Delayed fixation of the transcervical fracture of the neck of the femur in the pediatric population: results and complications

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Abstract

Purpose To determine the impact of a substantial delay in providing surgical treatment on the final outcome in transcervical femoral neck fractures in children.

Methods Data on all pediatric patients with transcervical fractures of the femoral neck that were fixed by reduction and internal fixation after a delay of ≥ 7 days in our department between 2000 and 2008 were collected both retrospectively and prospectively.

Results The medical records of 14 patients (15 fractures) were analyzed. The results after an average of 43 months of follow-up showed that the complication and avascular necrosis rates were higher in cases in which treatment had been delayed compared to those in comparable fractures that had been treated promptly after the event in *other series*. Nine of the 15 fractures had developed avascular necrosis at final follow-up. Overall, there were four excellent, three good, and eight poor results (based on the Ratliff criteria).

Conclusions Children whose transcervical fractures of the femoral neck were surgically treated after a delay of 1 week or longer had a high avascular necrosis rate and a relatively poor outcome. Reduction and internal fixation as the initial treatment should be implemented shortly after injury in order to enhance treatment outcome.

Keywords Fracture · Femoral neck fractures · Children · Delay of treatment

Introduction

Hip fractures in children are usually the result of high-energy trauma [1–3]. The presence of an active growth plate and a poor blood supply make the head of the femur especially vulnerable to serious complications, such as avascular necrosis (AVN) and physeal closure [4, 5]. The incidence of complications after femoral neck fractures can be as high as 60% [6]. The elements that can potentially influence the development of complications include the degree of initial displacement, time between the injury and fracture reduction, quality and stability of the reduction and fixation, decompression of the hip joint, and weightbearing status. There is evidence to support the belief that prompt reduction (i.e., within 24 h) of a displaced fracture may reduce the incidence of AVN [7, 8]. There are very few studies on the incidence of complications in cases in which the fixation of transcervical femoral neck fractures had been delayed [9]. The present study is the first to report the results of fixation of the transcervical fracture of the neck of the femur which had not been surgically treated until 1 week or longer after injury occurrence among children.

Materials and methods

After obtaining ethical board approval (IRB), a retrospective chart review was carried out on the records of all patients under the age of 16 years with a transcervical/Ratliff type II fracture of the femoral neck that were surgically fixed over a 9-year period (2000–2008) at the Government Hospital for Bone and Joint Surgery, Bagat, Barzullah, Srinagar, Kashmir, India [10]. Patients who fulfilled the study's entry criteria were assessed prospectively and retrospectively. All patients presented for

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treatment and underwent surgery following a delay of at least 1 week after sustaining the trauma that caused the fracture of the femoral neck.

All fractures were fixed with Moore pins to prevent epiphyseal damage that might have been caused by threaded pins. Supplemental screw fixation was added for additional strength when indicated. The quality of the reduction was determined by the following scale: <2-mm step-off and no angulation = excellent, <4-mm step-off and <5° angulation = good, >4-mm step-off and <10° angulation = fair, and >5-mm step-off and >10° angulation = poor. The score was determined under the C-arm in both the anteroposterior and lateral X-ray views, and were reviewed in all cases for which there were postoperative radiographs. Exceptions to this criterion in the protocol were the cases where a hip spica was applied and the lateral postoperative view was difficult to obtain. Follow-up radiographs were taken on a monthly basis and evaluated to determine the time to union, as evidenced by bridging trabeculation across the fracture site. Findings on the radiographs were also used to determine long-term sequelae, such as angular deformity, leg-length discrepancy, and AVN.

The average follow-up of these patients was 3.5 years. The results were assessed using the Ratliff criteria at the end of a mean follow-up of 43 months, range 19–72 months (Table 1).

Results

Fourteen children (ten males and four females, average age 11.5 years, range 8–16) fulfilled the entry criteria and comprised the study group for this investigation (ten retrospectively and four prospectively). The cause of the delay to surgery in 12 cases was due to the inability of the patients to promptly reach adequate health care facilities and had resorted to seeking initial relief from traditional Indian bone setters, whose treatment did not include proper traction or casting. The fractures were part of polytrauma in two cases, including one boy with a bilateral fracture, and they were medically diagnosed relatively late (13 and 10 days following the injury). Neither patient, however,

appeared to have suffered from shock at any point (Table 2).

There was a total of nine right-sided and six left-sided fractures. The patients reported to the hospital from 6 to 12 days after the trauma, with an average delay of 8 days. The mean time to surgery was 9 days. Three fractures required open reduction. Immediate postoperative anteroposterior and lateral X-ray view radiographs were available for 12 fractures. Assessment based on all of the C-arm and postoperative radiographs revealed that the reduction was excellent in 11 fractures, good in three, and fair in one. The intraoperative records and postoperative radiographs showed that 12 reductions were excellent, two were good, and one was fair. Two patients (including the one with bilateral fractures) were put in a hip spica as a supplement to the internal fixation. At final follow-up, nine hips had developed AVN, and two developed coxa vara, leaving only four hips with an enduring excellent result. The patient with the bilateral femoral neck fracture developed AVN on both sides. Two of the three fractures that required open reduction developed AVN. All three hips that had spica immobilization developed AVN. Two of the nine hips with AVN developed a fused stable hip, one was eventually revascularized, and the other six developed proximal migration. Based on the Ratliff criteria, there were four excellent, three good, and eight poor results.

Discussion

Femoral neck fractures in children are severe injuries that carry the possible complication of AVN. The available literature contains only a few series of these rare fractures among children [11]. Unlike hip fractures in adults, hip fractures in children are associated with high-energy trauma, unless there is an underlying pathologic process (e.g., unicameral bone cyst, fibrous dysplasia) [12, 13]. Transcervical fractures of the proximal femur are the most common (45–50%) type of hip fracture in children [1]. The lateral epiphyseal artery is vulnerable at the proximal femoral epiphysis and can be damaged by the fracture ends. AVN is the leading cause of poor postoperative results. A sobering fact is that very little can be done to avoid that sequela,

Table 1 The Ratliff classification of the results of surgery for fracture of the hip (adapted from [10])

	Good	Fair	Poor
Pain	None or patient ignores it	Occasional	Disabling
Movement	Full or slightly reduced	Up to 50%	Less than 50%
Activity	Normal or slightly restricted	Moderately restricted	Severely restricted
X-ray	Normal or some evidence of deformity	Severe deformity of the femoral neck and mild avascular necrosis	Severe avascular necrosis, arthritis, and arthrodesis

Table 2 Patient data

Fx.	Sex	Age (years)	Mechanism of trauma	Delay to surgery (days)	Fixation	Reduction ^a	Follow-up (months)	Complication	Result
1.	M	14	Fall	7	CRIF	Excellent	72	AVN	Poor
2.	M	15	Fall	9	CRIF	Excellent	71	Coxa vara	Good
3.	F	8	RTA	7	CRIF	Excellent	68		Excellent
4.	F	10	Fall	9	CRIF	Good	67	Coxa vara	Good
5.	M	12	Crush	11	CRIF	Excellent	48		Excellent
6.	M	11	Fall	9	CRIF	Excellent	43	AVN	Poor
7. ^b	M	14	Fall	13	ORIF	Excellent	37	AVN	Poor
8. ^b	M	14	Fall	13	CRIF	Good	37	AVN	Poor
9.	M	9	RTA	7	CRIF	Excellent	35	AVN	Good
10.	M	9	Crush	7	CRIF	Excellent	33		Excellent
11.	F	14	Fall	10	ORIF	Excellent	32	AVN	Poor
12.	M	8	Fall	8	CRIF	Excellent	28	AVN	Poor
13.	M	11	Fall	10	CRIF	Excellent	28	AVN	Poor
14.	F	12	RTA	8	CRIF	Fair	24		Excellent
15. ^b	M	12	RTA	7	ORIF	Excellent	19	AVN	Poor

Fx fracture (7 and 8 belong to the same patient); *M* male; *F* female; *RTA* road traffic accident; *CRIF* closed reduction internal fixation; *ORIF* open reduction internal fixation; *AVN* avascular necrosis

^a Ratliff criteria

^b Spica

Fig. 1 **a, b, c, d** and **e** Fracture of the neck of the femur fixed after 11 days in this case. Final photograph after 4 years depicts an excellent result with no complications. Figure **e** shows the picture after hardware removal

whose incidence ranges from 0 to 92% in various series, and very few possibilities of reducing this rate have been offered [14]. In addition to AVN, leg-length discrepancy and coxa vara have been associated with injury to the growth plate, as has inadequate reduction or failure to maintain the reduction. Femoral neck fractures in children continue to pose considerable difficulties for the orthopedic surgeon.

Since there is a significant difference in the prognosis of the fractures included in the Ratliff classification [10], we singled out the transcervical fracture of the femoral head for study and could accumulate a small but highly informative series of this comparatively rare fracture.

The occurrence of complications in these fractures is associated with a number of causative and contributory

Fig. 2 a, b, c and d Bilateral trans cervical fracture fixed after 15 days of the trauma. The patients needed additional screw fixation and spica immobilisation. However bilateral avascular necrosis developed leaving significant residual dysfunction. Final photograph **d** taken 3 years after the initial trauma

factors, among them the degree of initial displacement, the time between injury and reduction, the quality and stability of the reduction and fixation, the decompression of the hip joint, and the weightbearing status. Transcervical fractures account for most (45–50%) of all hip fractures reported in children [1, 15]. The blood supply is damaged at the time of maximum displacement, which is supposed to occur at the time of the fracture. The tenuous nature of the blood supply to the femoral epiphysis results in a higher complication rate than in corresponding adult fractures.

Hematoma also plays a role in the occurrence of AVN in these fractures [6]. It has recently been reported that the complication rate can be reduced considerably with open or closed reduction and internal fixation within the first 24 h [16] (Figs. 1, 2).

The high rate of AVN reported by Bombaci et al. [9] (54.6%, 12 patients) in the only series in which a delay of at least 24 h was the basic inclusion criteria is slightly higher than the figures reported by Davison and Weinstein (47% [4]), Morrissy (40% [17]), Ratliff (42% [10]), and Canale and Bourland (43% [15]), but comparable with the figure reported by Bagatur and Zorer (53% [18]). The impact of the time to surgery was not clear in those series [4, 10, 14, 17, 18].

It is not possible to conduct a controlled study on the effect of delay on the outcome of surgical treatment of femoral neck fractures. Our current study was based on data accumulated over a 9-year period on 14 cases of patients who reported to the hospital not before at least 1 week after sustaining the trauma that caused the fracture. All of the cases included in our study were classified as having Ratliff type II transcervical fracture [10]. Our cases were at risk of fracture displacement due to the delay in

treatment, as well as to the effect of the tamponade. Our patients had an AVN rate of 60%, which is higher than most series [4, 9, 10]. In addition, the overall complication rate that we encountered was expectedly higher than the published figures for surgery in Ratliff type II transcervical fractures, supporting the view that delay can cause a higher rate of complications. Nevertheless, surgery with an open reduction approach should still be the first line of management in these fractures as well.

We are aware of several limitations to our study. One is that part of it is retrospective, a feature that can introduce some bias. Although the number of cases is small, finding cases with more than 1 week's delay in such a rare fracture is somewhat a feat in itself. It did, however, preclude statistical analysis. We, therefore, recommend a multicenter study where data can be shared and lead to better, more definitive answers.

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