PREDICTING THE OUTCOME OF PATIENTS WITH PROXIMAL HUMERAL FRACTURE BY RADIOGRAPHIC FINDINGS. A RETROSPECTIVE STUDY

*MICHAEL J.CALLAGHAN

MANCHESTER ROYAL INFIRMARY

OXFORD ROAD

MANCHESTER M13 9WL

And

ELAINE BALL

COLLEGE OF HEALTH AND SOCIAL CARE

SALFORD UNIVERSITY

FREDERICK ROAD

MANCHESTER M6 6PU

*Correspondence contact: michael.callaghan@manchester.ac.uk

Abstract

Background: A retrospective study was undertaken to establish if the outcome of patients with proximal humeral fracture could be predicted by radiographic findings. 12 patients were reviewed with a proximal humeral fracture and were treated conservatively with sling immobilisation, followed by physiotherapy. After each treatment was completed, patient's radiographs, taken immediately after the initial trauma, were reviewed and the fracture was classified according to Neer and arbeitsgemeinschaft orthopaedie (AO). There were two crucial time points.

Methods: Reviewer one, blinded to the patients' final functional outcome, attempted to forecast patient functionality by placing each patient into one of 3 broad groups described as 'good', 'moderate' or 'poor' based on the radiographs. Six months after finishing physiotherapy all patients were reassessed functionally by another researcher (reviewer 2), blinded to radiographic classification and prediction. Multiple regression analysis was used to measure outcomes at both interval points.

Results: Multiple regression analysis revealed a significant correlation (R^2 0.613, p = 0.014) between the radiographic predicted outcome and the immediate post treatment outcome when adjusting for age. At 6 months review, there was a significant correlation between predicted radiographic outcome and functional outcome when adjusted for patients' age (R^2 0.765 P = 0.001); patients remained in their predicted groups. Six months after physiotherapy only one patient reported being pain free. Poisson linear regression analysis revealed that compared to the patients in the 'poor' and 'moderate' groups those in the 'good' group had 3 treatment sessions wasted (P < 0.001). Those in the 'poor' group accounted for 50 out of 76 treatments after their progress had plateaued.

Conclusions: This study indicates that knowledge of the types of proximal humeral fracture classification and accurate radiological diagnosis may help planning conservative treatment realistically and reduce the number of unnecessary physiotherapy treatments.

Keywords: Retrospective study; Proximal humeral fractures, Radiographic review, Physiotherapy

Background

Proximal humeral fractures are the third most common osteoporotic fracture [1]. Coupled with an increased ageing population, this figure is growing exponentially as people live longer. Conservative figures estimate that fractures of the proximal humerus in later age accounts for 5% of all fractures [2]. A Finnish study over a twenty three year period identified that proximal humeral fractures have quadrupled from 1987 to 2009 [3]. The proximal humeral fracture is usually caused by a fall on an outstretched hand from a standing height or less. In the elderly patient, severe trauma does not often play a significant role which is probably due to the amount of osteoporosis present in this population [4]. In contrast, severe trauma is more likely to be a factor in a younger patient, resulting in a more serious fracture. A further study [5] reported that a high number of patients with a proximal fracture of the humerus did not undergo any fixation operation confirming that conservative treatment for this problem is usually adopted.

Referral to physiotherapy is regarded as an important part of such conservative treatment, the purpose of which is to prevent muscle atrophy and joint stiffness and to decrease pain. Rehabilitation is generally long and time consuming with patients attending many physiotherapy treatment sessions. A realistic evaluation of treatment and prediction of outcome may be possible from radiographic appearances and an accurate classification of the proximal humeral fracture.

To investigate this, a retrospective study was undertaken. The chief aim of the study was to establish if outcome of patients with a proximal humeral fracture could be

predicted by radiographic findings. Subsidiary aims were to investigate the functional outcome six months after final discharge from physiotherapy, to discover at which stage of treatment patients stopped progressing and thus to calculate the number of excessive treatments received by patients.

Methods

All patients over a 6 month period referred to physiotherapy department with a diagnosis of proximal humeral fracture, and treated non-surgically were included for review. After approximately six week's immobilisation in a sling, all patients were referred to the physiotherapy department and received treatment primarily by active and passive exercise and accessory mobilisation of the joint. Other adjuncts to treatment were also utilised as deemed appropriate by the physiotherapist (e.g. electrotherapy and hydrotherapy). When the patient had been discharged from physiotherapy, the radiographs were reviewed by an experienced consultant orthopaedic surgeon with a special interest in trauma who had no prior knowledge of the final outcome of treatment or the identity of the patient. The radiographs were classified according to the Neer and arbeitsgemeinschaft orthopaedie (AO) methods. Relying solely on the radiographic appearances, the reviewer attempted to forecast the functional outcome and place each patient into one of three broad categories (table 1). Following discharge from physiotherapy the patients were reviewed six months later by another researcher blinded to the radiographic classification and the post discharge outcome.

For the purpose of this study, patients were recalled to a six month review; active ranges of flexion and abduction were re-measured for using a standard universal goniometer. Internal rotation was measured by visualising the 'hand behind back' position relative to the spinous process level. These measurements were used as they were recorded in the patients' case notes during treatment and at final discharge.

Definition of classification of fractures

The most commonly used classification is the 4 part system developed by Neer in 1970. Neer based this on Codman's work which differentiated 4 major fragments of any proximal humeral fracture: 1) anatomical head 2) greater tuberosity 3) lesser tuberosity 4) shaft of humerus. Neer developed this into a system based on 4 major fragments and their relationship to each other [6]. When any of the major fragments is displaced over 1 cm or angulated more than 45^0 then the fracture is classified as displaced. Thus, a hairline fracture or a fissure line is not considered to be displaced. One of the major fragments may have several displaced components and so should not be considered as separate. A fracture of the proximal humerus, which is not displaced or minimally displaced (<1cm), is considered to be a Part I fracture.

Arbeitsgemeinschaft orthopaedie (AO)

The AO group classification [7] have modified Neer's classification and emphasised the vascular supply to the articular segment which, they claim, plays a pivotal role in the prognosis of the proximal humeral fracture. The AO system uses 3 categories according to severity for the proximal humerus according to topography and the extent of the bone lesion: Type 11-A is the least severe, is extracapsular unifocal and

involves 2 of the 4 major segments. Type 11-B is more severe, is extra-articular bifocal involving 3 of the 4 major segments. Type 11-C is the most severe, intra-articular and involves all the 4 major segments. Each of the types A, B, C are subdivided numerically with higher numbers generally reflecting greater severity (e.g. A 1.1 is less severe than C 3.3) (Figure 1). For further detail, the reader is directed to the definitive text [7].

The advantage of the Neer classification over the AO system is that it is easier and quicker to classify a fracture in the clinical setting without reference to a text and with nothing to memorise. The disadvantage of Neer's system is that it is a concept rather than a numerical classification and the AO is more precise. In combination, both systems provide practicality with orthopaedic accuracy in a clinical setting.

Analysis

Multiple regression analysis with adjustment for age was performed to assess the relationship between the predicted radiographic outcome based on the Neer classification and the actual outcome after physiotherapy immediately after discharge and 6 months later;

Poisson regression performed in order to assess any association between the group severity and the number of treatments attended after the range of motion had stopped progressing.

Results

There were 12 patients who fulfilled the criteria; one patient (in the "poor" group) had died leaving 11 for review. The subjects' mean age was 63 (SD 16.3 years). The average period of immobilisation in a sling was average 27 days (range 14-49 days). Some patients also received electrotherapy (n=5) and hydrotherapy (n=2) as adjunct treatments.

Multiple regression analysis revealed a significant correlation (R^2 0.613, p = 0.014) between the radiographic predicted outcome and the post treatment outcome when adjusted for patients' age. At 6 months review, there was also significant correlation between predicted radiographic outcome and functional outcome when adjusted for age (R^2 0.765 P = 0.001); patients remained in their predicted groups. One patient classified with a 3 part Neer fracture and a AO 1.1 fracture was categorised by radiograph as 'moderate' whereas the functional outcome was 'good'. At six months only one patient reported being pain free. Poisson linear regression analysis revealed that the patients in the 'poor' and 'moderate' groups continued with 50 extra treatments out of 76 treatments after their progress had plateaued.

Table 1 shows the definitions of the categories for the functional outcomes.

Table 1

Table 2 shows the classification of each patient's fracture, the predicted outcome according to the radiograph reviewer, the actual outcome after physiotherapy and the outcome at six months review.

Table 2

Table 3 shows the number of treatments given after patients' progress stopped.

Patients in the 'poor' group accounted for 51 of 76 physiotherapy treatments (median values 'poor'= 6, 'moderate'= 2 'good'= 2 $p > 0.05$) which they received after their progress had stopped.

Table 3

Discussion

This study asked if the outcome of a patient with a proximal humeral fracture could be predicted by radiographic findings. Whilst evidence shows that conservative management is the preferred option in the treatment of a proximal humeral fracture [5], referrals to physiotherapy for such treatment often had a poor description of the type of fracture. The patient outcomes were not dependant on the number of treatments nor the number of modalities used; neither were they dependant on the patients' ages. The reviewer was able to predict accurately the outcome from the radiographs and in each case was able to place the patients into the appropriate category. This emphasised the importance of good radiographic diagnosis and classification so that physiotherapy treatment can be better planned and predicted and unnecessary treatment prevented.

The study also aimed to answer subsidiary questions. Firstly, did the patient improve further after discharge from formal physiotherapy and therefore did the patient

outcome alter at the 6 month call-back review? The results show that the more serious the fracture (in both Neer and AO classification), the worse the patient's range of motion outcome. At 6 months only 3 out of 11 patients had improved after formal physiotherapy had ended in terms of range of movement; one in the "poor" group and two in the "good" group. The "poor" group patient had only improved in one movement direction which was not sufficient to move into the "moderate" group. The 2 "good" patients continued to improve. The study indicates that patients categorised as 'poor' or 'moderate' do not improve 6 months after discharge from formal physiotherapy. Only one patient out of 11 stated that they were totally pain free although formal data using a VAS or a specific shoulder score were not collected. Anecdotally, it has been thought that patients would continue to improve in terms of range of motion, function and pain after discharge from formal outpatient treatment if they had been given a home exercise regime. There is no evidence in the literature to substantiate this opinion and this study suggests that a home exercise regime was not helpful as none of the patients had returned to full range of movement or normal function and only one reported being pain free. Only two patients from the "good" group continued to improve in some movements at six month's review. All the other patients showed neither improvement, nor minimal improvement that was sufficient to move them into the next group.

Another subsidiary question was at what stage did patient progress stop during physiotherapy treatment? Further analysis of the patient case notes revealed that some patients reached their discharge range of movement early in their treatment, with no more improvement despite further intensive treatment. All these patients were in the predicted "poor" group with a classification of 3 or 4 part Neer or AO B 2.2 or worse.

The total number of ‘after plateau’ treatments for all patients was 76. The patients in the ‘poor’ group accounted for 50 of these. Although physiotherapists should be wary of stopping treatment too soon, they should be able to prepare the patient with a realistic aim and timetable of treatment.

Conclusion

Figure 1

This retrospective study has established that radiographic findings can predict the final functional outcome in a group of patients treated conservatively following a proximal humeral fracture. It has also established that at six month’s review none of the patients had returned to full function, range of motion and only one was pain free. Those patients in the “poor” group were the most likely to plateau early into their physiotherapy treatment.

Abbreviations

AO = Arbeitsgemeinschaft orthopaedie
F = Flexion
Ab = Abduction
HBB = Hand behind back
IL Crest = Iliac crest

Competing interests

The authors declare they have no competing interests.

Authors' contributions

MC conceived, participated and provided oversight for the study design and coordination. MC and EB participated in the design and statistical analysis. MC and EB wrote, edited and approved the final manuscript.

References

1. Huttunen TT, Launonen AP, Pihlajamäki H, Kannus P, Mattila VM: **Trends in the surgical treatment of proximal humeral fractures–a nationwide 23-year study in Finland**. *BMC* musculoskeletal disorders 2012, **13**(1): 261.

2. Lanting B, MacDermid J, Drosdowech D, Faber KJ: **Proximal humeral fractures: a systematic review of treatment modalities**. J Shoulder Elbow Surg 2008, **17**(1): 42-54.

3. Handoll HH, Ollivere B J., & Rollins KE: **Interventions for treating proximal humeral fractures in adults**. *Cochrane Database Syst Rev* 2012, 12.

4. Melton LJ, Achenbach SJ, Atkinson EJ, Therneau TM, Amin S: **Long-term mortality following fractures at different skeletal sites: a population-based cohort study.** Osteoporosis International 2012, 1-8.

5. Okike K, Lee OC, Makanji H, Harris MB, Vrahas MS: **Factors associated with the decision for operative versus non-operative treatment of displaced proximal humerus fractures in the elderly**. Injury 2012, 223-236.

6. Neer JS: **Displaced proximal humeral fractures Part 1. Classification and evaluation**. J.Bone Joint Surg 1970, **52A**: 1077-1089.

7. Muller ME, Nazarian S, Koch P, Schatzker J: *The comprehensive classification of fractures of long bones*. Berlin, Heildelberg, New York: Springer-Verlag; 1990.

Table 1. Categories of measurement. Patients were categorised according to the active ranges of motion listed below

	ACTIVE FLEXION	ACTIVE ABDUCTION	ACTIVE HAND BEHIND BACK
POOR	≤90	≤90	to centre of sacrum
MODERATE	>90 - <120	>90 - <120	To L5
GOOD	≥120	≥120	>L5

Table 2. Comparison of outcome: predicted. actual and at 6 month review

AGE	NEER	AO	PREDICTED OUTCOME	ACTUAL OUTCOME	6 MONTHS REVIEW
29	2 part	A 3.1	good	F=160° Ab=150° HBB=T12	F=160° Ab=l60° HBB=T12
60	3 part	B 2.2	poor	F=50° Ab=30° HBB=L5	Flex=80° Ab=30° HBB=Il Crest
64	3 part	C 2.3	poor	F=90° Ab=90° HBB=L2	F= 90° Ab=90° HBB=Ll
42	2 part	A 3.3	good	F=130° Ab=130° HBB=L4	F=150° Ab=175° HBB=T9
75	2 part	A l.2	moderate	F=150° Ab=90° HBB=L5	F=150° Ab=l00° HBB=L5
63	2 part	B 1.1	poor	F90° Ab=90° HBB=L4	R.I.P.
69	4 part	C 2.2	poor	F=50° Ab=50° HBB=L5	F=90° Ab=90° HBB=L4
86	1 part	A 2.l	good	F=160° Ab=l00° HBB *	F=160° Ab=l70° HBB=L5
55	3part	C 2.l	poor	F=120° Ab=90° HBB=L5	F=120° Ab=90° HBB=L5
58	2 part	B 2.3	moderate	F=l10° Ab* HBB *	F=l10° Ab=l00° HBB=L4
73	3part	B l. l	good	F=140° Ab=160° HBB=L2	F=160° Ab=170° HBB=T12
84	3 part	C 1.1	moderate	F=165° Ab=180° HBB *	F=170° Ab=180° HBB=L5

KEY:

F = Flexion

Ab = Abduction

HBB = Hand behind back

IL Crest = Iliac crest

* = not recorded at discharge.

Table 3. Number of 'after plateau' treatments i.e after ROM plateaued

CATEGORY	No OF TREATMENTS AFTER PROGRESS STOPPED	TOTAL TREATMENTS No
moderate	5	11
Poor	2	6
poor	17	25
poor	20	27
good	3	31
good	4	40
poor	5	20
good	0	3
poor	6	23
good	1	11
moderate	1	10
moderate	2	10
TOTAL	76	217

Figure 1 Five key findings in a retrospective radiographic study predicting final functional outcomes in a group of patients treated conservatively following a proximal humeral fracture