Emergent Surgical Reduction and Fixation for Pipkin Type I Femoral Fractures

DASHENG LIN, MD; KEJIAN LIAN, MD; ZHIWEN CHEN, MD; LEI WANG, MD; JIANMING HAO, MD; HUANTANG ZHANG, MD

abstract

The purpose of this study was to assess the effect of timing of large fragment fixation in patients with Pipkin type-I fractures. Patients with Pipkin type-I fractures from the authors’ trauma center were prospectively observed between July 2007 and July 2010. Fragments that constituted more than one-fourth of the femoral head were included. Thirty-six patients were equally randomized to undergo emergent surgical reduction and fixation or secondary operative fixation after emergent closed reduction.

No significant differences existed between the 2 groups with regard to the baseline characteristics, operating time, and blood loss ($P > .05$). However, the emergent surgical reduction and fixation group had a shorter hospital stay ($P < .05$). The results after more than 2-year follow-up showed that the complication and avascular necrosis rates were higher in the secondary operative fixation after emergent closed reduction group compared with the emergent surgical reduction and fixation group ($P < .05$).

It was difficult to achieve an anatomically reduced femoral head when the fragments constituted more than one-fourth of the femoral head. Patients who underwent secondary operative fixation after emergent closed reduction had a high avascular necrosis rate and a relatively poor outcome. Emergent surgical reduction and fixation should be performed shortly after injury to enhance the treatment outcome.

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Fracture of the femoral head is a severe and relatively uncommon injury; it typically occurs following traumatic posterior hip joint dislocation. The Pipkin classification is the most commonly used classification system. For Pipkin type-I fractures, no clear evidence exists that indicates whether to treat the fracture conservatively or operatively. Historically, most femoral head fractures have been treated with prolonged bed rest and in-line traction following closed reduction, but relatively poor results have been reported. Furthermore, limitations in patient mobility and the high cost of prolonged length of hospital stay have led to the abandonment of this method. Surgical intervention has become the primary means of managing femoral head fracture-dislocations. Controversy exists with regard to performing excision or internal fixation of fracture fragments. However, most surgeons believe fixation should be performed if a fragment is large enough to allow stable internal fixation. Small or comminuted fragments or fragments not in the weight-bearing portion of the femoral head can be excised without compromising the outcome.

The previous treatment strategy consisted of performing emergent closed reduction and then secondary operative fixation. However, avascular necrosis of the femoral head and posttraumatic arthritis are debilitating long-term complication following Pipkin fractures. The overall incidence ranges from 8% to 75%, and its cause is likely multifactorial. The purpose of the current study was to assess the effect of the timing of large fragment fixation in patients with Pipkin type-I fractures.

**Materials and Methods**

Between July 2007 and July 2010, the authors preselected 36 patients with Pipkin type-I fractures and randomly divided them into 2 groups of 18 patients. Group 1 underwent emergent surgical reduction and fixation (less than 6 hours), and group 2 underwent secondary operative fixation (more than 2 days) after emergent closed reduction. Fragments that constituted more than one-fourth of the femoral head were included. Exclusion criteria were pathologic femoral head fracture or associated severe multiple injuries.

The patients in group 1 had general or epidural anesthesia and underwent emergent surgical reduction and fixation via a Smith-Petersen approach. Patients without other problems were discharged 1 week postoperatively and were called back for follow-up at 3, 6, 12, and 24 months postoperatively. Patients were rapidly mobilized and were instructed to use toe-touch weight-bearing with crutches or a walker for 12 weeks. Patients could progress to full weight bearing when they had the strength and balance to do so. They were instructed to wean off of crutch support when they were able to walk without a substantial limp.

The patients in group 2 underwent immediate closed reduction of the fracture-dislocation of the hip while under general or epidural anesthesia. The limb was put into skin traction for 2 to 3 days and then for the operation, which was performed via a Smith-Petersen approach. Postoperative management was the same as for group 1.

All patients were followed for 24 months or more. Functional outcomes were determined using the Thompson and Epstein score9 and the d’Aubigné and Postel score. Heterotopic ossification was assessed using the Brooker classification. Descriptive statistics were calculated for all continuous and categorical variables. Post hoc analysis included Student’s t tests and Wilcoxon rank-sum test. A P value less than .05 was considered statistically significant.

**Results**

In group 1, thirteen men and 5 women with a mean age of 32.6±7.2 years (range, 21-45 years) at the time of the accident were included. Twelve patients sustained their injuries in a traffic accident and 6 fell from a height. Mean time from injury to emergent surgery was 4.7±1.5 hours (range, 2-6 hours). In group 2, twelve men and 6 women with

<table>
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<th>Table 1</th>
<th>Pre- and Postoperative Characteristics*</th>
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<td>Assessment</td>
<td>Group 1 (n=18)</td>
</tr>
<tr>
<td>No., M:F</td>
<td>13:5</td>
</tr>
<tr>
<td>Age at surgery, y</td>
<td>32.6±7.2</td>
</tr>
<tr>
<td>Follow-up, mo.</td>
<td>27.1±4.3</td>
</tr>
<tr>
<td>Injury mechanism</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Motor vehicle accident</td>
<td>12</td>
</tr>
<tr>
<td>Fall from height</td>
<td>6</td>
</tr>
<tr>
<td>Operative time, min</td>
<td>68±21</td>
</tr>
<tr>
<td>Blood loss, ml</td>
<td>127±30</td>
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<tr>
<td>Length of stay, d</td>
<td>7.6±1.2</td>
</tr>
<tr>
<td>Outcome</td>
<td>&lt;.05</td>
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<tr>
<td>Excellent</td>
<td>10</td>
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<tr>
<td>Good</td>
<td>4</td>
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<tr>
<td>Moderate</td>
<td>2</td>
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<tr>
<td>Poor</td>
<td>2</td>
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<tr>
<td>Complications</td>
<td></td>
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<tr>
<td>Heterotopic ossification</td>
<td>2</td>
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<td>Avascular necrosis</td>
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</table>

*Data are presented as number or mean±SD.
a mean age of 33.4±8.5 years (range, 20-47 years) at the time of injury were included. Eleven patients sustained their injuries in a traffic accident and 7 fell from a height. The interval between injury and successful closed reduction was 4.4±1.7 hours (range, 2-6 hours). Mean time from injury to secondary operative fixation was 2.4 days (range, 2-3 days). No significant differences existed in the baseline characteristics of the 2 groups (Table 1).

Operative times for groups 1 and 2 were 68±21 minutes (range, 50-90 minutes) and 64±17 minutes (range, 45-80 minutes), respectively. Groups 1 and 2 had respective blood losses of 127±30 mL (range, 90-200 mL) and 119±22 mL (range, 70-180 mL). No significant differences existed between the 2 groups with regard to operative time and blood loss. Lengths of stay for groups 1 and 2 were 7.6±1.2 days (range, 7-10 days) and 9.4±1.9 days (range, 7-14 days), respectively. Group 1 had a shorter length of stay than group 2 (P<.05) (Table 1).

In groups 1 and 2, patients were followed for 27.1±4.3 months (range, 24-60 months) and 26.7±3.9 months (range, 24-57 months), respectively. According to the Thompson and Epstein score and the d’Aubigné and Postel score, 10 patients in group 1 had excellent results, 4 had good, 2 had moderate, and 2 had poor (Figure 1). In group 2, three patients had excellent results, 7 had good, 3 had moderate, and 5 had poor. A Wilcoxon rank-sum test analysis of these data reached statistical significance (P<.05) (Table 1). In group 2, nine patients did not achieve an anatomically reduced femoral head during closed reduction due to the large fragments interposed in the articular surface (Figure 2). Significant differences existed in the Thompson and Epstein score and the d’Aubigné and Postel score between patients with and without an anatomically reduced femoral head (Table 2). Heterotopic ossification was found in 5 patients: 2 in group 1 and 3 in group 2.

Avascular necrosis of the femoral head was found in 7 patients: 2 in group 1 and 5 in group 2 (Table 1).

**Discussion**

The treatment of Pipkin fractures is focused on avoiding complications by per-
forming emergent closed reduction and by providing a congruent and stable joint. A direct relationship exists between delayed reduction and an increased incidence of avascular necrosis of the femoral head.\textsuperscript{5,6} Avascular necrosis occurs more frequently in hips that have remained unreduced for more than 6 hours than in those managed immediately after injury.

The cause of avascular necrosis is thought to be multifactorial. First, the cervical vessels to the head and the contributions from the ligamentum teres are damaged at the time of injury. Second, an ischemic insult to the femoral head while it is dislocated affects the outcome. Many authors have demonstrated femoral head ischemia in adult rabbits caused by dislocation.\textsuperscript{12,13} Contrary to previous beliefs, the authors reported that the cervical vessels to the head are not normally disrupted by the dislocation but do not provide adequate circulation due to spasms of the larger vessels or of the cervical vessels.\textsuperscript{12,13} Yue et al\textsuperscript{14} reported a similar kinking effect in human cadavers. Extrapolated to the clinical situation, this work indicated that the majority of avascular necrosis is secondary to the initial ischemia of the femoral head, not to torn vessels, and that emergent reduction may reduce the incidence of avascular necrosis.\textsuperscript{15} Furthermore, new laboratory evidence suggests that a prolonged dislocation time will increase in chondrocyte apoptosis, as shown when increasing time to reduction for hip dislocation in a rat model.\textsuperscript{16} Similarly, Torzilli et al\textsuperscript{17} reported subchondral fractures and decreased metabolic activity in cartilage exposed to a compression injury.

In the clinical treatment process, most Pipkin fractures can achieve an anatomically reduced femoral head through emergent closed reduction. However, when the fragment is sufficiently large and interposed within the articular surface, the femoral head is generally reduced within the acetabulum but is incongruous. Whether delay in reduction and fixation for this incongruous hip results in worse outcomes remains inconclusive. The current study showed that it was difficult to achieve an anatomically reduced femoral head when the fragments constituted more than one-fourth of the femoral head. Patients who underwent secondary operative fixation after emergent closed reduction had a high rate of avascular necrosis and a relatively poor outcome.

Emergent surgical reduction and fixation of the large fragment improves outcomes in patients with Pipkin type-I femoral head fractures. This may be attributed to the following factors. First, the femoral head is reduced in the acetabulum but is incongruous, which could also increase the hip intracapsular pressure and impair blood perfusion to the femoral head. Second, this condition could decrease metabolic activity in cartilage exposed to a compression injury. In this series, 9 patients with Pipkin type-I fractures had delays in reduction and fixation for the incongruous hip, 4 had avascular necrosis, and 2 had heterotopic ossification. Surgery should be performed on an urgent basis. This implies that emergent open reduction and internal fixation of the large fragments should be performed as soon as the patient is considered stable.

An urgent operation allows early reduction, capsular decompression, restoration of the anatomy, and restoration of femoral head vascularity by unkinking the vessels. However, no marked correlation exists between the timing of surgery and an anatomically reduced femoral head.

This study also had several limitations. Although the clinical situation to extrapolate that the large fragments interposed in the articular surface could increase the hip intracapsular pressure, impair blood perfusion to the femoral head, and decrease metabolic activity in cartilage exposed to a compression injury, hematologic screening (eg, digital subtraction angiography) investigation is required.

\textbf{REFERENCES}


\begin{table}
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\begin{tabular}{|l|c|c|}
\hline
Group 2 & Anatomically Reduced & Not Anatomically Reduced & \textit{P} \\
\hline
No. of patients & 9 & 9 & >.05 \\
Outcome & & & <.05 \\
Excellent & 2 & 1 & \\
Good & 5 & 2 & \\
Moderate & 1 & 2 & \\
Poor & 1 & 4 & \\
Complications & & & \\
Heterotopic ossification & 1 & 2 & \\
Avascular necrosis & 1 & 4 & \\
\hline
\end{tabular}
\caption{Outcomes in Patients in Group 2 With or Without an Anatomically Reduced Femoral Head}
\end{table}


