

Hand grip – a simple test for morbidity after fracture of the neck of femur¹

C W Twiston Davies MB FRCS

D Moody Jones MB FRCS

J R Shearer PhD FRCS

Southampton General Hospital, Southampton SO9 4XY

Summary: Seventy-six female patients, having sustained a fracture of the neck of femur, were assessed preoperatively by measuring their muscle strength in the form of grip using a hand-held dynamometer and by measuring serum albumin. A grip strength of < 15 kg was found to be a reliable predictor of subsequent postoperative complications in female patients over the age of 80. Serum albumin had no predictive value. There was no significant difference in complication rates between different surgeons.

Introduction

Femoral neck fractures are common in old people and are increasing at a greater rate than the increase in the elderly population, showing that the incidence of these fractures is increasing (Lewis 1981). Despite improvements in anaesthesia, implants and prostheses, the morbidity and mortality following such fractures remain unchanged. A probable cofactor in prolonged morbidity and significant mortality is poor general nutrition before the fracture (*British Medical Journal* 1972, Hackett *et al.* 1979). It has been shown that protein requirements after operation are not met by standard hospital diet (Older *et al.* 1980, Hill *et al.* 1977).

Many indices have been measured in attempts to identify those patients who are at greatest risk of suffering complications after operation, but with little success. These tests include creatinine clearance, glomerular filtration rate and radioactive calcium absorption. However, they are cumbersome, invasive and expensive (Wootton *et al.* 1979, Bistran *et al.* 1974, 1975), and an inexpensive, simple and quick test would therefore be of great value.

Protein depletion has been shown to have an adverse effect on surgical patients (Kammerling *et al.* 1978). It may result from inadequate intake before admission or may be initiated or compounded by increased catabolism (trauma or operation). Protein content of muscle has been shown to be directly proportional to muscle power (Daniel *et al.* 1977). Hand dynamometric measurements have been shown to be valuable in general surgical patients at Southampton General Hospital, in the detection of malnutrition (Klidjian *et al.* 1982) and in the prediction of postoperative complications (Klidjian *et al.* 1980). It was felt that this simple measurement of muscle power might provide a useful predictor of patients at risk of postoperative complications on the Orthopaedic Unit. A study was therefore carried out on orthopaedic patients suffering from fractures of the neck of the femur.

Methods

A total of 254 patients with fractured neck of femur were admitted to Southampton General Hospital between 20 August 1982 and 14 March 1983. Patients who were unable to use the grip strength meter because of physical disability (such as rheumatoid arthritis or cerebrovascular accidents) or who were unable to cooperate because of mental deterioration were excluded, as were all male patients for their numbers were insufficient. Amongst the remaining 77 female patients studied in detail, there were both intra- and extracapsular

¹Accepted 20 June 1984

Table 1. Operations performed

Thompson hemiarthroplasty	9
Austin Moore hemiarthroplasty	10
Stanmore total hip replacement	1
McGloughlin pin and plate	12
Pugh nail plate	26
Dynamic hip screw	11
Ender nails	4
Howse screws	2
Watson Jones nail	1

Table 2. Serum albumin levels (g/l) according to age group (normal range 32–50)

Age	No complication	Complication
< 70	31–42	—
70–79	27–42	29–41
80+	27–44	28–45

fractures. One patient died preoperatively. Operations performed on the remaining 76 patients are listed in Table 1.

Muscle function was assessed before operation using the Clinifeed/Roussel hand grip dynamometer to measure the hand grip strength. It was often necessary to demonstrate the use of the dynamometer several times before a patient was able to understand how to hold it correctly prior to measurement. Three readings were taken from the non-dominant hand, allowing a period of ten seconds between each measurement. The best of the three readings was recorded. Serum albumin concentration was measured using a Vickers SP 120 auto-analyser and the Bromo Cresol green method. Accepted normal values given by Southampton General Hospital laboratory were between 32 and 50 g/litre.

These results were then correlated with the development (or lack) of serious complications postoperatively. For the purpose of this study, a serious complication was defined as one that resulted in a delay of 16 or more days between operation and discharge from hospital. Serious complications included wound infection, chest infection, failure of implant and death. Extended admissions due to placement difficulties were not included. No distinction was made between discharge to the patient's own home or discharge to an institution.

Results

Serum albumin was found to have no predictive value (Table 2). There was no significant difference in complication rates between surgeons (Table 3), and increasing age appeared to be the main factor producing a high incidence of complications (Table 4).

Assessment was therefore made within each group to show a true assessment of the value of grip strength. The results, in patients under 70, were inconclusive. Between the ages of 70 and 80 years of age, the numbers were small, producing no significant result. In patients over 80 years of age, significant results were obtained. These were not due to age within this group. The median age of patients with complications was 86 years and of those without complications 85 years. The Mann-Whitney U test demonstrated that this age difference was not statistically significant ($P < 0.297$). Grip strengths in this group ranged from 2 to 27 kg. Each patient's grip strength was recorded and grouped (Table 5). Comparison of each group, relating postoperative complications to preoperative grip strengths, showed clearly that 15 kg was the most significant reference point (Table 6). The median grip strength of those with complications was 10 kg and without complications 16 kg. This difference was

Table 3. Comparison between surgeons of complications in patients aged 80+

Grade	No complications	Complications	Total
Senior Registrar	10	15	25
Registrar	11	15	26
Total	21	30	51

Table 4. Complications in age groups

Age	No complications	Complications
< 70	9	0
70–79	13	3 (19%)
80+	21	30 (59%)

Chi-squared 14.9 with 2 degrees of freedom, $P < 0.01$

Table 5. Grip strengths (range 2–27 kg) in female patients aged 80+

Grip strength (kg)	No complications (n = 21)	Complications (n = 30)
10 or less	4	15 (75%)
10.1–11	2	0
11.1–12	1	7 (87%)
12.1–13	0	1 (100%)
13.1–14	3	4 (57%)
14.1–15	0	0
15.1–16	2	1 (33%)
16.1–17	3	0
17.1–18	2	1 (33%)
18+	4	1 (20%)

Table 6. Complications related to grip strength in female patients aged 80+

	No complications	Complications
> 15 kg	11	3 (21%)
< 15 kg	10	27 (73%)

Chi-squared 9.114, $P < 0.01$ with Yates' correction

Thus: Sensitivity of test 90%

Specificity of test 48%

Overall accuracy 75%

Negative predictive value 79%

Positive predictive value 73%

significant ($P < 0.007$), indicating that in age-matched patients in this group a low grip strength was a reliable predictor of complications, a value of less than 15 kg in the non-dominant hand predicting those at high risk.

Discussion

In patients 80 years or older with a fractured neck of femur, it is possible to detect those at highest risk by the application of the grip strength test. Those identified in this group will benefit from early nutritional support, with a subsequent decrease in the length of hospital stay (Gallanaugh *et al.* 1976, *British Medical Journal* 1979). This age group included more than half the patients presenting with fractured neck of femur. Lawton *et al.* (1983) recently suggested two distinct populations of femoral neck fracture, trochanteric and cervical, and showed a significant difference between them. No such difference was found in the present study, but this is possibly due to different environmental factors. However, in female patients over 80 years, grip strength has been found to provide significant results with an accuracy of 75%. Grip strength has satisfied the basic requirements of the investigation, providing an effective and rapid method of determining those at risk. Wootton *et al.* (1979) reported reduced serum albumin levels in patients with fractured neck of femur who were at risk of complication. In 1974 Bistran *et al.* reported similar findings, but in 1975 they stated that the creatinine height index (defined as creatinine excretion divided by expected 24-hour creatinine excretion of normal adult of same height) was more sensitive than serum albumin. In the present series, serum albumin was found to have no predictive value.

More work is required to determine the indications for the grip strength test in other age groups. It shows some promise in the seventh decade but in younger patients assessment is unlikely to be of value. Nutritional status and reaction to the stress of the injury are the two most likely reasons for the predictive success of grip strength.

The hand grip dynamometer seems to be a crude but effective 'will to live meter' (Hart & Huskisson 1972) and enables those at highest risk to be recognized early and treated by parenteral nutrition and special care methods.

Acknowledgments: We would like to thank Messrs Wilkinson, Jackson, Fitzgerald, Wood and Robertson for allowing us to enter their patients in the trial, and Mr P C Fulford and Mr P P Monro for their invaluable advice.

References

- Bistran B R, Blackburn G L, Hallowell E & Heddle R (1974) *Journal of the American Medical Association* **230**, 858–860
- Bistran B R, Blackburn G L, Sherman M & Scrimshaw N S (1975) *Surgery, Gynecology and Obstetrics* **141**, 512–516
- British Medical Journal* (1972) *i*, 400

British Medical Journal (1979) ii, 1529

Daniel P M, Pratt O E & Spargo E (1977) *Lancet* ii, 446-448

Gallanaugh S C, Martin A & Millard P H (1976) *British Medical Journal* ii, 1496-1497

Hackett A F, Yeung C K & Hill G L (1979) *British Journal of Surgery* **66**, 415-418

Hart F D & Huskisson E C (1972) *Lancet* i, 28-30

Hill G L, Pickford I, Young G A *et al.* (1977) *Lancet* i, 689-692

Kammerling K, Foster K J & Karran S J (1978) *British Journal of Surgery* **65**, 365

Klidjian A M, Archer T J, Foster K J & Karran S J (1982) *Journal of Parenteral and Enteral Nutrition* **6**, 119-121

Klidjian A M, Foster K J, Kammerling R M, Cooper A & Karran S J (1980) *British Medical Journal* **281**, 899-901

Lawton J O, Baker M R & Dickson R A (1983) *Lancet* ii, 70-72

Lewis A F (1981) *British Medical Journal* **283**, 1217-1220

Older M W J, Edwards D & Dickerson J W T (1980) *British Journal of Surgery* **67**, 884-886

Wootton R, Brereton P J, Clark M B *et al.* (1979) *Clinical Science* **57**, 93-101