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## Retrospective Study

**Neglected traumatic hip dislocation: Influence of the increased intracapsular pressure**

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**Abstract****AIM**

To investigate that the increased intracapsular pressure, during the delay period, can interrupt the blood flow to the femoral head.

**METHODS**

An observational retrospective study included a group of 17 patients with traumatic hip dislocation, their ages at time of injury averaged 26 (range from 3 to 70) years. Outcomes were assessed clinically and radiographically at a period averaged 11.5 (range from 4 to 20) years.

**RESULTS**

Minor trauma caused dislocation in seven and severe trauma in ten patients. All dislocations were posterior, six isolated dislocation and 11 were associated with other injuries. The negligence period averaged 2.5 (ranged from 1 to 4) d. At the latest visit, the radiography revealed normal hip in 11 and avascular necrosis (AVN) in six patients. Clinically, eight patients were rated as excellent, three good, three fair and three poor.

**CONCLUSION**

We believe the factors that contribute to increased intracapsular pressure also increase the influence of delayed reduction toward the development of AVN.

**Key words:** Avascular necrosis; Intracapsular pressure; Traumatic hip dislocation; Delayed reduction

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**Core tip:** Factors influencing outcomes of traumatic hip dislocation include reduction time, the severity of trauma, patients' ages and direction of dislocation. Although these factors have been thoroughly investigated, any of them was not assigned as the causative for the development of the avascular necrosis (AVN). Does the increased intracapsular pressure is the foremost factor? We believe that the factors as hemarthrosis, the position of the limb during the pre-reduction period particularly in posterior dislocation and traction in post-reduction period can increase the intracapsular pressure to a level sufficient for occlusion of intracapsular blood vessels. Delayed reduction accentuates influence of increased intracapsular pressure in favour of the development of AVN.

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## INTRODUCTION

As the hip is an inherently stable joint, a substantial force is required for its dislocation. Therefore, associated injuries must be sought<sup>[1,2]</sup>. However, some biological factors can predispose to dislocation even with minor trauma, for instance, increased the head-shaft angle and diminished or increased femoral torsion<sup>[3-5]</sup>. In children, hip dislocates mostly after relatively trivial accidents such as slipping or tripping<sup>[2,6]</sup>. Consequently, the associated injuries are uncommon. The prominence of the associated injury or insignificance of the causative trauma leads to the negligence of hip dislocation<sup>[6,7]</sup>.

There is almost a consensus regarding the prompt reduction of the dislocated hip in order to minimize the incidence of avascular necrosis (AVN)<sup>[6-9]</sup>. However, an experimental study reported that the reduction time did not consider a critical factor in the appearance of AVN<sup>[10]</sup>.

Effusion of the hip joint was detected with traumatic dislocation at about 35 d post injury<sup>[11]</sup>. The effusion increases the intracapsular pressure to a level sufficient for tamponade of the retinacular blood vessels<sup>[2,11,12]</sup>. Likewise, placement of the injured limb in the particular positions during the pre and/or post-reduction periods can tighten the capsule, which increases the intracapsular pressure<sup>[13-15]</sup>. These reasons explain why some authors noted AVN despite early reduction<sup>[6,9]</sup>.

Over a period of twenty-year, we observed a group of patients with missed traumatic hip dislocations. Although all hips were reduced late and received the same post reduction management, however, only about 35% developed AVN. Therefore, we hypothesized that the delayed reduction is not only the direct factor that

contributes to the development of AVN. However, the factors that increase intracapsular pressure may play an important role in the development of AVN.

In order to investigate our hypothesis, we present this study using the patients' records as a source of the outcomes.

## MATERIALS AND METHODS

Between February 1993 and March 2013, we have observed and followed a group of 17 patients with a neglected traumatic hip dislocation. Local Ethics Committee approved this retrospective study. Patients were not required to give informed consent to the study because the analysis used anonymous clinical data. The included patients are seven females and ten males their ages at time of injury averaged 26 (range from 3 to 70) years. Baseline details are listed in Table 1. The causative trauma was graded into minor trauma as running, tripping or falling and severe trauma as high-energy impact, crushing, excessive speed (cycling) or excessive force (football)<sup>[7]</sup>. Dislocation was classified according to the direction into anterior, posterior and central. Then the posterior dislocation was classified according to the Thompson-Epstein classification system<sup>[16]</sup>. Additionally, dislocation was classified as an isolated or associated with other injuries, which were then classified into polytrauma, or injuries related to the dislocated side as sciatic nerve injury, femoral fractures or knee injuries. Negligence period was estimated from time of the trauma to the time of the certain reduction.

All dislocations were reduced closed and received the same post reduction management, which consists of aspiration of the hip joint, skin or skeletal traction for three weeks followed by another three weeks of non-weight bearing. In case of the dislocations associated with fractures, full weight bearing was allowed when the fractures healed.

Follow-up reviews were undertaken at every other week for 6 wk, and then at three, six and twelve months. After first year, patients were re-evaluated twice per year for 3 years, and then they invited once per year. The follow-up period averaged 11.5 (range from 4 to 20) years.

### Outcome measures

**Radiological assessment:** In order to assess the stability of reduction, plain radiography was repeated every other week for 6 wk. Development of AVN was assessed every 6 mo for 3 years and then once per year. AVN was defined as the appearance of subchondral sclerosis or the presence of segmental collapse. Associated fractures were considered during the follow-up visits.

**Clinical assessment:** Clinical outcome was evaluated according to Matta clinical evaluation system<sup>[17]</sup> that evaluates with points the pain, walking and range of hip

**Table 1** Baseline data and outcome for a group of patients, they were treated late for traumatic hip dislocation

No.	Baseline data						Outcomes			
	Age	Sex	NP in days	Trauma	Dislocation type	Associated injury	Follow-up period, yr	Clinical		Radiologic
								Score	Rating	
1	3	M	4	Minor	T-E type 1	Isolated	20	18 point	Excellent	Normal
2	33	M	3	Severe	T-E type 1	Polytrauma	18	14 point	Fair	AVN
3	5	F	3	Minor	T-E type 1	Isolated	18	18 point	Excellent	Normal
4	27	M	2	Severe	T-E type 1	Polytrauma	16	12 point	Poor	AVN
5	55	M	1	Severe	T-E type 4	Polytrauma	15	14 point	Fair	AVN
6	26	M	1	Severe	T-E type 2	Acetabular fracture	15	16 point	Good	Normal
7	19	M	2	Severe	T-E type 3	Acetabular fracture	13	14 point	Fair	AVN
8	6	F	2	Minor	T-E type 1	Isolated	12	18 point	Excellent	Normal
9	4	M	3	Minor	T-E type 1	Sciatic	12	18 point	Excellent	Normal
10	70	F	3	Minor	T-E type 1	Isolated	9	18 point	Excellent	Normal
11	36	F	4	Severe	T-E type 4	Polytrauma	8	12 point	Poor	AVN
12	4	F	3	Minor	T-E type 1	Isolated	8	18 point	Excellent	Normal
13	36	M	2	Severe	T-E type 2	Acetabular fracture	8	17 point	Good	Normal
14	24	F	2	Severe	T-E type 2	Acetabular fracture	7	16 point	Good	Normal
15	6	F	2	Severe	T-E type 1	Femoral fracture	7	18 point	Excellent	Normal
16	29	M	4	Severe	T-E type 1	Polytrauma	6	12 point	Poor	AVN
17	57	M	1	Minor	T-E type 1	Isolated	4	18 point	Excellent	Normal

NP: Negligence period; M: Male; F: Female; T-E: Thompson-Epstein; AVN: Avascular necrosis.

motion. The clinical scores were classified as excellent = 18 points, good = 15-17 points, fair = 13-14 points and poor  $\leq$  13 points<sup>[17]</sup>.

## RESULTS

The causative trauma was classified as minor in seven cases and severe trauma in ten cases. The direction of the hip dislocations was posterior in all cases. According to the Thompson-Epstein classification system<sup>[16]</sup>, 11 cases were classified as a type 1, three cases type 2, one case type 3, and two cases type 4. Six cases were classified as isolated dislocation and 11 cases were associated with other injuries (Table 1). The negligence period averaged 2.5 (ranged from 1 to 4) d.

Post-reduction aspiration of the hip joints revealed hemarthrosis in six, synovial fluid in four, and negative aspiration in seven hip joints.

### Radiographic outcome

The normal appearance of the femoral head compared to the contralateral side was observed in 11 patients and AVN signs were observed in six patients.

### Clinical outcome

According to Matta<sup>[17]</sup> eight patients were rated as excellent, three good, three fair and three poor (Table 1). The overall rating was good and the overall score averaged 16 (ranged from 12 to 18) points. No general complication was reported, the associated fractures healed in the accepted position and the injured sciatic nerve cured.

We have noticed a relationship between the patients' ages and severity of the trauma on one hand and the outcomes on the other hand. Five patients with an average age of 4.4 years (range from 3-6 years) had hip dislocation due to minor trauma achieved excellent

outcomes as well signs of AVN were not detected during the follow-up period. Similarly, a female patient 6-years old, although had dislocation due to severe trauma, however, has an excellent result with no AVN. Conversely, the patients who developed AVN their ages averaged 33 years (range: 19 to 55 years), had exposed to severe trauma and the post-reduction aspiration of the hip joints revealed hemarthrosis.

## DISCUSSION

Factors influencing outcomes of traumatic hip dislocation include reduction time, severity of trauma, patients' ages and direction of dislocation. Although these factors have been thoroughly investigated, any of them was not assigned as the causative for the development of the AVN. Does the increased intracapsular pressure is the foremost factor?

Diagnosis of traumatic hip dislocation is easy, many authors and we likewise have noticed missed cases. Prominence of the associated injuries or insignificance of the trauma really leads to delay of the diagnosis<sup>[6,7]</sup>. Although delayed reduction has been regularly linked to incidence of AVN, definition of negligence period is not clear in the literature<sup>[1,9]</sup>. Experimentally, AVN was produced in the capital femoral epiphysis of immature dogs after increasing the intracapsular pressure for six hours and in the adult dogs for 12 h<sup>[18,19]</sup>. Consequently, dislocation is considered neglected when the reduction was not achieved before 12 h of injury. In the present study, all cases were reduced at an average 2.5 d, only 35% of the cases developed AVN (Table 1). Sapkas *et al*<sup>[10]</sup> have considered the reduction time is not a critical factor in the appearance of AVN.

Minor trauma can dislocate the hip in children (Figure 1), likewise at any age in the presence of the biological predisposing factors<sup>[2-5]</sup>. Thus, it is not mostly



**Figure 1** Plain radiographs of the pelvis both hip joints for a 4-year-old boy; the right hip joint was dislocated after minor trauma. A: Notice the neck-shaft angle; B: A radiograph was taken one week after closed reduction shows the stable reduction; C: A radiograph was taken after three years of reduction shows no signs of avascular necrosis.



**Figure 2** Plain radiographs of the pelvis both hip joints for a 27-year-old male, was admitted to hospital as a polytraumatized patient, the right hip dislocation was reduced two days after injury. A: The right hip dislocated posteriorly; B: Stable reduction by the second month; C: A radiograph was taken 16 years after reduction shows avascular necrosis of the femoral head and degenerative changes of the right hip joint.

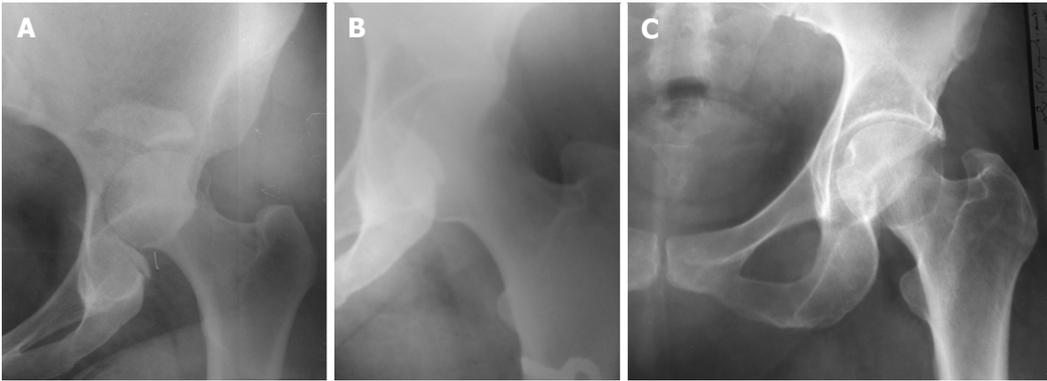
associated with other injuries<sup>[6-8]</sup>. However, severe trauma at least associated with a hemarthrosis. Laorr *et al*<sup>[11]</sup>, investigated 18 patients with traumatic hip dislocation and found hemarthrosis in all cases. This explains why many authors have linked severity of trauma to the incidence of AVN<sup>[7,10,20]</sup>. In the present study, we detected hemarthrosis in six, synovial fluid in four, and negative aspiration in seven hip joints. Additionally, the hips that were dislocated due to minor trauma have normal femoral heads, while most of those had dislocations due to severe trauma developed AVN during the follow-up period (Figures 1 and 2). However, the dislocations that associated with acetabular (Figure 3) or femoral shaft fractures have not developed AVN (cases No. 6, 13, 14 and 15 in Table 1). The associated femoral fractures, likely resulted from a substantial force sufficient for laceration of the hip capsule additionally<sup>[1]</sup>. Any of acetabular fracture or capsular laceration allowed for leakage of the hemarthrosis, and therefore, the intracapsular pressure has not increased.

The patient's age can predict the outcomes through the severity of trauma on the one hand and the age-related changes of the femoral head circulation on the other hand. At age under 5 years, the acetabulum is primarily soft pliable cartilage as well as there is a generalized ligamentous laxity, therefore the minor trauma can dislocate the hip joint<sup>[2,6]</sup>. Additionally, it

has been reported that the variations in the age-related sequelae of the traumatic hip dislocation have been in part attributed to the age-related changes in the hip circulation<sup>[2,8,12,21]</sup>.

At the fourth year of age, the femoral head is supplied through a retinacular arterial system, which consists of multiple arteries. With age, the multiple small vessels of the young coalesce to a limited number of larger vessels. Thus, damage to a single blood vessel can have serious consequences<sup>[2]</sup>. Most authors suggest that the posterosuperior branch of the medial circumflex artery is the most likely site of vascular damage<sup>[10,21,22]</sup>. Nevertheless, such vessels have a more ability to accommodate the extreme posterior displacement of the femoral head<sup>[23]</sup>. This explains why many authors have reported the continuation of femoral head circulation after reduction of pure hip dislocation<sup>[8,22]</sup>.

Direction of hip dislocation plays an important role in the development of AVN<sup>[8]</sup>. Generally, pure anterior dislocations have a better long-term prognosis than posterior dislocations<sup>[1,20]</sup>. In anterior dislocations, the capsule is disrupted anteriorly and inferiorly while in posterior dislocations the capsular tear either inferoposterior or directly posterior, depending on the amount of flexion present<sup>[1]</sup>. As the posterosuperior vessels is the most likely site of vascular damage<sup>[10,21,22]</sup>, the posteriorly dislocated femoral head compress



**Figure 3** Plain radiographs of right hip joint for a 42-year-old female, was diagnosed two days after a motor car accident. A: A posterior dislocation of the right hip with acetabular fractures; B: A radiograph was taken two weeks after closed reduction shows stable reduction; C: A radiograph was taken seven years after reduction shows no signs of avascular necrosis in the head of right femur.

these vessels against the posterior acetabular rim and interrupt the femoral head circulation<sup>[22]</sup>. Position of the limb prior to reduction also plays a role in the development of AVN<sup>[13]</sup>. In posterior dislocations, the leg is flexed, adducted, and internally rotated while in anterior dislocations, the leg is externally rotated with varying amounts of flexion and abduction<sup>[1]</sup>. So, the deformity in anterior dislocation increases capacity of the hip capsule to accommodate pressure more than that in posterior dislocation<sup>[13-15]</sup>. Moreover, recognizable limb deformity in anterior dislocation renders negligence is less likely.

Hip joint is enclosed by a thick fibrous capsule<sup>[2]</sup>. Therefore, the trauma that has sufficient severity to dislocate the inherently stable joint, constantly results in hemarthrosis, which increases the intracapsular pressure to a level sufficient to tamponade of the retinacular blood vessels<sup>[2,11,12]</sup>. This was proved experimentally in two separate studies, as they produced AVN when the intracapsular pressure of the hip was increased for six or twelve hours<sup>[18,19]</sup>. Likewise, the tight repair of the hip capsule after surgical dislocation led to a drop in the perfusion of the femoral head<sup>[20,22]</sup>. Given that, the development of AVN must depend essentially upon the steadiness of interruption of blood flow<sup>[21]</sup>. Hence, the hemarthrosis that was detected at an average 13.2 d after injury will offer the circumstance sufficient for the development of avascular AVN even after prompt reduction<sup>[11,12]</sup>.

Post reduction management plays a role in the development of AVN. Most surgeons recommend a period of traction until the patient's initial pain has subsided. However, this position increases the intracapsular pressure<sup>[13-15,20,21]</sup>. Therefore, the best recommendations for post-reduction treatment are avoidance of strict immobilization and allow full weight bearing once the patient can control his leg in space<sup>[1,11-13]</sup>. Aspiration of the hip, if it has hemarthrosis, should be repeated during the first day and in the next days as long as the joint effusion persists.

The present study has many limitations: In part, the included data were retrospectively collected from a

heterogeneous group of patients and in another part, lacked the use of the diagnostic tools as measuring of intracapsular pressure and MRI. However, heterogeneity provided an opportunity for studying of different age groups and different types of trauma, albeit in a small number of patients. Availability of patients for a considerable period of follow-up offered the data that warranted the building of the logical opinion.

We believe that the factors as hemarthrosis, the position of the limb during the pre-reduction period particularly in posterior dislocation and traction in post-reduction period can increase the intracapsular pressure to a level sufficient for occlusion of intracapsular blood vessels. Delayed reduction accentuates influence of increased intracapsular pressure in favour of the development of AVN.

## ARTICLE HIGHLIGHTS

### Research background

In February 1993, a 3-years old boy present with the secondary inability to walk after fall during running since four days. Hip dislocation was detected and reduced immediately. In June 1995, a male 33-years-old had present with multiple traumas due to a motor car accident and a hip dislocation that was missed for three days. By the sixth-month post reduction, the second patient developed avascular necrosis (AVN). In the same week, I called the first patient for follow-up and radiological examination that revealed normal hips. At this moment I wondered, why the second patient developed AVN despite the delayed reduction was the common denominator? In subsequent years I started a study titled "Fixation of intracapsular femoral neck fractures: Effect of transosseous capsular decompression" (published). Therefore, the importance of the intracapsular pressure has resurfaced. Again I wondered, what the relationship between the age and the severity of the trauma regarding the hip dislocation? As well, what the influence of hemarthrosis on the development of AVN?

### Research motivation

This study was conducted for answering of the inquiries that can be summarized in, "when we expect the development of the AVN after hip dislocation and how to avoid the predisposing factors".

### Research objectives

The objective of this study was the detection of the factor(s) that can accentuate hazardous of delayed reduction. We assumed increased intracapsular pressure is the concerned factor. Realizing this hypothesis will open the way for avoidance the complications resulted from hip joint effusion either due to

trauma or disease.

### Research methods

This is an observational retrospective study depend on the analysis of patients records and reviewing of the literature in realizing of its objectives.

### Research results

We have noticed a relationship between the patients' ages and severity of the trauma regarding the incidence of the hip dislocation, as well the severity of trauma and development of AVN.

### Research conclusions

Increased intracapsular pressure can be a result of the combined effect of hip dislocation and traction of the limb in the post-reduction period. Complications of hip diseases that associated with hip effusion as infections or Perthes disease can be diminished through reduction of intracapsular pressure. The prompt reduction is not enough to avoid the development of the AVN. The interferences as traction of the limb for immobilization can increase the intracapsular pressure of hip joint. Influence of the intracapsular pressure varies according to the patient's age. I suggest a prospective study using the advanced instruments for prediction of the development of AVN. The associated acetabular fractures allowed leakage of the hemarthrosis as well fracture of femoral shaft possibly lacerated the hip capsule and in both cases, we could not detect fluid through aspiration. The recommendations for post-reduction treatment are the aspiration of the hemarthrosis, avoidance of strict immobilization and allow full weight bearing once the patient can control his leg in space.

### Research perspectives

Despite the heterogeneity of the patients, however, it provided an opportunity for studying of different age groups and different types of trauma, albeit in a small number of patients. The future research should be directed toward the reduction of the complications of the diseases that associated with increased of the intracapsular pressure. The best method for the future research is a prospective randomized controlled study.

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