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Femoral Neck Fracture in Pediatric Patients: A Literature Review

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Abstract: ***Introduction: Hip fractures in Pediatric are uncommon for only 1% of all fractures in children. Almost 50% of cases, femoral neck fractures in Pediatric result from high-velocity mechanisms. Most recommendation toward open reduction and internal fixation (ORIF). The timing of surgery has also been linked to lower complication rates of this injury is associated. The current recommendation is surgical treatment within 24 hours of the trauma. Discussion: Younger patients which the periosteum is thicker and have stronger bone, it require high energy injury to break and displace the femoral neck. Sideways impacts on the greater trochanter result in compressive loading of the femoral neck, the forces required to are lower. Surgery time has an important role yet it is not only the factor as bone quality of patients, reduction status, metabolic, rehabilitation and nutritional parameters are essential as well. Overall, good outcomes after surgery occur in up to 60% of patients, and they are inversely linked to occurrence of osteonecrosis. Conclusion: Femoral neck fractures in Pediatric are uncommon and differ from elderly. It have a high risk of complication, the most common and serious being osteonecrosis and non-union. Complications can be minimized. Early mobilization with adequate nutrition and rehabilitation are needed to bring a good outcome for the patient.***

Keywords: femoral neck, fracture, pediatric, orthopaedic

1. Introduction

Hip fractures are commonly in elderly patients from low-energy injury such as falls from standing or secondary osteoporosis. Hip fractures in Pediatric are uncommon injuries accounting for only 1% of all fractures in children [1]. The most incidents incidence occurs during early teen years, and male patients are more common than female by a 1.3–1.7:1 ratio. Almost 50% of cases, femoral neck fractures in Pediatric result from high-velocity mechanisms such as motor vehicle accidents, falls from height, or significant sports injuries [2]. This indicate that these fractures may be associated with polytrauma including head, chest, or abdominal injuries as well as other orthopaedic injuries such as pelvic or acetabular fractures and ipsilateral femur fractures. With that more complex trauma, a comprehensive trauma team including an evaluation by a general surgical trauma team is often warranted. In younger patients, particularly those that are nonambulatory, nonaccidental trauma must be considered as a potential mechanism. In Pediatric patients some elements of the proximal femur have a direct impact on the fracture characteristics and its natural history. Their thick periosteum and strong bone require high energy to break and displace the femoral neck [3]. Although the hip joint contact forces reported in the literature easily exceed 500% BW and can be as high as 4000–5000 N of load during daily activities, spontaneous fractures typically do not occur in healthy individuals [4]. The other concern for this trauma is the exclusive femoral head blood supply from lateral epiphyseal arteries with no metaphyseal anastomosis creates a high risk of avascular necrosis of femoral head (AVN) after trauma [5]. For those children who suffer a hip fracture from a seemingly low-energy mechanism, pathologic fracture from a bone cyst, osteomyelitis, metabolic bone disease, fibrous dysplasia, etc., should be excluded [2].

There are controversy regarding the best methods of treatment to achieve an anatomic, stable, and reliable reduction because it has been shown to directly impact the complication rate [2]. Most recommendation toward open reduction and internal fixation (ORIF) over closed reduction and internal fixation (CRIF) for better outcomes [6] may be because the former likely results in better reduction. ORIF should routinely be the method of choice for late intervention [7]. The timing of surgery has also been linked to lower complication rates of This injury is associated with such as osteonecrosis and nonunion, with reported rates of 11%– 86% and 16%–59%, respectively, including coxa vara, and the current recommendation is surgical treatment within 24 hours of the trauma [8].

Epidemiology

Hip Fracture is a serious and debilitating condition not only in older people but also younger people. The epidemiology data are various between countries. The number of global hip fractures is expected to increase from 1.26 million in 1990 to 4.5 million in by the year 2050. There is significance difference between the population of elderly and younger patients which in elderly the patient are more likely female but in younger patient are likely male with a ratio male : female of 1.3–1.7:1 [9]. The incident of femoral neck fracture in children reaches it peak at years of 11 and 12 years [10]. This may occur because is elderly patients the most common pathomechanism are low energy injury from falling or secondary osteoporosis, which in younger patients

which the periosteum is thicker and have stronger bone, it require high energy injury from motorcycle incident, fall from height or sport injury to break and displace the femoral neck [9].

Anatomy

Blood supply to the proximal femoral epiphysis is precarious during childhood. Throughout life, the blood supply to the femoral head is predominantly from the lateral epiphyseal vessels, which are the terminal branches of the medial circumflex femoral artery, arising from its deep branch [11].The retinacular branches (posterosuperior and posteroinferior) of the medial circumflex artery (MCA) form the main supply to the femoral head. The lateral circumflex artery (LCA) supplies the greater trochanter, medial metaphysis, and the medial portion of the physis. The blood supply from the artery of the ligamentum teres and the branches of the LCA begin to regress after the age of 4 until 10 years and the postero-superior branch of the MCA becomes the major vessel supplying the head during this period. The higher risk of AVN in the growing child can be explained by the tenuous blood supply during this period [12]. The anterior and lateral aspects of the femoral head are predominantly supplied by the posterosuperior branch of the MCA and an anterior capsulotomy for open reduction does not jeopardize this as shown by Ganz [13]. Between 7 and 10 years, the vessels of the ligamentum teres (medial epiphyseal vessels) become more prominent and contribute to the blood supply of the epiphysis. During adolescence, as skeletal maturity overture, the growth plate is gradually obliterated and the vessels of the metaphysis, epiphysis and ligamentum teres anastomose freely with each other. In adults, this anastomosis provides robust blood supply to the epiphysis, which is not completely dependent on the retinacular end arteries; accounting for the lesser incidence of AVN after femoral neck fractures in adults as compared to children [14].

Pathophysiology

Although the hip joint contact forces reported in the literature easily exceed 500% BW and can be as high as 4000–5000 N of load during daily activities, spontaneous fractures typically do not occur in healthy individuals. In Femoral neck fracture situations, the loads exceed the strength of the proximal femur. We have to consider both the load and the direction of loading. Fractures of the femoral neck occur during vertical impact along the femoral shaft axis typically while the hip is flexed. In another case, femoral neck fracture can also occur during sideways impact on the greater trochanter or during torsional moments acting on the leg, generally when the hip is abducted, when loads are transferred to the hip joint. Vertical loading of the hip joint creates a bending moment at the femoral neck, resulting in tension at its superior aspect and compression at the inferior part of the neck. It is typically the tensional strain at the superior aspect, which causes the initiation of failure. Consequently, the most common site of fracture initiation during vertical overloading is the superior lateral aspect in the subcapital region of the femoral neck [15]. In contrast to vertical impacts, sideways impacts on the greater trochanter result in compressive loading of the femoral neck, the forces required to induce a fracture from a sideways fall are lower compared with those for vertical impact loading. The resulting fractures during sideways falls are more often basicervical or even trochanteric. Femoral neck fractures in younger individuals require relevant amounts of fracture energy resulting in considerable levels of impact load [16].

The natural process of muscles around the hip cause typical displacements after femur neck fractures [17]. The point for movement, which normally lies at the center of the femoral head, is shifted to the femoral shaft after a fracture. The net effect of the pull of the iliopsoas, abductors, external rotators, gluteus maximus and adductors on the distal fragment is proximal and medial translation and external rotation of the shaft. The proximal fragment, having no muscle attachments, is pushed passively by the trochanteric fragment so that its fracture surface comes to face antero-supero-laterally [18].

Classification

Although hip fracture are less likely occur in younger patient with only 1% of fracture in children, the direct cost of hip fracture are enormous since it requires a long period of hospitalisation and continuous rehabilitation. Delbet classification for femoral neck fracture is commonly used to determine the choice of reduction and complication rate (Table 1) [19].

Table 1: Delbet Classification for Femoral Neck Fracture in Pediatric [19]

Type	*Description*	*Incidence*	*AVN*	*Non-Union*
Type I	Transphyseal (with or without epiphyseal dislocation)	<10%	38-100%	
Type II	Transcervical	40-50%	28%	15%
Type III	Cervicotrochanteric (or basicervical)	30-35%	18%	15-20%
Type IV	Intertrochanteric	10-20%	5%	5%

Diagnosis

The child is terrified of any passive movement and unable to transport actively. Nerve blocks for preliminary pain remedy in pediatric femoral fractures in the form of femoral nerve blocks and fascia iliaca compartment block have been described [20]. The diagnosis is confirmed by plain radiographs in two planes. The anteroposterior (AP) view of the pelvis with the hip extended and 15 degrees internally rotated, as tolerated by the patient, will serve to evaluate any displacement with the opposite side. Cross table lateral view to keep away any displacement and pain at the same time as mobilization should also be taken and a full-length radiograph AP and lateral views of the femur are also taken to complete the assessment. An skilled ultrasonologist can detect a fracture line and fracture hematoma in doubtful cases. A latest look study concluded that it does not appear that habitual computed tomography scanning to assess concomitant femoral neck fractures in association with ipsilateral femoral shaft fractures as in adults is justifiable because the danger of radiation exposure within the young and the low occurance of such incident in children (<0.7%) [21]. Magnetic resonance imaging (MRI) can be taken in special situations to detect a stress fracture [22].

Management

The situation about surgical timing is controversy, some studies suggest that early surgery within 6-24 hours might

decrease femur head femoral head necrosis. Some studies indicating that to decrease the rate of AVN in patient below 60 years we need an early fixation within 12 hours, on the other hand, others indicate that internal fixation should be applied in the first 24 hours in order to minimalize the risk of complication [23]. Braun et al state that fixation applied during the first 6 hours improves both functions and avascular necrosis rates yet Upadhyay et al maintain that fixation during and after first 48 hours does not affect bone nonunion and femur head avascular necrosis rate. Elmi et al [24] claim that timing of the surgery has an important role yet it is not only the factor as bone quality of patients, reduction status, metabolic, rehabilitation and nutritional parameters are essential as well.

The first choice of treatment for younger patient with femoral neck fracture is ORIF, one of them by using Canulated Screw. When treating femoral neck fractures with CS systems, the stability of the fixation construct has been shown to be affected by several factors related such as: screw type, number, thickness, and position, direction, and configuration of screws. Recent studies state that 3 screws should be used with diameters of larger than 6 mm, a fourth screw has not shown to provide biomechanical benefits, most likely due to the weakening of the lateral wall by the screw insertion holes. Screws should be placed in a triangular arrangement with an inverted triangle and spread apart as far as achievable under the anatomic circumstances. This configuration will provide the best axial and torsional stiffness and result in improved failure strength [4].

Multiple studies have quotes low rates of AVN when treatment for femoral neck fractures is blended with joint decompression [25]. Most recently, Bukva et al [8] discovered substantially lower incidence of AVN and better final outcomes with hip decompression; with needle aspiration and open drainage being equally effective. Contrarily, numerous authors have suggested no widespread disntiction in rates of AVN with and without decompression. Interpretation of diverse review is tough as there are some of confounding elements affecting the prevalence of AVN, such as fracture type, displacement, time to surgery, fixation type etc. A recent systematic review concluded that capsular decompression provided no significant protection against AVN [26]. Direct vascular damage going on at the time of the fracture is an important cause for AVN [6]; in such cases, the tamponade effect does not play a role and capsular decompression won't be able to prevent AVN.

Although its benefits have not definitively been validated, needle decompression is a simple process without any complications, and we advise that it be performed in all fractures treated by CR. A percutaneous capsulotomy can be performed under C-arm guidance using a no. 10 surgical blade during closed reduction and fixation [27]. After making sure that the blade is firmly fixed to the BP handle, slide the blade over the anterior aspect of the greater trochanter, in line with the center of the femoral neck on anteroposterior view. Complete the capsulotomy while observing the blade on the lateral view, making sure that the blade is right on top of the femur neck, each by feel and on imaging. A gush of hematoma fluid must be visible to ooze out of the wound once the capsulotomy is complete. A safer alternative is to perform an open anterior capsulotomy with direct visualization of the capsule, or to simply aspirate the hematoma using a large-bore needle [2].

Complication

Overall, good outcomes after surgery according to Ratliff's criteria (Table 2) occur in up to 60% of patients, and they are inversely linked to occurrence of AVN. Leg length discrepancy (LLD) is associated with coxa vara, nonunion, AVN, and/or physeal arrest. In addition to management of concomitant causes, altering growth in the contralateral distal femur must be considered if the predicted difference at maturity is greater than 2 cm. Overgrowth of the Femoral Neck may occur in up to 40% of patients, with 6 mm average. It generally happens in young patients and is often associated with good prognosis (low AVN incidence and better outcomes). All efforts start from nutrient and rehabilitation need to be made to avoid AVN, non union, coxa vara, and others because once it happens, the treatment is very difficult [28].

Table 2: Ratliff's Criteria for Outcome. [28]

	Clinical	Radiographic
Good	Clinically, no or negligible pain, full or minimal restrictive hip movement, and normal activity or the avoidance of games.	Normal or some deformity of the femoral neck in the radiograph.
Fair	Clinically, occasional pain, hip movement restriction less than 50%, and normal activity or the avoidance of games.	Severe deformity of the femoral neck and mild avascular necrosis in the radiograph.
Poor	Clinically, disabling pain, hip movement restriction more than 50%, and restricted activity.	Severe avascular necrosis, degenerative arthritis, and arthrodesis in the radiograph.

2. Conclusion

Femoral neck fractures in Pediatric are uncommon and differ from elderly, mostly as the result from high energy injury, the sideway impact need lower energy to cause fracture than vertical impact loading, it have a high risk of complication, long term hospitalization and continuous rehabilitation, the most common and serious being AVN and non-union. Complications can be minimized if principles of early intervention, joint decompression, and anatomic reduction with stable fixation are achieved. Early mobilization with adequate nutrition and rehabilitation are needed to bring a good outcome for the patient.

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