

## Highlights on Complications Affecting the Outcome during Treatment of Developmental Dysplasia of the Hip

Treatment of developmental dysplasia of the hip (DDH) had a tremendous evolution during the last decades. Numerous articles were published to evaluate different treatment options and to establish treatment algorithm according to the severity of the condition and the age of presentation. The goal of DDH treatment is to achieve concentric and stable reduction while avoiding complications as much as possible.<sup>[1-4]</sup> Avoidance of complications remains the benchmark of obtaining a virtuous outcome. In most instances, a child with untreated DDH is far better than a treated child with complication.

Early diagnosis and treatment are crucial to provide the best possible functional outcome. Whereas, the treatment of DDH in older patients involves more extensive surgery with more possible complications which negatively affect the treatment outcome.<sup>[5,6]</sup> There is a general agreement that the major complications, which have noticeable and adversarial influences on the outcome following DDH treatment, are avascular necrosis (AVN) of the femoral head, and redislocation.

AVN following treatment of DDH is proven to be a serious complication. AVN has been described to compromise femoral head and acetabular development after reduction of the hip joint and is accordingly associated with unfortunate long-term clinical and radiographic consequences.<sup>[1]</sup> This major complication has a reported incidence in the literature of up to 47% and could drastically worsen the functional outcome of the affected hip and may impact the overall health and the quality of life of the patient through the ensuing pain, stiffness, joint incongruity, limb-length discrepancy, and other sequelae.<sup>[5,7]</sup>

The exact etiology of AVN after treatment of DDH is unidentified but most likely seems multifactorial. The previous literature identifies both a number of protective factors and risk factors. Protective factors that could have an influence on the incidence of AVN include the age at reduction, the presence of an ossific nucleus, and the use of an adductor tenotomy. Thus far, there are conflicting assumptions in the literature regarding whether age at the time of closed or open reduction and a specific surgical approach has an impact on the occurrence of AVN.<sup>[1,7]</sup>

The risk of AVN following treatment of DDH is hypothetically associated with the method of reduction and hip abduction angle in the cast. Some authors have suggested that open reduction is a risk factor for AVN; however, the argument regarding open versus closed reduction is still a controversial issue.<sup>[3,7]</sup> Findings from a meta-analysis, done by Wang *et al.*,<sup>[5]</sup> suggested that open reduction is a risk factor for the development of AVN compared with nonsurgical treatment.

Some investigators stated that closed reduction is a simple procedure and has the advantages of minimal invasion and negligible complications compared with open surgery. On the other hand, some researchers have concluded that open reduction is usually associated with a lower rate of AVN. They presumed that psoas and adductor release, tackling internal and external obstacles, and putting the cast in a slightly abducted position are effective in reducing the pressure exerted on the femoral head and consequently reducing the chance of AVN. Nevertheless, future studies are necessary to explore the relation between open reduction combined with pelvic and/or femoral osteotomy and the incidence of AVN.<sup>[3,5]</sup>

Undoubtedly, the literature is full with recommendations and precautions to be taken during closed or open reduction of DDH at different age groups to avoid the development of AVN.<sup>[5]</sup> The term safe reduction is used to describe the closed reduction of DDH in which measures were taken to avoid all risk factors responsible for the occurrence of AVN. Indisputably, arthrogram is playing an important role to achieve this task. There were significant evidences that the incidence of AVN decreased immensely by using arthrogram during closed reduction of DDH at any age.<sup>[3,7]</sup> Similarly, meticulous surgical approach, preserving capsular blood supply to the femoral head and femoral shortening in older children are associated with significant reduction in the occurrence of AVN after open reduction of DDH.<sup>[1,2]</sup>

Early redislocation after initial closed or open reduction of DDH is an acknowledged serious complication. Factors that are responsible for failure to achieve concentric and stable reduction by closed or open methods encompass the age of the patient at time of initial reduction, accepting suboptimal initial management, the performed surgical approach, flawed postreduction hip spica, inherent features of the affected hip, lack of experience of the treating surgeon, and other technical issues.<sup>[4]</sup> Bhaskar *et al.* analyzed the behavior of different cases of DDH after closed or open reduction to assess the role of bony ossific nucleus in providing stability after reduction. They presumed that presence of bony ossific nucleus may be a possible factor that may confer increased stability against redislocation.<sup>[8]</sup> However, this concept is not accepted by many pediatric orthopedic surgeons. Moreover, there is no strong evidence to support this hypothesis.

In some instances, concentric closed reduction of DDH, although initially achievable, cannot be maintained after applying the hip spica cast because of a deficient posterior acetabular wall and consequently redislocation become inevitable. A “hip-at-risk” instability test at the time of closed

reduction was proposed to identify potentially unstable hips that are prone to redislocation even with an adequate hip spica cast. These hips were best stabilized with a percutaneous K-wire through the greater trochanter into the pelvic bone. The procedure is considered a safe, reliable technique to prevent redislocation in the cast after a successful closed reduction.<sup>[9]</sup>

Technical failure is supposed to be the usual cause for redislocation after open reduction in patients with DDH.<sup>[4]</sup> Some recent studies have shown that one-stage surgery of DDH in children of walking age is feasible where femoral shortening is a part of the procedure to facilitate reduction and reduce the risk of redislocation and AVN. However, one-stage surgery of late-diagnosed DDH had a better outcome in younger children than older children. Moreover, Tonnis Grade II and III DDH is a risk factor for redislocation after the one-stage surgery.<sup>[2]</sup>

Obviously, there are certain recommendations that should be considered during the treatment of DDH to avoid notorious complications mainly AVN and redislocation. By following these precautions, the prevalence of the undesirable complications could be reduced to almost nil. Arthrographic assessment and the “hip-at-risk” instability test are essential safeguards during closed reduction. On the other hand, avoiding aggressive surgical practice, tackling coexisting deficiency in the posterior acetabular wall, and performing femoral shortening in older children are considered the principal safety measures during open reduction. It turns out that during DDH treatment, most of the complications occur due to temptations to skip safety precautions or accepting compromise when facing a confusing situation. Therefore, it is advisable to disregard all deceiving or doubtful influences and be fully committed to all safety precautions that were proven to have an important role in avoidance of adverse complications.

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