

Displaced fracture of the femoral neck in children

OPEN VERSUS CLOSED REDUCTION

K.-S. Song

From Keimyung University, Daegu, South Korea

We have investigated whether early anatomical open reduction and internal fixation (ORIF) reduces the incidence of complications of fracture of the femoral neck in children, including avascular necrosis, compared with closed reduction and internal fixation (CRIF). We retrospectively reviewed 27 such fractures (15 type-II and 12 type-III displaced fractures) in children younger than 16 years of age seen in our hospital between February 1989 and March 2007. We divided the patients into three groups according to the quality of the reduction (anatomical, acceptable, and unacceptable) and the clinical results into two groups (satisfactory and unsatisfactory). Of the 15 fractures treated by ORIF, 14 (93.3%) had anatomical reduction and reduction was acceptable in one. Of the 12 treated by CRIF, three (25.0%) had anatomical reduction, eight had acceptable reduction (66.7%), and one (8.3%) unacceptable reduction. Of the 15 fractures treated by ORIF, 14 (93.3%) had a good result and one a fair result. Of the 12 treated by CRIF, seven (58.3%) had a good result, two (16.7%) a fair result and three (25.0%) a poor result. There were seven complications in five patients.

ORIF gives better reduction with fewer complications, including avascular necrosis, than does CRIF in fractures of the femoral neck in children.

Displaced fractures of the femoral neck in children are rare. They are associated with a high rate of complications, the most serious of which is avascular necrosis (AVN).¹⁻⁴ It is not clear from the literature whether or not the method of treatment affects the complication rate.

We have therefore attempted to determine whether early anatomical open reduction and internal fixation (ORIF) decreases the incidence of complications, compared with closed reduction and internal fixation (CRIF), by analysing a consecutive series of displaced fractures of the femoral neck in children.

Patients and Methods

After obtaining informed consent from each patient's parent(s) or guardian(s) and the approval of our Institutional Review Board, we retrospectively reviewed 27 fractures in children (11 boys, 16 girls) under 16 years of age seen in our hospital over a period of 18 years from February 1989 to March 2007. The fractures were classified according to the Delbet system as described by Colonna.⁵ We included 15 type-II and 12 type-III displaced fractures in patients who had been clinically monitored for a mean period of 33.7 months (16 to 156). Undisplaced fractures, pathological fractures and extra-articular type-IV

fractures, were excluded. We recorded the patient's age, the degree of initial displacement, the type of fracture, the timing of surgery and the method of treatment.

Between 1989 and 2002, we routinely performed ORIF for displaced fractures of the femoral neck. We did not attempt closed reduction in order to avoid damaging the intracapsular vessels before surgery. After careful positioning of the patient on the fracture table the hip was exposed through a Watson-Jones approach and a longitudinal capsular incision to the anterior aspect of the femoral neck exposed the site of the fracture. After evacuation of the haematoma, a slow, gradual reduction was completed under direct vision. The capsular incision was not closed. Anatomical reduction was confirmed by fluoroscopy before internal fixation.

We considered the possibility that ORIF might represent overtreatment, with an unnecessary incision. Therefore, between 2003 and 2005, CRIF was the preferred treatment. We did not carry out additional procedures such as aspiration or capsulotomy of the hip to reduce the intracapsular pressure. In 2006, we reverted to ORIF as the preferred procedure because we encountered several complications with CRIF. After reduction, fixation of the fracture was

■ K.-S. Song, MD, PhD,
Professor
Department of Orthopaedic
Surgery
Dongsan Medical Center,
Keimyung University, 194
Dongsandong, Daegu 700-712,
South Korea.

Correspondence should be sent
to Professor K.-S. Song; e-mail:
skspos@dsmc.or.kr

©2010 British Editorial Society
of Bone and Joint Surgery
doi:10.1302/0301-620X.92B8.
24482 \$2.00

J Bone Joint Surg [Br]
2010;92-B:1148-51.
Received 18 January 2010;
Accepted after revision 18
March 2010



Fig. 1a



Fig. 1b



Fig. 1c



Fig. 1d



Fig. 1e

Radiographs of a 15-year-old girl with a displaced fracture of the femoral neck showing a) Anteroposterior (AP) and b) lateral view of a type-II fracture and c) AP and d) lateral views after arthrotomy and open reduction and internal fixation performed within 24 hours of the injury and e) two years after treatment showing union and no complications.

achieved using cannulated screws in 17 patients, Kirschner (K)-wires in four, cannulated screws combined with K-wires in three, and Knowles pins in two and a compression hip screw in one. In addition, we used hip spica casts in 11 patients to avoid further displacement.

We evaluated the quality of the reduction for all the fractures and divided them into three groups as follows: those with anatomical reduction, with no displacement or angular deformity; those with acceptable reduction (displacement of < 2 mm or angular deformity within 20° of the normal neck-shaft angle on anteroposterior and axial radiographs) and those with unacceptable reduction (displacement of > 2 mm or angular deformity of > 20° on anteroposterior or axial radiographs). We assessed the final results using Ratliff's method.¹ The cases were divided into the ORIF and the CRIF groups and into two groups according to the end results (satisfactory or unsatisfactory). The satisfactory group were graded as satisfactory according to Ratliff's assessment and had no complications, and the unsatisfactory group were graded as fair or poor or who had complications.

Results

Of the 27 fractures, 15 were type II (8 ORIF, 7 CRIF) and 12 were type III (7 ORIF, 5 CRIF). The mean age of the patients at the time of fracture was 9.7 years (5.0 to 15.0) for those treated by ORIF and 10.1 years (5.0 to 16.0) for those treated by CRIF. The mechanisms of injury included traffic accidents in 14 fractures, slips in seven, falls in five, and assault in one. Of the 27 fractures, 22 were totally displaced (12 ORIF, 10 CRIF) and six were partially displaced (3 ORIF, 3 CRIF) with the degree of displacement ranging from 10% to 60%. A total of 24 patients (12 ORIF, 12 CRIF) had surgery within 24 hours of the injury, but in three ORIF was delayed because of a delay in arrival at the hospital and extensive associated injuries.

In terms of the quality of reduction, 14 of the 15 fractures (93.3%) treated by ORIF achieved an anatomical reduction (Fig. 1), with one an acceptable reduction. Out of 12 fractures treated by CRIF, three (25.0%) had an anatomical reduction, eight an acceptable reduction (66.7%), and one (8.3%) an unacceptable reduction.



Fig. 2a



Fig. 2b



Fig. 2c



Fig. 2d



Fig. 2e

Radiographs of an 11-year-old girl with a displaced fracture of the femoral neck showing a) Anteroposterior (AP) and b) lateral views showing a type-II displaced fracture and c) AP and d) lateral views showing acceptable open reduction and internal fixation with three cannulated screws after several attempts at closed reduction and internal fixation over a period of 20 minutes and e) AP radiograph taken two months later showing bending of a screw and a gap on the superior part of the fracture.

Of 15 fractures treated by ORIF, 14 (93.0%) had a good result and one a fair result. Of 12 treated by CRIF, seven (58.3%) had a good result, two (16.7%) fair, and three (25.0%) a poor result. There were seven complications in five patients treated by CRIF, with some having more than one complication (AVN in two cases, nonunion in two, and coxa vara in two; Fig. 2).

Discussion

Because fractures of the femoral neck in children are so rare, it takes some time to accumulate sufficient cases for a meaningful study.⁶ Variation in the reported rate of AVN and lack of statistical evidence have minimised the prognostic power of individual studies, especially regarding the method of treatment. The role of surgical treatment in the development of AVN is difficult to assess because of the variation in treatment protocols and surgical technique. Only 20 of 275 reports have provided patient-level data and could be included in a meta-analysis.⁷ We had homogenous data for a

comparative study between two groups treated by ORIF and CRIF.

Displaced fractures of the femoral neck are associated with a high rate of complications.^{1,4,6,8-10} AVN is the most serious and has been reported to have a variable incidence,¹⁻⁴ depending on several factors including age,^{7,11} the degree of initial displacement,^{2-4,6,8,9} the type of fracture,^{6,7,12} the time of surgery,^{1,7,11} and the method of fixation.^{1,12-15} However, there have been no reports relating the incidence of AVN to the method of treatment and the quality of reduction.

There is some published evidence that the type of initial treatment has little effect on the incidence of AVN.^{2,4,6-9,12,16} If this were true, the incidence of AVN between series would be similar regardless of the method of treatment. However, this is not the case and it is difficult to explain the reason for the extreme range of incidence reported, from 0% to 92%.^{11,14} Our results suggest that capsulotomy with early ORIF may be effective in reducing this incidence.

Several recent studies have reported more favourable results following early anatomical reduction and stable internal fixation but no consensus has been established.^{1,7,8,12-15}

A few studies have shown that the type of treatment has a greater influence on the rate of complications than the characteristics of the fracture itself,^{12,14} and reports of these studies have provided detailed descriptions of methods of treatment and the quality of the reduction.^{11,13-15} However, no reports have indicated that the method of reduction influences the outcome. In reviewing the literature on AVN after immediate ORIF, we found no assessment of the factors which influence the outcome such as the time from injury to treatment, the frequency of attempted closed manipulation, the surgical technique, and the quality of reduction.


In actual practice, the decision about whether to use CRIF is difficult. The surgeon must consider what constitutes an adequate reduction, how many times closed manipulation should be attempted and which is the most appropriate surgical technique to use. Even with repeated manipulation, acceptable alignment cannot always be achieved. Furthermore, fluoroscopic views cannot be relied upon to give an accurate assessment of the quality of reduction of the fracture.

It is difficult to know how much such manipulation further jeopardises the vasculature (Fig. 1). We believe that gradual reduction under direct vision with an open method is safer than forceful repeated closed reduction.

Our results are similar to those achieved with the recent treatment methods for fracture of the femoral neck in young adults, in which the goals of treatment include early diagnosis, early surgery, anatomical reduction, capsular decompression and stability of the fracture.¹⁷

Despite our experience being limited to a small group of patients, our results validate the hypothesis that anatomical ORIF is a more reliable form of treatment than CRIF for displaced fractures in children, producing good results and reducing the rate of AVN and other complications.

Supplementary material

 A table showing the details of the 27 patients with displaced fractures of the femoral neck is available with the online version of this article on our website at www.jbjs.org.uk

We thank K. O'Moore-Klopf, ELS, of East Setauket, New York, for providing editorial assistance.

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

References

1. Flynn JM, Wong KL, Yeh GL, Meyer JS, Davidson RS. Displaced fractures of the hip in children: management by early operation and immobilisation in a hip spica cast. *J Bone Joint Surg [Br]* 2002;84-B:108-12.
2. Forlin E, Guille JT, Kumar SJ, Rhee KJ. Complications associated with fracture of the neck of the femur in children. *J Pediatr Orthop* 1992;12:503-9.
3. Hughes LO, Beaty JH. Fractures of the head and neck of the femur in children. *J Bone Joint Surg [Am]* 1994;76-A:283-92.
4. Morsy HA. Complications of fracture of the neck of the femur in children: a long-term follow-up study. *Injury* 2001;32:45-51.
5. Colonna PC. Fracture of the neck of the femur in children. *Am J Surg* 1929;6:793-7.
6. Morrissy R. Hip fractures in children. *Clin Orthop* 1980;152:202-10.
7. Moon ES, Mehlman CT. Risk factors for avascular necrosis after femoral neck fractures in children: 25 Cincinnati cases and meta-analysis of 360 cases. *J Orthop Trauma* 2006;20:323-9.
8. Canale ST. Fractures of the hip in children and adolescents. *Orthop Clin North Am* 1990;21:341-52.
9. Heiser JM, Oppenheim WL. Fractures of the hip in children: a review of forty cases. *Clin Orthop* 1980;149:177-84.
10. Leung PC, Lam SF. Long-term follow-up of children with femoral neck fractures. *J Bone Joint Surg [Br]* 1986;68-B:537-40.
11. Shrader MW, Jacofsky DJ, Stans AA, Shaughnessy WJ, Haidukewych GJ. Femoral neck fractures in pediatric patients: 30 years experience at a level 1 trauma center. *Clin Orthop* 2007;454:169-73.
12. Togrul E, Bayram H, Gulsen M, Kalaci A, Ozbarlas S. Fractures of the femoral neck in children: long-term follow-up in 62 hip fractures. *Injury* 2005;36:123-30.
13. Cheng JC, Tang N. Decompression and stable internal fixation of femoral neck fractures in children can affect the outcome. *J Pediatr Orthop* 1999;19:338-43.
14. Song KS, Kim YS, Sohn SW, Ogden JA. Arthrotomy and open reduction of the displaced fracture of the femoral neck in children. *J Pediatr Orthop B* 2001;10:205-10.
15. Ng GP, Cole WG. Effect of early hip decompression on the frequency of avascular necrosis in children with fractures of the neck of the femur. *Injury* 1996;27:419-21.
16. Ratliff AH. Fractures of the neck of the femur in children. *J Bone Joint Surg [Br]* 1962;44-B:528-42.
17. Ly TV, Swionkowski MF. Treatment of femoral neck fractures in young adults. *Instr Course Lect* 2009;58:69-81.