitions.
- Description of procedure or intervention, including post-operative protocol.
- The outcome measures or scores were used.
- The minimum follow-up period.
- A statistical analysis section should be included at the end of this section to detail statistical tests and package used, the reasons why these tests were used, and what p-value was considered statistically significant. A power analysis is recommended for studies comparing two or more groups.
- Provide sufficient detail so that another researcher can replicate the study.
- The reader should understand from this description all potential sources of bias such as referral, diagnosis, exclusion, recall, or treatment bias. This includes the manner in which investigators selected the patients. Consecutive inclusion implies all patients with a given diagnosis are included, while selective implies patients with a given

diagnosis but selected according to certain explicit criteria (e.g. state of disease, choice of treatment).

- Do not describe standard procedure for common operations. Only include new procedures or adaptations to standard procedure.
- If you name any specific product, then it requires the name, city and state/country of the manufacturer.
- Present in narrative format and use past tense.
- Where relevant, tables or figures may be included to provide information more clearly.
- Generally, no data should normally be presented in this section.

Results

- Describe the relevant results and analysis thereof.
- Provide details of the number of patients included and excluded, as well as the reason for exclusion.
- It is important to state the follow-up period (mean and range).
- The results can be broken down into separate sections, e.g. Treatment, Functional outcome, Complications, etc.
- Tables may be used but avoid repeating data reported in the text in the tables.
- All appropriate data should be presented as means with ranges, not with standard deviations (SDs). Medians should only be used when the data is skewed, accompanied by an interquartile range (IQR).
- Avoid using percentages in studies involving well under 100 subjects.
- All results must be backed-up with p-values or survivorship analysis. All Kaplan-Meier data should be presented with the confidence intervals. Always present exact absolute p-values, whether significant or not, unless $p < 0.001$.
- However, p-values do not always convey the entire picture and where relevant the confidence interval will also be required (in addition to the power of the study reported in the methods section).

Discussion

- The question or hypothesis stated at the end of the introduction should be discussed and supported or rejected.
- The results must be interpreted clearly and any deficiencies expressed. All possible confounding factors, sources of bias, weaknesses in the study should be identified.
- Explore the significance of the results of the work, rather than repeating the results.
- The discussion must point out the relevance of the work described in the paper and its contribution to current knowledge.
- Explain what can be deduced from the results and how will it affect clinical practice should be clearly stated
- Should include a review of the relevant literature, placing the results of the study in the context of previous work in this area.
- Discussion of relevant prior research and references must be concise. Avoid extensive citations and discussion of published literature but put emphasis on previous findings that agree (or disagree) with those of the present study.
- Do not repeat the introduction.
- The limitations of the study must be presented and suggest how the study could have been improved for a future study.
- Authors should avoid making inferences from non-significant trends unless they believe their study is adequately powered to answer the question; in that case, provide a power analysis.

Conclusion

Summary statement which conveys the conclusions of the findings. Do not draw conclusions not supported by the data obtained from the specific study presented.

Appendix D: Student's contribution to the research and writing of the "submissible" paper

Division of Orthopaedic Surgery

Faculty of Health Sciences, 4M Room 12, Wits Medical School, 7 York Road, Parktown 2193
• Tel: +27 11 717-2538 • Fax: +27 11 717-2551

13 September 2021

Faculty of Health Sciences, University of the Witwatersrand

RE: JOSEPH DANIEL WESSELS' CONTRIBUTION TO THE RESEARCH AND WRITING OF THE "SUBMISSIBLE" PAPER

To whom it may concern,

This letter serves to confirm that the co-authors of the "submissible" research paper have agreed to its use by Joseph Daniel Wessels (student number 1828766), as part of his MMed research report. Joseph Daniel Wessels made a substantial contribution to conducting the research study and writing the manuscript.

Yours sincerely,

.....

Prof Chris Frey
Primary Supervisor

.....

Dr Brenda Milner
Co-supervisor

.....

Dr Joseph Daniel Wessels
MMed Candidate