

Current Concepts in Proximal Femoral Osteotomy for Treatment of Perthes Disease

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Received: December 30, 2019; **Published:** February 11, 2020

Abstract

Legg Calve Perthes Disease (LCPD) is a common pediatric hip disorder, in which there is avascular necrosis of the femoral head.

Conservative treatment is better in younger children with an early presentation, while Surgical interventions produced better outcomes for older children with late presentation Perthes.

Different surgical options exist, mostly aiming at containing the femoral head in the acetabulum until remodeling occur. In this paper we review different types of proximal femoral osteotomies in Perthes including femoral varus osteotomy, femoral valgus osteotomy and transtrochanteric rotational osteotomy.

Femoral Varus osteotomy still remains the main surgical option that was the most commonly used and reported in literature.

Keywords: *Perthes; Femoral Osteotomy; Femoral Varus Osteotomy; Femoral Valgus Osteotomy; Transtrochanteric Rotational Osteotomy*

Introduction

Legg Calve Perthes Disease (LCPD) was defined as the femoral head's osteonecrosis onset in childhood [1]. Its etiology remains unclear with different precipitating theories, all of them end in an incident of femoral head ischemia [2].

Many classification systems have been developed. Lateral pillar classification was first described by Herring, *et al.* in 1992, detailing the amount of the femoral head's lateral pillar loss in height during the disease's fragmentation stage [3,4]. Another classification with great prognostic value is Stulberg's classification which relies on the congruency of the femoral head and the acetabulum after skeletal maturity [5]. Recently, Shah, *et al.* proposed the "Sphericity Deviation Score" to avoid the poor inter and intra-observer reliability of Stulberg classification and provide prognostic indication on the course of the disease after skeletal maturity [6,7].

Main prognostic determinants of LCPD are lateral pillar classification and the age of the patient. Patients presented with lateral pillar A and before the age of 6 years had consistently favorable prognosis whatever the management was, while those presented older than 8 years old performed worse whatever the management was [8].

Surgery is not commonly indicated for LCPD patients; however, surgical interventions produced better outcomes for late presentation LCPD and lateral pillar B and B/C [1].

Different surgical options exist, mostly aiming at containing the femoral head in the acetabulum until remodeling occur. Pelvic osteotomies including innominate and lateral shelf osteotomy are used separately or combined with femoral osteotomy. Techniques for femoral osteotomies in LCPD were described, aiming for containment, pain relief and range of motion improvement [8]. They included femoral varus osteotomy, femoral valgus osteotomy and transtrochanteric rotational osteotomy.

Femoral varus osteotomy (FVO)

It was the first surgical technique for LCPD treatment. It has been widely used despite age or disease's severity. There is a strong body of evidence regarding the advantages, disadvantages and limitations of this technique [9].

The goal of FVO in LCPD is to contain the femoral head inside the acetabulum until remodeling occurs along with decreasing the pain and improving range of motion [1].

FVO results in femoral shortening of about 1 - 2 cm according to the degree of Varus achieved. However, this shortening is easily compensated by a growing child given the fact that the osteotomy itself stimulates bone growth. Limping, limiting hip abduction and trochanteric bulging are also reported. To avoid these complications, Weiner, *et al.* had a recommendation to keep the neck shaft's angle at or above 105 degrees [9]. Moreover, Kim, *et al.* recommended setting a limitation to the induced Varus to a maximum of 10 - 15 degrees [10].

Outcomes of 97 LCPD hips treated by FVO were reported by Joseph, *et al.* They addressed the optimal timing for containment surgery and found better results when done during fragmentation stage [11]. Wiig, *et al.* also compared the outcomes of FVO with nonsurgical treatment on 358 LCPD patients with 5 years follow-up and found FVO to be superior to nonsurgical treatment in patients over 6 years old at onset or if more than 50% of the femoral head is necrosed [8].

Technique

A pin is inserted under fluoroscopic guidance below the greater trochanter and advanced into the femoral neck perpendicular to the long axis of femur, central position of the pin in both anteroposterior and lateral views is confirmed by fluoroscopy. The angle from the pin to the femoral shaft should equal (90 minus the degree of Varus needed). Blade plate is advanced under fluoroscopy and fixed to femoral shaft after achieving needed Varus.

Femoral valgus osteotomy

Valgus femoral osteotomy is a salvage procedure for LCPD hips. It could be utilized in any disease stage; however some authors restrict its use for healed femoral heads with hinged abduction [12].

Valgus osteotomy restores the joint's congruity if LCPD hip becomes congruent on adduction but non-congruent on abduction. It also relieves the femoroacetabular impingement [13-15].

There are many proposed advantages for valgus osteotomy such as 1) Avoiding the hinging on abduction by repositioning the head of femur inside the acetabulum, 2) Its increase femoral length which compensates the shortening resulting from LCPD, 3) Repositioning the greater trochanter increases abductor tension and length and 4) Increasing weight bearing surface area leads to decreased pain and improves remodeling of the femoral head [13,14,16].

Several authors studied valgus osteotomy in LCPD, they reported improvement of functional and radiographic parameters, especially in younger age groups. Bankes., *et al.* reported results of valgus extension osteotomy in 51 hips for hinged abduction LCPD. They reported that average Iowa score was 86 at 10 years follow-up. They concluded that younger age, open triradiate cartilage and phase of reossification are associated with favorable outcomes [13]. Raney., *et al.* found similar results with valgus Osteotomy for hinge abduction LCPD. The reported results were of 31 hips with more than 5 years follow-up and found average Iowa hip score of 93 [16].

Kim., *et al.* reported the use of valgus osteotomy instead of the usually done varus osteotomy or innominate osteotomy in 25 hips with severe LCPD in late fragmentation stage. Improvements in the Mean Iowa hip score from 71 before surgery to 90 at the last follow-up were reported, with improvements in femoral head roundness as well [10].

Our team conducted a prospective non-randomized case series study in 36 patients (8 - 12 years) with symptomatic Perthes disease who were in reossification and healing stages. We performed valgus femoral osteotomy and observing them over 3 - 15 years with functional assessment using Iowa score. We found significant improvement in Iowa score from mean of 53.27 preoperative to 85.41 at the final follow-up. Our hypothesis was that valgus femoral osteotomy can relieve the existing symptoms as regard pain, limping, and limb length discrepancy which are for many patients may be the only problems encountering them for a long time and so to extend the use of valgus femoral osteotomy beyond salvage role in hinge abduction cases only. Our study is still under review now.

Technique

Same concepts of performing Varus femoral osteotomy apply to valgus femoral osteotomy. However, an increase in leg length is expected according to the degree of valgus done. The angle of correction is determined, with maximum magnitude of valgus correction in LCPD is proposed to be around 35 degrees. AO 130 degrees-angled blade plate or 150 degrees-locking compression plates could be used for fixation of the osteotomy.

Transtrochanteric rotational osteotomy (TRO)

Sugioka first described TRO for treatment of nontraumatic femoral head necrosis in adults. The main concept is by rotating the femoral head anteriorly or posteriorly, depending on the location of remaining intact area of the femoral head, the intact area is transposed to the load-bearing portion [17]. This procedure's purpose is to preserve the joint and prevent articular surface collapse. The same concept applied by Atsumo., *et al.* using posterior rotational osteotomy for patients with collapsed head after femoral head osteonecrosis and found this procedure to allow joint preservation for a long time even in advanced cases [18].

The first report of TRO on LCPD by Sugioka included 7 hips presented older than 10 years old. They found good radiographic outcomes after one year of follow-up [17]. The same concept was applied by Nakashima., *et al.* [19] and Hotokebuchi., *et al.* [20] showing good results and improvement in functional scores.

Technique

The femoral head is rotated along the axis of the femoral neck with 2 osteotomy lines. The first osteotomy line must be perpendicular to neck axis and directed toward the lesser trochanter. The angle of the second osteotomy to the first osteotomy must be calculated based on the intended direction of rotation (anterior or posterior). The second osteotomy should be directed toward the first osteotomy. Fixing the two fragments after achieving the required rotation is done using two large diameter screws (4.4 ml shank diameter).

Overview

The course of Perthes disease is a controversy. While some authors believe that it has a benign long term prognosis [21], others believe that it may have poor long term sequelae [22].

Most patients develop arthritis after the age of 50 years. According to Stulberg classification, only aspherical incongruent cases carry the risk of severe OA development in the 5th decade. There is not any typical relation between Perthes disease and OA, nor any correlation between the symptoms and the osteoarthritic radiographic changes in Perthes disease [22]. That is why the treatment of Perthes disease is a matter of dilemma.

We summarized different types of femoral osteotomies in treatment of LCPD in table 1.

	Femoral Varus Osteotomy (FVO)	Femoral Valgus Osteotomy	Transtrochanteric rotational osteotomy (TRO)
Advantages	<ul style="list-style-type: none"> • Simple and effective. • Improves intraosseous circulation, around the femoral head. • Head decompression. • Prevents femoral head subluxation. • Restores joint congruity. • Relives femuro-acetabular impingement. 	<ul style="list-style-type: none"> • Abductor mechanism improvement. • Abnormal hinge movement correction. • Increases weight bearing surface area which leads to decreased pain and improvement in femoral head remodeling. • Increases femoral length which compensates the shortening resulting from LCPD. • Decrease in lateral femoral head subluxation. 	<ul style="list-style-type: none"> • Obtain large rotation of the femoral head. • Joint preservation. • Prevent collapse of articular surface.
Disadvantages	<ul style="list-style-type: none"> • Femoral shortening. • Limping. • Excessive varus. • Nonunion. • Overgrowth. • Abductor weakness and Trendelenburg gait. 	<ul style="list-style-type: none"> • Degenerative arthritis. • Excessive valgus. • Nonunion. • Overgrowth. • Degenerative arthritis. • Increased contact pressure on femoral head will alter forces passing through the knee vertically. 	<ul style="list-style-type: none"> • More complicated surgical procedure. • Technically demanding • Osteophyte formation which may lead to impingement of the hip joint and subsequent osteoarthritis.

Table 1: Summary of different types of proximal femoral osteotomies in treatment of Perthes.

Conclusion

Femoral Varus osteotomy still remains the main surgical option that was the most commonly used and reported in literature [22]. Transtrochanteric rotational osteotomy is more technically difficult yet a promising procedure that still requires more evidence to be regularly used in LCPD [19]. Femoral valgus osteotomy was mainly used to alleviate hinged abduction in advanced LCPD [15]. With all these surgical options available, surgery must be reserved for selected patients according to age of presentation and severity of disease.

Conflict of Interest

The authors declare no conflict of interest.

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Volume 11 Issue 3 March 2020

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