Low interobserver reliability of radiographic signs predicting healing disturbance in displaced intracapsular fracture of the femoral neck

Kristian Bjørgul[1,2] and Olav Reikerås[2]

[1]The Ostfold Central Hospital, NO-1602 Fredrikstad, Norway, [2]Oslo Orthopedic University Clinic, NO-0570 Oslo, Norway. E-mail: kristianb@halden.net
Submitted 01-05-08. Accepted 01-09-04

ABSTRACT – We determined the interobserver agreement of 3 radiographic signs previously shown to predict a disturbance in healing of femoral neck fractures. 6 orthopedic surgeons evaluated 32 radiographs for the presence of comminution of the femoral calcar, varus displacement in excess of 30 degrees and a small head fragment. They also classified the radiographs with Garden's method and determined the presence or absence of displacement. The kappa values were 0.2 for comminution of the calcar, 0.5 for varus displacement and 0.4 for a small head fragment. In the Garden classification, the kappa value was 0.4, increasing to 0.6 when divided into Garden 1–2 and 3–4. When the fracture was classified as displaced or undisplaced, the kappa value was 0.5. The strength of agreement of signs predicting a disturbance in healing was thus shown to be poor to moderate.

■

The treatment of a displaced fracture of the femoral neck is still debated. When closed reduction and osteosynthesis are done, as many as half of the patients need a second operation (Parker and Pryor 2000). Revision is usually done by arthroplasty, partly because of non-union and partly because of necrosis of the femoral head. To avoid reoperations, it seems desirable to try to select the patients who will later need secondary surgery. It has been suggested that comminution of the calcar femorale, varus displacement in excess of 30 degrees and small head fragment predict a disturbance in healing (Alho et al. 1992). The presence of one or more of these signs was found to predict early failure when fractures of the femoral neck were treated with osteosynthesis. In our hospital these signs have been used since 1996 to determine which fractures seem suitable for initial treatment with closed reduction and osteosynthesis or bipolar hemiarthroplasty.

However, these signs were derived from retrospective studies analyzing preoperative radiographs and using regression analysis. Their validity and reliability should be tested before they are accepted for clinical work, which does not seem to have been done. We therefore determined the interobserver reproducibility of these signs to assess their value in clinical work.

Patients and methods

We randomly selected 32 from a total of 283 fractures from the local hip fracture register which had been diagnosed and treated as displaced fractures (Tables 1–3). We treat about 100 displaced intracapsular fractures from a catchment area of 154,000 people annually. The first radiographs (a frontal and lateral view) of the fractures taken at the time of admission were compiled and the identity of the patient concealed. The quality of the radiographs was representative of those available in routine work.

The observers consisted of 6 orthopedic surgeons who had used these radiographic signs described by Alho et al. (1992) for at least 4 years. Before the study no effort was made to increase their ability to classify such fractures since this would have interferred with the aim of the study. They were first asked to classify the fracture as

Table 1. Gender and age of patients in the sample and the whole group

	Number of patients		Age	
	Sample	Whole group	Sample	Whole group
Male	2	65	82	79
Female	30	217	81	81

Table 2. Distribution of patients according to ASA group at the time of surgery in the sample and the group from which the sample was drawn

ASA group	1	2	3	4	Missing value
Sample	0	13	18	1	0
Whole group	14	133	124	4	8

Table 3. Abode of patients at the time of admission

	Own home	Sheltered housing	Nursing home	Other
Sample	21	2	0	9
Whole group	180	34	50	19

displaced or undisplaced. Comminution of the femoral calcar was defined as loss of bone on the distal side of the fracture and labeled as present or not. A small head fragment was defined as the distance from the center of the femoral head to the fracture line of less than 15 millimeters. Varus angulation was classified as more or less than 30 degrees (Alho et al. 1992). Lastly, they were asked to classify the fracture in one of four groups using Garden's method (1961).

The statistical analysis was done by calculating the kappa values using the SPSS statistical software (Altman 1999). For the kappa value, we compared the findings of each observer to those of the other observers concerning the signs, displacement and the Garden classification. We then calculated the median and range of kappa values for each sign, the displacement and Garden classification. We also calculated the aggregate kappa coefficients for the presence of one or more of the signs for each of the observers and for the whole group of observers.

Altman (1999) recommends the following guidelines for interpretation of the kappa values as an expression of strength of agreement:

< 20: poor strength of agreement
0.21–0.40: fair
0.41–0.60: moderate
0.61–0.80: good
0.81–1.0: very good

Results (Tables 4 and 5)

The kappa values were 0.2 (–0.03–0.8) for comminution of the calcar, 0.4 (0.1–0.7) for a small head fragment and 0.5 (0.2–0.7) for varus displacement. When we determined the presence of one or more signs, the values ranged from –0.04 to 1 with a median value of 0.4.

The kappa value for strength of agreement of the Garden classification was 0.4 (0–0.6). When divided into Garden 1–2 and 3–4, the value increased to 0.6 (0.2–0.8). On the question of displacement or not, the value was 0.5 (0.2–1.0).

Discussion

In our clinic for the past 6 years, we have used the signs proposed by Alho et al. (1992) to decide

Table 4. Summary of kappa values for interobserver agreement on radiographic signs predicting a disturbance in healing, displacement and the Garden classification

	Displacement	Comminution of the calcar	Varus > 30 degrees	Small head fragment	Garden	Garden dichotomized
Median	0.53	0.19	0.52	0.44	0.35	0.62
Minimum	0.21	–0.03	0.24	0.08	0	0.21
Maximum	1	0.8	0.74	0.73	0.56	0.84

Table 5. Data on each patient for all observers on comminution of the calcar (A), varus displacement (B), small head fragment (C), Garden classification (D) and displacement (E)

Patient	Observer 1					Observer 2					Observer 3					Observer 4					Observer 5					Observer 6				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
54	2	1	1	4	1	2	1	1	3	1	2	1	2	4	1	2	1	1	3	1	2	1	1	3	1	1	1	1	4	1
70	1	1	1	3	1	2	1	1	3	1	2	1	1	3	1	2	1	1	3	1	2	1	2	2	1	2	1	1	3	1
83	2	1	1	3	1	2	1	1	3	1	2	1	1	3	1	2	1	1	3	1	2	1	1	3	1	2	1	1	3	1
91	2	2	2	3	2	2	2	2	2	2	2	1	2	3	1	1	1	2	3	1	2	1	2	2	1	1	2	2	2	2
102	1	1	1	3	1	1	1	2	4	1	2	1	2	3	1	1	1	1	3	1	2	1	1	3	1	1	1	1	3	1
115	1	1	1	3	1	2	1	1	3	1	2	1	2	3	1	1	1	2	3	1	2	1	2	3	1	1	1	1	3	1
138	1	1	1	3	1	2	1	2	3	1	1	1	1	3	1	1	1	2	3	1	1	1	1	4	1	2	1	1	3	1
144	2	2	2	3	2	2	2	2	2	2	1	1	2	4	1	1	1	2	3	1	2	1	2	3	1	1	1	2	4	1
150	1	1	1	3	1	2	1	2	3	1	1	1	1	4	1	2	1	1	4	1	2	1	1	3	1	2	1	1	4	1
160	1	1	1	4	1	2	1	1	4	1	2	1	1	4	1	1	1	1	4	1	2	1	1	4	1	1	1	1	4	1
179	1	1	1	4	1	2	1	1	4	1	2	1	1	4	1	1	1	1	4	1	1	1	1	4	1	2	1	1	4	1
234	1	1	1	4	1	2	1	1	4	1	2	1	1	4	1	2	1	1	4	1	2	1	1	4	1	2	1	1	4	1
247	2	2	2	1	2	2	2	1	1	2	2	2	2	1	2	2	2	2	2	2	2	2	2	1	2	2	2	2	1	2
257	1	1	2	3	1	2	1	2	3	1	1	1	2	4	1	2	1	2	4	1	1	1	2	4	1	2	1	2	4	1
262	2	1	1	3	1	1	1	1	3	1	2	1	2	3	1	1	1	1	4	1	1	1	2	3	1	1	1	1	3	1
270	2	2	2	1	2	2	2	1	2	2	2	1	2	2	1	2	1	2	3	1	2	2	1	2	2	2	2	2	1	2
280	1	1	1	3	1	2	1	2	3	1	1	1	2	3	1	1	1	2	3	1	1	1	2	3	1	1	1	2	3	1
289	2	2	1	1	2	2	2	1	2	2	2	1	1	1	1	2	2	1	1	2	2	2	1	1	2	2	2	1	2	2
290	1	1	1	4	1	2	1	2	4	1	1	1	2	4	1	2	1	1	4	1	1	1	1	4	1	1	1	1	4	1
328	1	1	1	4	1	2	1	1	3	1	2	1	1	3	1	2	1	1	3	1	2	1	1	4	1	1	1	1	4	1
329	2	1	1	3	1	1	1	1	3	1	1	1	2	3	1	2	1	2	3	1	1	1	1	3	1	1	1	1	4	1
337	1	1	1	4	1	2	1	2	3	1	2	1	1	4	1	2	1	1	4	1	1	1	1	4	1	2	1	2	3	1
341	1	1	2	3	1	2	2	2	2	2	1	1	2	3	1	1	1	2	3	1	2	1	2	3	1	1	1	2	3	1
344	1	1	1	4	1	1	1	2	3	1	2	1	1	3	1	1	1	1	4	1	1	1	1	4	1	1	1	1	3	1
347	1	1	1	4	1	2	1	1	3	1	2	1	1	3	1	2	1	2	3	1	2	1	1	4	1	2	1	1	4	1
367	1	1	1	3	1	2	1	1	3	1	1	1	1	0	1	2	1	1	3	1	1	1	1	3	1	2	1	1	3	1
386	1	1	1	3	1	2	1	1	4	1	2	1	1	4	1	1	1	1	4	1	1	1	1	4	1	2	1	1	3	1
411	1	1	1	3	1	2	1	1	3	1	2	1	2	3	1	1	1	2	3	1	1	1	1	3	1	1	1	1	3	1
423	2	2	2	2	2	2	2	2	1	2	2	1	1	3	1	2	1	2	3	1	2	1	1	2	1	2	2	2	1	2
430	1	1	1	4	1	2	1	2	4	1	2	1	2	3	1	2	1	1	4	1	1	1	1	4	1	1	1	1	4	1
434	1	1	1	4	1	2	1	2	3	1	1	1	2	3	1	1	1	2	3	1	1	1	1	4	1	1	1	2	3	1
438	1	1	2	4	1	1	1	2	3	1	1	1	2	3	1	1	1	2	3	1	1	1	2	3	1	1	1	1	3	1
452	1	1	1	3	1	2	2	2	2	2	1	1	1	3	1	2	1	1	3	1	1	1	1	2	1	2	2	1	3	2
461	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1
462	1	1	1	3	1	2	1	2	3	1	2	1	1	3	1	1	1	1	4	1	1	1	1	4	1	1	1	1	3	1

1 Present, 2 Absent, except for Garden where the number equals the group.

whether to treat patients with primary hemiarthroplasty or osteosynthesis. The surgeons participating in this study have worked closely together for several years.

In this study, we did not determine the intraobserver reliability of the signs. In clinical work, surgeons make decisions independently of each other. It is therefore important for the clinic that the interobserver reliability is good. Furthermore, since the interobserver reliability of the signs was low, we found it irrelevant to determine the intraobserver agreement. Since the clinical decision about whether to perform hemiarthroplasty or screw fixation is usually made by the orthopedic surgeon without consulting a radiologist, we did not include a radiologist among the observers.

Of the three signs we tested, comminution of the calcar shows the worst strength of agreement. It is defined as loss of bone on the femoral side of the fracture. In osteoporotic bone, it is hard to imagine a femoral neck fracture without comminution. Posterior comminution has been found to occur in 35–100% of fractures of the femoral neck (Scheck 1980). It seems very likely that the degree of comminution varies. In accordance with the findings in the original article, we did not quantify

the amount of bone loss. The observers were only asked to state whether comminution was present or not. The lack of strict definitions in defining bone loss is an obvious source of variability and probably contributes to the poor strength of agreement for this sign.

The strength of agreement for varus displacement and the size of the head fragment were better than that of the Garden classification, but not as good as that of the simplified Garden classification. The size of the capital fragment is measured with a ruler. The observers had to define the center of the head, find the fracture line and make a line perpendicular to the fracture line from the center of the femoral head. There are several sources of error in this process that probably contribute to the low rate of agreement. The same applies to the definition of the angle of the femoral head. The fracture line of the femoral head varies according to the position of the femoral head. The orientation of the femoral head may vary widely, especially in a completely dislocated fracture. The fracture line on the femoral side is more stable since it is controlled by the position of the leg. The varus angulation is measured as the angle between the fracture lines. This is less uncertain, which may explain the slightly better level of agreement than the identification of a small head fragment.

Since Alho et al. (1992) stated that the fracture would probably not heal if one or more of these signs were present, we determined the interobserver agreement for these signs. Unfortunately, the reliability of the signs does not improve when they are used together.

In our study, the reliability of the Garden classification is fair and becomes good when the findings are divided into undisplaced (Garden 1 and 2) and displaced (Garden 3 and 4). However, this classification has been shown to be unreliable (Frandsen et al. 1986, Thomsen et al. 1996) and it is therefore recommended that an intracapsular fracture should be classified as undisplaced or displaced (Eliasson et al. 1988), but even this may not improve the agreement (Thomsen et al. 1996). We found that the reliability of the simplified classification is better than that of the original.

Kappa values between 0.30 and 0.70 are common in fracture classification systems (Schipper et al. 2001). We did not evaluate a fracture classification system, but assessed radiographic signs that predict a disturbance in healing which is the same—i.e., helping the surgeon choose the right method of treatment and provide information about the outcome of the treatment (Burstein 1993). These radiographic signs have shown promising results in a retrospective study. However, recently the size of the femoral head fragment was found not to predict failure to heal (Rajan and Parker 2001). We have shown that the interobserver reliability of these signs is poor to moderate which limits their value.

We thank the following colleagues for their kind participation in the study: J R Dokke, M Dragland, B Heimdahl, A R Nilsen, M Soukop, T Vedeler, A Brenner, T H Sundøen.

No benefits of any kind have been or will be received from a commercial party related directly or indirectly to the subjects of this article.

Alho A, Benterud J G, Rønningen H, Høiseth A. Prediction of disturbed healing in femoral neck fracture. Acta Orthop Scand 1992; 63 (6): 639-44.

Altman D G. Practical statistics for medical research. Chapman & Hall/CRC, London 1999.

Burstein A H. Editorial. Fracture classification systems: Do they work and are they useful? J Bone Joint (Am) 1993; 75: 1743-4.

Eliasson P, Hansson L I, Kärrholm J. Displacement in femoral neck fractures. Acta Orthop Scand 1988; 59 (4): 361-4.

Frandsen P A, Andersen E, Madsen F, Skjødt T. Garden's classification of femoral neck fractures. J Bone Joint (Br) 1986; 70 (4): 588-90.

Garden R S. Low-angle fixation in fractures of the femoral neck. J Bone Joint (Br) 1961; 43 (4): 647-63.

Parker M J, Pryor G A. Internal fixation or arthroplasty for displaced cervical hip fractures in the elderly. Acta Orthop Scand 2000; 71 (5): 440-6.

Rajan D T, Parker M J. Does the level of an intracapsular femoral fracture influence fracture healing after internal fixation? A study of 411 patients. Injury, Int J Care Injured 2001; 32: 53-6.

Scheck M. The significance of posterior comminution in femoral neck fractures. Clin Orthop 1980; 152: 138-42.

Schipper I B, Steyerberg E W, Castelein R M, van Vugt A B. Reliability of the AO/ASIF classification for pertrochanteric femoral fractures. Acta Orthop Scand 2001; 72 (1): 36-41.

Thomsen N O B, Jensen C M, Skovgaard N, Pedersen M S, Pallesen P, Soe-Nielsen N H, Rosenklint A. Observer variation in the radiographic classification of fractures of the neck of the femur using Garden's system. Orthop Int (SICOT) 1996; 20: 326-9.