

The Outcome of Fractures of the Proximal Humerus after Hemiarthroplasty

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Declaration

I, Leslie Jacobs declare that this research report is my own work. It is being submitted for the degree of Master of Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signature:.....

.....day of.....20.....in.....

Dedication

This research report is dedicated to my family. You are my greatest blessing.

Acknowledgements

Prof A. Aden

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Abstract

Study design: This is a prospective clinical audit of patient data.

Objectives: to determine the clinical outcomes in patients who have undergone hemiarthroplasty surgery of the shoulder.

Background: Hemiarthroplasty of the shoulder involves the replacement of the humeral head in patients with fractures of the proximal humerus deemed too severe to fix. It is done routinely at Helen Joseph Hospital.

Methods: Our study cohort consisted of 32 patients who had undergone hemiarthroplasty surgery for proximal humerus fractures over a period of four years from 2009 to 2013.

All patients were assessed for the following:

- The amount of pain they are experiencing in the operated shoulder
- Whether their pain post fracture resolved with the surgery
- How their activities of daily living are affected
- Any functional impairment they are experiencing in the operated shoulder

The data that was obtained from the patients included age, gender, Disabilities of Arm, Shoulder and Hand (DASH) score¹ and range of motion of both the operated shoulder and the unoperated shoulder. Data was first captured using Microsoft Excel and then Stata 13.0 was used to perform the analysis.

Results: Of the 32 patients that participated in the study, there were 12 males and 20 females. The mean age of the patients was 70.5 years (range 51 – 84 years). The mean DASH score was 36.9 (range 18.3 – 53.3). The DASH scores were positively correlated with the ages of the patients. The active range of motion of the operated shoulder was compared to the opposite shoulder in each patient. The range of motion was assessed according to flexion, extension, abduction, internal rotation and external rotation. In each of the 5 movements, the degree of movement in the operated shoulder was less than in the opposite shoulder, which had not been previously operated on. These differences were statistically significant $p < 0.001$.

Conclusion: Hemiarthroplasty remains a viable option for the treatment of patients with proximal humerus fractures that are deemed too severe to repair.

It provides good pain relief to patients, but the function of the operated shoulder is less than it was pre-injury.

Table of Contents

DECLARATION	II
DEDICATION	III
ACKNOWLEDGEMENTS	IV
ABSTRACT	V
LIST OF FIGURES	VIII
LIST OF TABLES	VIII
CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW	1
1.1 ANATOMY	1
1.2 CLASSIFICATION	3
1.3 EPIDEMIOLOGY.....	4
1.4 NATURAL HISTORY	4
1.5 MANAGEMENT	5
CHAPTER 2: RESEARCH QUESTION	7
2.1 BACKGROUND	7
2.2 HYPOTHESIS	7
2.3 AIM	7
2.4 OBJECTIVES	7
2.5 SIGNIFICANCE	8
CHAPTER 3: STUDY DESIGN AND METHODOLOGY	9
3.1 INCLUSION CRITERIA.....	9
3.2 EXCLUSION CRITERIA.....	10
CHAPTER 4: RESULTS	11
CHAPTER 5: DISCUSSION	15
CHAPTER 6: CONCLUSION	18
6.1 RECOMMENDATION	18
REFERENCES	19
APPENDICES	22
APPENDIX A: DISABILITIES OF THE ARM, SHOULDER AND HAND	22
APPENDIX B: DATA COLLECTION SHEET	24
APPENDIX C: HELEN JOSEPH RESEARCH COMMITTEE APPROVAL.....	25
APPENDIX D: HUMAN RESEARCH ETHICS COMMITTEE CLEARANCE CERTIFICATE.....	26

List of Figures

Figure 1. The shoulder joint	2
Figure 2. Bony anatomy of the humerus.....	2
Figure 3. Neer’s four part classification of proximal humerus fractures.....	3
Figure 4. Hemiarthroplasty Shoulder.....	6
Figure 5. X-ray of Hemiarthroplasty of Shoulder joint	6
Figure 6: DASH scores post-surgery	13
Figure 7: Correlation between DASH scores and age of patients.....	14
Figure 8: DASH scores by gender of patients.....	14

List of Tables

TABLE 1: DESCRIPTION OF DEMOGRAPHIC AND CLINICAL EXAMINATION RESULTS	12
TABLE 2: COMPARISON OF FUNCTIONALITY BETWEEN THE OPERATED AND OPPOSITE SHOULDER.....	12

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

How we interact with our environment is determined to a large extent by how well our upper limbs function. Whether we are making a telephone call, using a computer, driving a car, getting dressed, combing our hair or just reaching for a can of tinned food in our pantry, an adequately functioning and pain-free shoulder joint affects how well we carry out any of these activities.

1.1 ANATOMY

The humerus is a long bone found in the arm. The proximal or upper end of the humerus forms the shoulder joint together with the glenoid of the scapula. The humerus has a long tubular middle section known as the shaft. Due to its structure, the humerus is classified as a long bone. The distal or lower end of the humerus forms the elbow joint together with the olecranon of the ulna and the radial head. The proximal humerus is made up of 5 components. The first component is the articular surface of the humeral head and is covered with cartilage. The anatomical neck of the humerus borders the articular surface. Thereafter are two prominences, the greater tuberosity and the lesser tuberosity. Distal to the tuberosities is the surgical neck of the humerus. It is the junction between the humeral head and the shaft. The surgical neck is named as such due to the fact that it is much more frequently fractured than the anatomical neck of the humerus². Attached to the humeral tuberosities, are the muscles that make up the rotator cuff. These muscles are the supraspinatus, infraspinatus, teres minor and subscapularis. The rotator cuff together with the deltoid muscle is responsible for the movement of the shoulder joint. The supraspinatus, infraspinatus and teres minor attach to the greater tuberosity, while the subscapularis attaches to the lesser tuberosity.

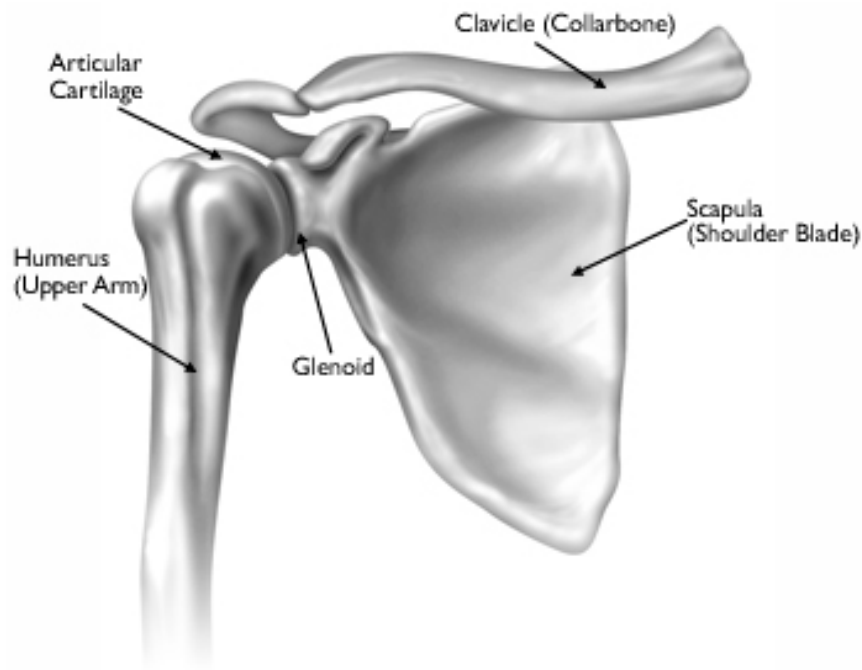


Figure 1. The shoulder joint

(<http://orthoinfo.aaos.org>) Image accessed December 2016

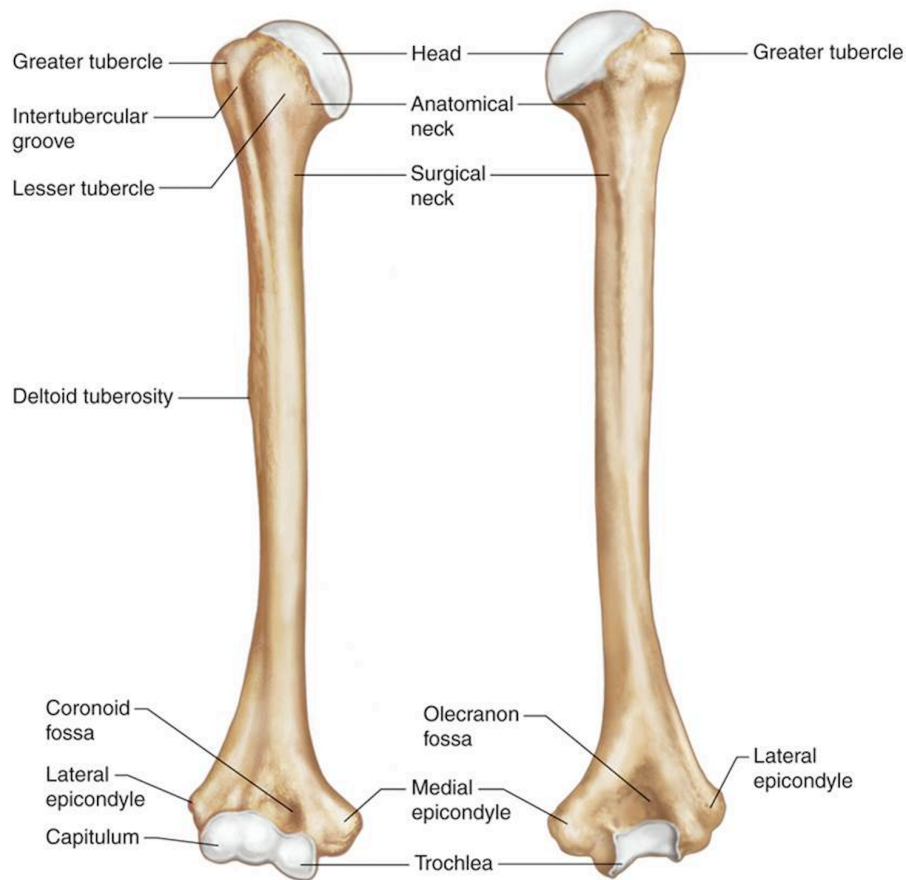


Figure 2. Bony anatomy of the humerus

(<http://chandlerphysicaltherapy.net>) Image accessed December 2016

1.2 CLASSIFICATION

In 1970 Charles Neer^{3,4} published the results of his study on the anatomy of 300 displaced proximal humeral fractures. From his study, he developed a new classification system for proximal humeral fractures, the Neer four-part classification system for proximal humerus fractures. His system took into account the four components of the proximal humerus, namely the head, the greater and lesser tuberosities and the surgical neck. In his classification system, undisplaced fractures were not of concern as he felt these fractures would respond well to non-operative management. His system dealt with displaced fractures or fractures with associated dislocation of the glenohumeral joint, which he felt, required special attention. In his system, a fracture involving any of the 4 components became significant if that part was displaced more than a centimetre or angulated more than 45°^{3,4}. Neer's classification has become the gold standard for classifying proximal humerus fractures.














	2 part	3 part	4 part
Anatomical neck			
Surgical neck			
Greater tuberosity			
Lesser tuberosity			
Fracture dislocation anterior			
Fracture dislocation posterior			

Figure 3. Neer's four part classification of proximal humerus fractures

(<http://shoulderdoc.co.uk>) Image accessed December 2016

1.3 EPIDEMIOLOGY

Proximal Humerus fractures represent 4-5% of all fractures^{5,6,7,8}. And account for 53%⁵ of all significant shoulder girdle fractures. Proximal humerus fractures limit the functioning of the affected upper limb, which subsequently have a negative impact on the patient's activities of daily living, their work and their sleep. All of this can be severely detrimental to the patient's quality of life. In older patients, many of whom have osteoporotic bone, proximal humerus fractures occur as a result of low energy trauma, an example of which is a fall from a standing position^{6,10,11}. In younger patients, these fractures occur as a result of high-energy trauma such as pedestrian-vehicle accidents, motor vehicle accidents or a fall from height. The incidence in females to males is 7:3¹⁰. More than 71% of proximal humerus fractures occur in women older than 60 years^{9,12}. Proximal humerus fractures are the third most common fracture in the elderly after Colles fractures (of the wrist) and hip fractures¹⁰. The incidence of proximal humerus fractures increases rapidly with increasing age, with the highest incidence in women between the ages of 80 to 90 years⁹.

1.4 NATURAL HISTORY

The natural history of displaced proximal humerus fractures that are treated non-operatively results in nearly all fractures healing, but in an un-reduced position resulting in a malunion¹². It is very rare that the fractures do not heal resulting in a non-union. Also very rarely do these patients develop avascular necrosis in their humeral heads. Despite the end result being a mal-union, most of these patients are pain-free¹². They also have adequate movement and strength to carry out basic activities of daily living. The limitation in shoulder movement is compensated by scapulo-thoracic and elbow movement. While this limited function may be acceptable to older less active patients, it is unacceptable to younger active patients to whom the limitation in function can have devastating consequences on their ability to work or participate in sporting activities.

1.5 MANAGEMENT

Proximal humerus fractures are assessed using X-rays to determine the fracture pattern as well as whether the fragments are displaced. If undisplaced, the fracture is amenable to nonoperative treatment. If, however, the fracture is displaced, the fracture needs to be managed surgically. If the fracture is going to be treated surgically, the decision must be made whether the fracture is fixable or not. If fixable, there are various treatment options such as k-wires, external fixators, intramedullary nails or plates⁸. If the fracture is deemed unfixable, the one common surgical option is a replacement of the proximal humerus. As the glenoid is not commonly damaged in the setting of a proximal humerus fracture, replacement can involve the proximal humerus alone while leaving the glenoid un-touched. This replacement of half of the shoulder joint is known as a hemiarthroplasty. Charles Neer first popularised the use of hemiarthroplasty in the treatment of complex proximal humerus fractures^{3,4,13}. Hemiarthroplasty of the shoulder has become the “gold standard” for the management of proximal humerus fractures when the humeral head is deemed to be unreconstructable^{4,13}.

The indications for hemiarthroplasty:

- Displaced Humeral head fracture involving all four parts.
- Fracture of the humeral head where the head is “split” and more than 40% of the articular surface of the humeral head is damaged^{4,13}

If the glenoid is involved, then a total joint replacement can be performed with the replacement of both the proximal humerus and the glenoid.

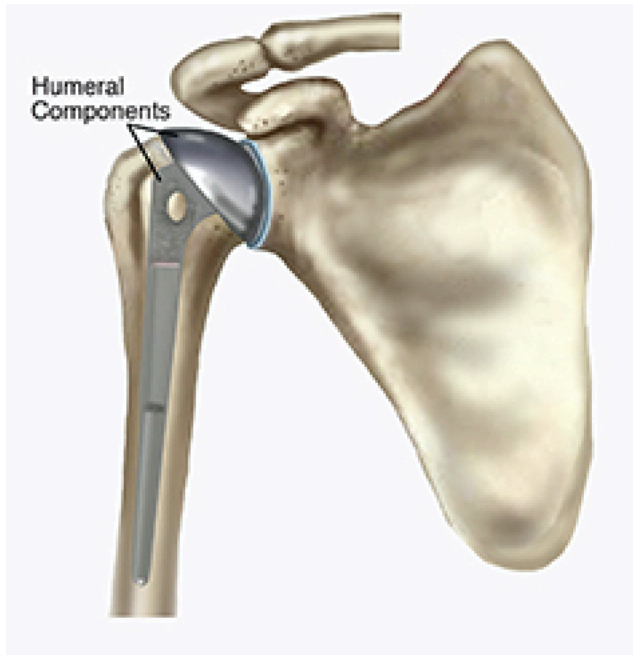


Figure 4. Hemiarthroplasty Shoulder
(<http://moveforwardpt.com>) Image accessed December 2016



Figure 5. X-ray of Hemiarthroplasty of Shoulder joint
(<http://orthodoc.aaos.org>) Image accessed December 2016

CHAPTER 2: RESEARCH QUESTION

2.1 BACKGROUND

The University of the Witwatersrand Medical School has 3 main academic hospitals associated with it, Helen Joseph Hospital, Charlotte Maxeke Johannesburg Academic Hospital and Chris Hani Baragwanath Academic hospital. Helen Joseph Hospital is an accredited teaching hospital by the Health Professions Council of South Africa (HPCSA) for both undergraduate and postgraduate medical students. Helen Joseph Hospital is classified as a tertiary level institution, which provides health care from specialists. It is located in Auckland Park Johannesburg. The Orthopaedic department at Helen Joseph Hospital is recognised as the main upper limb referral unit within the University of Witwatersrand orthopaedic circuit.

2.2 HYPOTHESIS

Hemiarthroplasty offers good pain relief but diminished shoulder function to patients undergoing the surgical procedure.

2.3 AIM

The aim of this study is to assess the patients' functional outcome and quality of life after they have undergone hemiarthroplasty shoulder surgery.

2.4 OBJECTIVES

To determine patients' outcome post-hemiarthroplasty surgery of the shoulder by:

- Assessing the amount of pain they are experiencing in the operated shoulder.

- Assessing whether their pain post-fracture has been resolved with the surgery.
- Assessing how their activities of daily living are affected.
- Assessing any functional impairment they are experiencing in the operated shoulder.

2.5 SIGNIFICANCE

Hemiarthroplasty of the shoulder has become the “gold standard” for the management of proximal humerus fractures when the humeral head is deemed to be unreconstructable^{4,13}. However, there are currently very few, if any, studies depicting the outcome of these procedures in South African patients.

CHAPTER 3: STUDY DESIGN AND METHODOLOGY

A retrospective study of all patients who underwent hemiarthroplasty shoulder surgery at Helen Joseph Hospital between January 2009 and January 2013 was performed. Ethics clearance to perform the study was first obtained from the Helen Joseph Ethics Committee as well as from the University of Witwatersrand Human Research Ethics Committee. Theatre records were accessed and patients' details were obtained. The patients' details were used to obtain the patients' files from the records department. From the patients' files, their contact details were obtained. Patients were contacted and invited to participate in the study. Patients who consented to participate in the study were interviewed at Helen Joseph hospital. Patients' participation involved the completion of a Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire as well the clinical examination of both shoulders. From the DASH questionnaire, a DASH score was obtained for each patient. From the clinical examination of each shoulder, 5 different types of movement were obtained. These movements were flexion, extension, abduction, external rotation and internal rotation. The gender, age, Dash score and degrees of movement for each patient were recorded on a data collection sheet.

3.1 INCLUSION CRITERIA

- Patients older than 18 years.
- Patients with proximal humerus fractures who underwent hemiarthroplasty surgery to treat the fracture.
- Normal bilateral shoulder function pre-injury.
- No substantial pre-injury shoulder pain in either shoulder
- The ability to raise both arms above shoulder height pre-injury.
- No previous surgery to either shoulder.

3.2 EXCLUSION CRITERIA

- Uncooperative patients
- Patients with Dementia
- Patients with a stiff or painful shoulders prior to injury
- Previous surgery to either shoulder

CHAPTER 4: RESULTS

Between 01 January 2009 and 01 January 2013, 35 patients underwent hemiarthroplasty shoulder surgery at Helen Joseph Hospital. All 35 patients were contacted. Of the 35 patients, 32 patients consented to participate in the study. The 3 patients that did not consent to participate were not included in the study. Data was first captured using Microsoft Excel and then Stata 13.0 was used to perform the analysis.

4.1 DESCRIPTIVE ANALYSIS

Overall, the mean age of the 32 patients was 70.5 years (range 51 – 84). There were 12 (37.5%) males and 20 (62.5%) females; no difference in age by gender was observed: males mean age 69.8 years (standard deviation 11.3) and females mean age 70.9 years (standard deviation 9.2). We compared the movements in degrees on both the operated and opposite shoulder. Overall, the mean movement in degrees was lower in the operated shoulder compared to the opposite one (Table 1). There was no difference in the movements by gender of the patient. A test for normality of continuous data was conducted using Shapiro-Wilk W test and flexion movement (across both shoulders) was not normally distributed. As the flexion data was not normally distributed, we used non-parametric statistical tests to compare the degree of movement between the operated and opposite shoulder. The test used was Wilcoxon sign-rank test as the samples were matched i.e. clinical examination was conducted on the same patient. For the other clinical examinations, which were normally distributed, a paired-sample t-test was used. The mean degree of movement in the operated shoulder was significantly lower compared to the opposite shoulder (Table 2).

TABLE 1: DESCRIPTION OF DEMOGRAPHIC AND CLINICAL EXAMINATION RESULTS

Variable	N	Mean	SD	P25	P75	MIN	MAX
Age	32	70.53	9.86	64.6	77.00	51.00	84.00
Flexion 1	32	98.78°	10.52	90.00°	105.0°	85.00°	120.00°
Extension 1	32	42.56°	2.13	40.00°	45.00°	39.00°	45.00°
Abduction 1	32	95.00°	6.92	90.00°	100.00°	85.00°	110.00°
Ext. Rotation 1	32	30.21°	8.46	25.00°	35.50°	20.00°	46.00°
Int. Rotation 1	32	49.46°	6.37	45.00°	55.00°	40.00°	60.00°
Flexion 2	32	173.71°	7.79	170.00°	180.00°	150.00°	180.00°
Extension 2	32	44.21°	1.84	45.00°	45.00°	40.00°	45.00°
Abduction 2	32	134.00°	11.29	122.50°	142.50°	120.00°	150.00°
Ext. Rotation 2	32	69.68°	10.99	60.00°	80.00°	50.00°	90.00°
Int. Rotation 2	32	70.31°	6.46	65.00°	75.00°	60.00°	80.00°

**Note: 1 is the operated shoulder. 2 is the opposite shoulder

TABLE 2: COMPARISON OF FUNCTIONALITY BETWEEN THE OPERATED AND OPPOSITE SHOULDER

Variable	Operated shoulder Mean (95% CI)	Opposite shoulder Mean (95% CI)	p-value
Extension	42.6° (41.8° - 43.3°)	44.2° (43.6°-44.9°)	P<0.001
Abduction	95.0° (92.5° - 97.5°)	134° (129.9°-138.1°)	P<0.001
External Rotation	30.2° (27.2°-33.3°)	69.7° (65.7° - 73.7°)	P<0.001
Internal Rotation	49.5° (47.2°-51.8°)	70.3° (67.9°-72.6°)	P<0.001

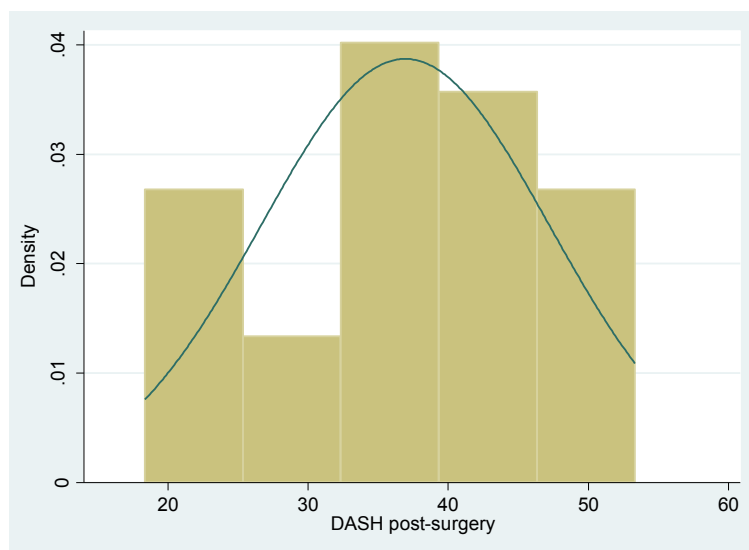
The Wilcoxon sign-rank test shows that the difference between the degree of flexion movement between the operated shoulder and the opposite one did not follow a systematic distribution around zero. The average degree of flexion movement was higher in the opposite shoulder compared to the operated shoulder (173.7° versus 98.8°). The difference was statistically significant with a $p < 0.001$.

The DASH score, which we used in the study, was obtained from questionnaires, which the participants filled out. The questionnaire consists of 30 questions. The questions deal with 3 aspects, the functioning of the participant, i.e. their ability to carry out their normal daily activities, the severity of the symptoms they are experiencing and the impact of the injury on participants ability to partake in social activities, self-image, ability to work and disturbance of sleep.

The participants answer each question by assigning a value to each question. The values are ranked from 1 to 5. In the case of a question that deals with the participant's functioning, for example, a mark of 1 indicates normal functioning, while a mark of 5 indicates very poor functioning. Similarly in a question dealing with pain experienced by the participant, a mark of 1 indicates no pain, while a mark of 5 indicates very severe pain.

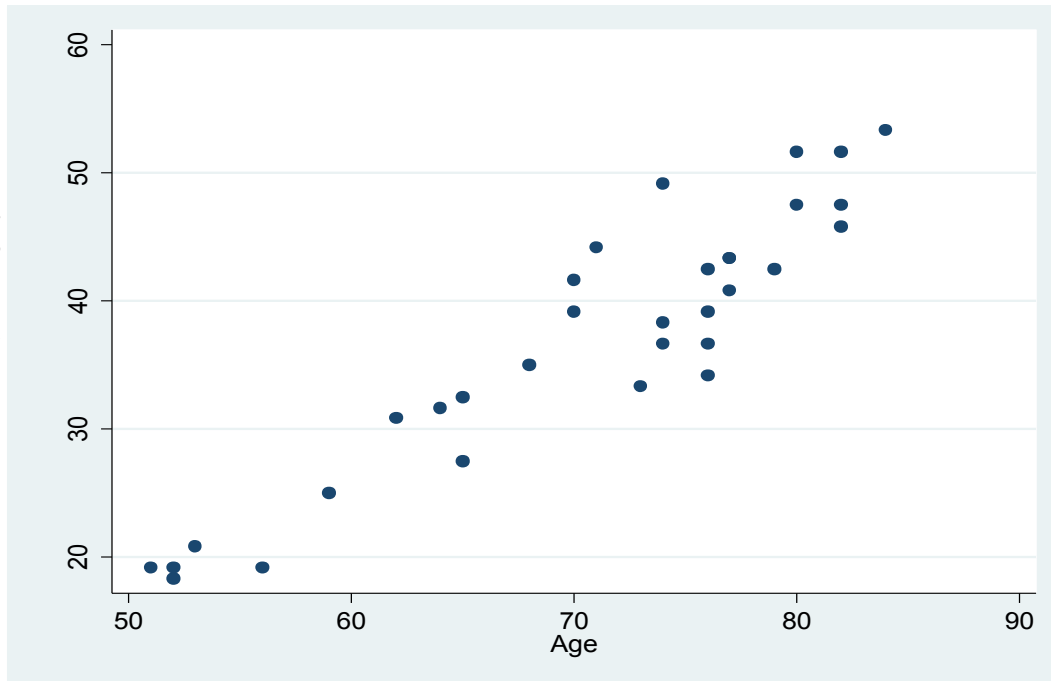
On completion of the questionnaire, the sum of the responses ranges from a minimum of 30 to a maximum of 150. A formula, $\left[\frac{(\text{sum of } n \text{ responses})}{n} - 1 \right] \times 25$, is then applied to the sum of responses to give the DASH score, which is a value out of a 100. The lower the value, the better the participants functioning and the less the pain they are experiencing. The mean DASH score for the cohort was 36.9 (range 18.3 – 53.3) (Figure 6)

Figure 6: DASH scores post-surgery



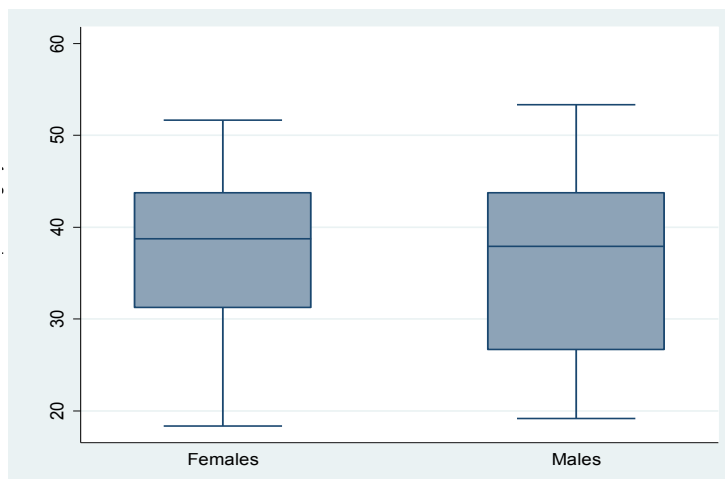
The DASH scores were positively correlated with age of the patients. As the age of the patients increased, the DASH scores increased (Figure 7).

Figure 7: Correlation between DASH scores and age of patients



There was no variation in DASH scores by gender (Figure 8). Among the females, the mean DASH score was 37.2 (range 18.3-51.7) while among the males it was 36.5 (range 19.2 – 53.3). However, the males had a wider interquartile range compared to the females.

Figure 8: DASH scores by gender of patients



CHAPTER 5: DISCUSSION

Proximal Humerus fractures represent 4-5% of all fractures^{5,6,7,8}. However, between 80% and 90% of patients with proximal humeral fractures can be managed conservatively¹⁴. This is due to the fact that the majority of these fractures are minimally displaced. Studies done by Olerud et al¹⁵ and Zyto¹⁶ have shown high union rates in patients with minimally displaced proximal humerus fractures. In young patients, proximal humerus fractures usually occur as a result of high energy trauma, while in elderly patients these fractures result from low energy trauma. In younger patients, anatomic reduction and stabilization of the proximal humerus should always be attempted via open reduction and internal fixation. If, however, an anatomic reduction and stable fixation is not achievable, then hemiarthroplasty is the preferred management option¹⁷. In older patients, whose proximal humerus fractures are complicated by pre-existing osteoporosis and severe fracture comminution, stable internal fixation is difficult to achieve and maintain¹⁸. Attempts at fixation result in implant failure, mal-union or avascular necrosis. Thus older patients are preferentially treated with a hemiarthroplasty. Charles Neer first popularised the use of hemiarthroplasty in the treatment of complex proximal humerus fractures^{3,4,13}. Hemiarthroplasty of the shoulder has become the “gold standard” for the management of proximal humerus fractures when the humeral head is deemed to be unreconstructable^{4,13}.

The Neer prosthesis was the first implant to replace the humeral head post fracture³. It had a monobloc design. Subsequent implants had a modular design. The modern prostheses are designed to achieve soft tissue balance in addition to restoring the bony anatomy. To achieve good shoulder function post-op, the rotator cuff muscles need to be properly functional. As the rotator cuff attaches to the tuberosities of the proximal humerus, provision is made on the prosthesis for re-attachment of the tuberosities with sutures or cables. Boileau et al¹⁹ in their study found that correct positioning of the tuberosities on the prosthesis was essential, as tuberosity malunion lead to impaired functional outcome in the operated shoulder. Loebenberg, Jones and Zuckerman²⁰ found that the optimal

position for the tuberosities was 10 – 16mm distal to the superior margin of the prosthetic head. A shortcoming in our study was that radiographic imaging of the operated shoulders was not done. As a result position of the tuberosities could not be determined.

In our study, the mean age of the participants was 70.5 (range 51 – 84) years. The mean DASH score was 36.9 (range 18.3 – 53.3). There was a positive correlation between the ages of the participants and the DASH score, meaning that the older the participant, the higher the DASH score. Thus indicating that the older participants had a poorer functional outcome and experienced more pain than the younger participants. Our results are comparable to a study done by Gallinet et al²⁰ whose study contained 17 participants who had undergone hemiarthroplasty shoulder surgery. The mean age of the participants was 74 years (range 49 – 95). The mean DASH score was 41.2 (range 18.3 – 60.7). The mean age in our study was slightly less than the participants in Gallinet's study (70.5 years vs. 74 years) and consequently, the mean DASH score in our study was slightly less than in Gallinet's study (36.9 vs. 41.2).

The disabilities of the arm, shoulder and hand (DASH) score was created by the American Academy of Orthopaedic Surgeons, the Council of musculoskeletal special societies and the Institute for Work and Health working together in 1996¹. DASH assesses physical function, symptoms as well as social and psychological function^{1,22}. The 30 questions are divided into questions pertaining to difficulties to perform physical activities (21 questions), symptom severity (5 questions) and the impact of the injury on participants ability to partake in social activities, self-image, ability to work and disturbance of sleep (4 questions)²³. DASH measures shoulder, elbow, wrist and hand function in a single combined value. DASH does not differentiate between the affected and the unaffected limb. This lack of differentiation may result in certain answers by the participant showing no response to treatment, especially if the dominant arm does the action in question and the non-dominant arm was treated. DASH has been validated in over 15 languages. While English is one of the 15 languages, the other 10 official South African languages are not part of the 15 validated

languages. Hence DASH has not been validated for the South African population. While every one of the 32 participants in our cohort understood English well enough to complete the DASH questionnaire, an interpreter was available, but not used.

In each of the participants, before they were included in the study, it was established that they had sustained no previous injury or undergone any previous surgery to either shoulder prior to sustaining the proximal humerus fracture. By examining the unoperated shoulder, the findings were used as a control against which the findings in the operated shoulder were compared. We equated the functioning of the un-operated shoulder to be the same as the functioning in the operated shoulder before the participant sustained the injury, i.e. the pre-morbid functional status. Thus instead of having a separate group of participants which were age, gender and functionally matched to act as a control group, the participants' un-operated shoulders acted as the control. Both shoulders in each participant were examined with regards to 5 movements: Flexion, extension, abduction, internal rotation and external rotation. The mean values of each of the 5 movements were found to be less in the operated shoulders than in the un-operated shoulders. This difference was statistically significant in all 5 movements with a $p < 0.001$. Our findings were in keeping with our hypothesis that Hemiarthroplasty gives good pain relief, but a poor functional outcome as compared to the patient's pre-morbid functional status.

CHAPTER 6: CONCLUSION

Hemiarthroplasty remains a feasible option for the management of patients with fractures of the proximal humerus that are deemed unfixable. It provides good pain relief to patients, but the functional outcome of the operated shoulder is less, despite rehabilitation, than the pre-morbid state. Union of the Tuberosities in the correct position leads to a better functional outcome^{19,20}.

6.1 RECOMMENDATION

Taking into account the shortcomings of our study, I would recommend a randomised control trial, with 2 groups of participants, comparing the outcome of proximal humerus fractures in patients being managed conservatively versus surgically with a hemiarthroplasty. The first group would be managed non-operatively, and the second group would be managed with hemiarthroplasty surgery. DASH scores would be done for the patients when they presented acutely post-injury and then at fixed intervals, so instead of a single DASH score, we would have a series of scores that would give us a trend. Radiographic imaging would also be done serially to assess the proximal humerus.

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Appendices

Appendix A: Disabilities of the Arm, Shoulder and Hand

DISABILITIES OF THE ARM, SHOULDER AND HAND

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Write.	1	2	3	4	5
3. Turn a key.	1	2	3	4	5
4. Prepare a meal.	1	2	3	4	5
5. Push open a heavy door.	1	2	3	4	5
6. Place an object on a shelf above your head.	1	2	3	4	5
7. Do heavy household chores (e.g., wash walls, wash floors).	1	2	3	4	5
8. Garden or do yard work.	1	2	3	4	5
9. Make a bed.	1	2	3	4	5
10. Carry a shopping bag or briefcase.	1	2	3	4	5
11. Carry a heavy object (over 10 lbs).	1	2	3	4	5
12. Change a lightbulb overhead.	1	2	3	4	5
13. Wash or blow dry your hair.	1	2	3	4	5
14. Wash your back.	1	2	3	4	5
15. Put on a pullover sweater.	1	2	3	4	5
16. Use a knife to cut food.	1	2	3	4	5
17. Recreational activities which require little effort (e.g., cardplaying, knitting, etc.).	1	2	3	4	5
18. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5
19. Recreational activities in which you move your arm freely (e.g., playing frisbee, badminton, etc.).	1	2	3	4	5
20. Manage transportation needs (getting from one place to another).	1	2	3	4	5
21. Sexual activities.	1	2	3	4	5

DISABILITIES OF THE ARM, SHOULDER AND HAND

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
22. During the past week, <i>to what extent</i> has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups? (circle number)	1	2	3	4	5

	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem? (circle number)	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. (circle number)

	NONE	MILD	MODERATE	SEVERE	EXTREME
24. Arm, shoulder or hand pain.	1	2	3	4	5
25. Arm, shoulder or hand pain when you performed any specific activity.	1	2	3	4	5
26. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5
27. Weakness in your arm, shoulder or hand.	1	2	3	4	5
28. Stiffness in your arm, shoulder or hand.	1	2	3	4	5

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? (circle number)	1	2	3	4	5

	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE
30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem. (circle number)	1	2	3	4	5

DASH DISABILITY/SYMPTOM SCORE = $\frac{(\text{sum of } n \text{ responses})}{n} - 1$ x 25, where n is equal to the number of completed responses.

A DASH score may not be calculated if there are greater than 3 missing items.

Appendix B: Data collection Sheet

Patient Study Number:

Gender: Male/ female

Age:

DASH Score:

$$\left[\frac{(\text{sum of } n \text{ responses})}{n} - 1 \right] \times 25$$

(n is equal to the number of completed responses on the DASH questionnaire)

Clinical Examination:

Movement in Degrees	Operated Shoulder	Opposite Shoulder
Flexion		
Extension		
Abduction		
External rotation		
Internal rotation		

Appendix C: Helen Joseph Research Committee approval



GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Helen Joseph Hospital
Enquiries: Dr. M. Mukansi
Research Committee - Chairperson
Tell: 011 489 0306/1087
Fax: 011 489 1038
Email: murimisi.mukansi@wits.ac.za

To whom it may concern
Date: 27 July 2016

SUBJECT: HELEN JOSEPH HOSPITAL RESEARCH COMMITTEE
Protocol Title: Assessing pain and functional outcome of patients treated with a hemithroplasty for proximal humerus fractures at Helen Joseph Hospital
Protocol Ref No: Not applicable
Ethics Clearance: Pending
Principal Investigator: Leslie Jacobs
Department: Orthopedics

Committee Recommendations

Committee approval is provisional. Pending HREC of the University of the Witwatersrand

Thank you in anticipation

Dr. M. Mukansi
Chairperson of the HJH Ethics and Research Committee

Appendix D: Human Research Ethics Committee Clearance certificate



R14/49 Dr Leslie Jacobs

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL) CLEARANCE CERTIFICATE NO. M160848

NAME: Dr Leslie Jacobs
(Principal Investigator)
DEPARTMENT: Orthopaedic Surgery
Helen Joseph Hospital


PROJECT TITLE: The Outcome of Fractures of the Promixal Humerus
After Hemiarthroplasty

DATE CONSIDERED: 26/08/2016

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Prof A.A. Aden and Dr R. Bhaga

APPROVED BY: 

Professor P Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 26/10/2016

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 authorized 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 the application 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 reviewed in August and will therefore be due in the month of August each year.

Principal Investigator Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix E: Plagiarism Report

The Outcome of Fractures of the Proximal Humerus After Hemi...

ORIGINALITY REPORT

19%	14%	14%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.jbjs.org Internet Source	1%
2	scribd.com Internet Source	1%
3	boneandjoint.org.uk Internet Source	1%
4	Submitted to Universiti Kebangsaan Malaysia Student Paper	1%
5	Submitted to University of Witwatersrand Student Paper	1%
6	www.wits.ac.za Internet Source	1%
7	archive.org Internet Source	1%
8	Submitted to University College London Student Paper	1%
9	www.ncbi.nlm.nih.gov Internet Source	1%
10	Submitted to University of South Florida Student Paper	1%