Outcome of Closed Wedge Varus Derotation Osteotomy with Trochanteric Apophysiodesis in Perthes Disease

Abstract

Background: Perthes disease is a condition in which a self-limiting avascular event affects the capital epiphysis of the femur with a very variable course. It has been shown frequently, however, that there is a group of patients who definitely benefit from containment, either surgical or nonsurgical, better with surgical. We studied midterm to long term outcome of closed wedge varus derotation osteotomy (VDRO) with trochanteric apophysiodesis in Perthes disease.

Materials and Methods: 88 children with mean age of 7.9 ± 2 years, belonging to Herring’s lateral pillar Groups B and C treated with VDRO with trochanteric apophysiodesis were included in this study. Radiological evaluation was done using Mose’s index, the epiphyseal quotient, the articulotrochanteric distance and center edge angle of Wiberg.

Results: Containment was achieved in all patients on postoperative radiographs. At a mean followup of 12 years, good results were obtained in 66, fair in 19, and poor in 3 patients using Catterall’s postoperative classification.

Conclusions: VDRO is an effective containment method of femoral head for patients belonging to the Herring’s Group B and also effective in many patients belonging to Herring’s Group C. It is a good procedure to attain containment in children <9 years of age. Trochanteric apophysiodesis reduces risk of limping.

Keywords: Perthes disease, trochanteric apophysiodesis, varus derotation osteotomy, outcome

MeSH terms: Perthes disease, trochanter, osteotomy

Introduction

Perthes disease is a condition in which a self-limiting avascular event affects the capital epiphysis of the femur with a variable course. Most of today’s therapeutic approaches are based on the concept of containment. These treatments include bracing, Petrie cast, femoral osteotomy, innominate osteotomy, and acetabular shelf procedures. Subtrochanteric varus derotation osteotomy (VDRO) aims to decrease the neck shaft angle and anteversion of the proximal femur so that anterior and lateral part of capital epiphysis is pushed into the acetabular cavity, improving the coverage of the femoral head. Thus, the contained head gets an opportunity to remodel with growth due to biological plasticity. After first being reported in 1965 as a treatment of Perthes disease, this procedure has consistently shown satisfactory results in properly selected patients over the last 50 years. Many studies recommend VDRO as the first line treatment for surgical containment of femoral head in Perthes disease.

In spite of the fact that Malabar region of Kerala comes in the western coastal area of India, which has a reported higher incidence of Perthes disease, not many studies were done here.

This study evaluates the functional outcome of Perthes disease treated by VDRO with trochanteric apophysiodesis. The clinical outcome was assessed by Catterall’s postoperative classification and radiological outcome was assessed by rate of regeneration of epiphysis after surgery, sphericity of the femoral head after healing, using Mose’s index, and percentage increase in the radius of the femoral head.

Materials and Methods

88 children with Perthes disease treated by VDRO with trochanteric apophysiodesis between 1990 and 2010 with minimum followup of 6 years were included in this retrospective study. The medical records and radiographs of the patients were collected and analyzed regarding the preoperative and postoperative status (the patients were also interviewed personally and radiographs obtained, after contacting them over phone...
and post). The cases were classified based on Herring’s lateral pillar groups.\textsuperscript{9} Indication for surgery was children with Perthes disease in the age group of 5–13 years lateral pillar Groups B and C containable hips, with a minimum of 30° abduction and those which are in the fragmentation stage. A total of 98 cases were operated during this period. Bilateral hip involvement was seen in four cases, which were excluded from our study. Complete followup was available in 88 cases, 70 males and 18 females, the remaining 6 cases were lost to followup. The minimum period of followup was 6 years and maximum of 26 years with the mean followup of 12 years. Mean age at presentation was 7.9 ± 2 years. The right hip was involved in 33 children, the left hip in 55. The mean time between diagnosis and surgery was three months.

**Operative procedure**

All patients were operated by the senior author. The surgical procedure used was a varus derotation femoral osteotomy. It was done using a lateral approach, with a closing medial wedge osteotomy at level of the subtrochanteric region. A varus correction of 20° was aimed, depending on the degree of desired varus correction. Using fluoroscopy image guidance, abduction of the extremity brings about the desired containment angle of the femoral head. The degree of abduction is expressed by the angle formed by the shaft of the femur and a vertical line parallel to the midline of the pelvis. This angle represents the desired wedge to be removed. Height of base of the wedge to be removed for varus osteotomy was calculated using Table 1.\textsuperscript{10} The distal fragment was externally rotated about 20° and the fragments were fixed using a molded 6-hole dynamic compression plate (3.5 system). Trochanteric apophysiodesis was done by drilling the apophysis and introducing the proximal most screw across the physeal plate.

**Figure 1:** (a) Preoperative X-ray pelvis with both hip joints anteroposterior view showing fragmentation stage, lateral pillar Group B Perthes disease right hip (b) Fluoroscopic view of (R) hip anteroposterior view showing preoperative planning – measuring desired varus angle, it is an angle between long axis of femur and a parallel line to midline (c) Immediate postoperative X-ray pelvis with with both hip joints anteroposterior view showing well-contained femoral head

**Figure 2:** Clinical photographs of same patient at final followup showing (a) Abduction of 0°–45° (b) Adduction 0°–30°. (c) Flexion 0°–130°. (d) Internal rotation 0°–40°. (e) External rotation 0°–40°. (f) X-ray pelvis with both hip joints anteroposterior view showing good outcome
No plaster immobilization was done, but weight bearing was denied until the osteotomy was united (nearly 8 weeks). The implants were removed after 12–18 months. At followup, all hips were evaluated clinically and radiographically. Clinical evaluation included range of joint motion, limping, limb length discrepancy (LLD), and Trendelenburg sign. LLD was determined by placing a block under the shorter limb to level the pelvis.

Catterall’s postoperative classification was used to classify the hips into good, fair, and poor, which is based on the range of hip motion, hip symptoms, and radiography. An asymptomatic hip with full range of motion and with a round and well-contained femoral head was classified as good. A fair result included an asymptomatic hip with slight restriction of movements, especially internal rotation with the head round but broadened and not fully contained (up to one-fifth being uncovered). A hip which was not free of symptoms and with restriction of movements was classified as poor. Radiologically, a poor outcome was associated with a flattened, broad, and irregular femoral head with adaptive changes in the acetabulum and widening of the medial joint space.

Sphericity of the femoral head was evaluated using the Mose’s index, in which anteroposterior and lateral views were studied by superimposing a template of concentric circles on the radiographs. According to this index, the results were classified as good if the head was spherical on anteroposterior and lateral radiographs. Fair results were those in which the head was not spherical but deviated <2 mm from the concentric circles and poor if there was >2 mm of deviation. The epiphyseal quotient was measured by dividing the epiphyseal index (greatest height of the epiphysis divided by its width) of the involved head by that of the uninvolved head. A quotient of 0.6 was classified as good, 0.4–0.6 as fair, and <0.4 as poor.

Amount of hip subluxation was evaluated using center edge angle of Wiberg. It is the angle formed by line joining the center of femoral head to outer edge of acetabular roof with a vertical line through the center of femoral head. CE angle >20° - good, 15–19° - fair, and <15° - poor. All the data were collected and filled in the format of the proforma.

The articulotrochanteric distance (ATD) was measured as the vertical distance between the tangent to the highest point of the hip joint to the tip of greater trochanter. It indicates the overgrowth of the greater trochanter in relation to the femoral head.

The statistical software namely Statistical Package for the Social Sciences (version 15.0, SPSS Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL 60606-6412) was used for the analysis of the data and Microsoft Word and Excel was used to generate tables and figures.

**Results**

Of the 88 children who were studied, 70 were males and 18 females. Male to female ratio in our study was 4:1. Of the 88 children who were studied, 55 of them had left side involvement and 33 had right side involvement [Table 2]. Most of the children presented to us within 3–6 months of onset of symptoms with mean age at presentation 7.9 ± 2 years [Table 3]. Fifty nine children showed involvement of >75% head and in the rest <75% of head was involved. All of them were in early

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**Table 1: Height of base of wedge to be removed for varus osteotomy**

| Desired angulatory change (degrees) | 10 | 12.5 | 15 | 17.5 | 20 | 22.5 | 25 | 27.5 | 30 | 32.5 | 35 | 37.5 | 40 |
|-----------------------------------|----|------|----|------|----|------|----|------|----|------|----|------|----|
| Femoral shaft width at osteotomy site (mm) | 1.5 | 2    | 2.5| 3    | 3.5| 4    | 4.5| 5    | 5.5| 6    | 6.5| 7    | 7.5|
| 10                                | 2  | 3    | 4  | 4.5  | 5  | 6    | 6.5| 7.5  | 8  | 9    | 10 | 105  | 11.5|
| 15                                | 3  | 4    | 5  | 6    | 7  | 8    | 9  | 10   | 11 | 12   | 13 | 14   | 15 |
| 20                                | 4.5| 5    | 6.5| 7.5  | 9  | 10   | 11.5| 12.5 | 14 | 15   | 16 | 17.5 | 18.5|
| 25                                | 5.5| 6.5  | 8  | 10   | 11.5| 12.5| 14  | 15.5 | 17 | 18.5 | 20 | 22   | 23 |
| 30                                | 6.5| 8    | 10 | 12   | 13.5| 14  | 17  | 18.3 | 21 | 22   | 24 | 26   | 27.5|
| 35                                | 8  | 10   | 12.5| 14.5| 16.5| 18.5| 20  | 23   | 25 | 27   | 29 | 31.5 | 33.5|

The height of the base of the wedge in millimeters is read at the junction of the horizontal axis (desired degrees of angulatory change) and the vertical axis (width of the femoral shaft at the osteotomy site).

**Table 2: Descriptive statistics of the patients**

| Sex/side of involvement | n (%) |
|-------------------------|-------|
| Gender                  |       |
| Male                    | 70 (79.5) |
| Female                  | 18 (20.5) |
| Side                    |       |
| Right                   | 33 (37.5) |
| Left                    | 55 (62.5) |
| Total                   | 88 (100) |

**Table 3: Distribution of the sample according to age group**

| Age groups (years) | n (%) |
|--------------------|-------|
| 4-6                | 21 (23.9) |
| 7-9                | 44 (50.0) |
| 10-12              | 22 (25.0) |
| 13-15              | 1 (1.1) |
| Total              | 88 (100) |

The articulotrochanteric distance (ATD) was measured as the vertical distance between the tangent to the highest point of the hip joint to the tip of greater trochanter. It indicates the overgrowth of the greater trochanter in relation to the femoral head.
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or late fragmentation stage with extrusion <20%. Most of the children were treated elsewhere conservatively with traction or rest. Seventy children had good range of motion at presentation and rest had mild stiffness.

The height of the lateral pillar of the femoral head at presentation was significantly associated with the outcome (Chi-square value = 0.04). Of the 88 children who underwent VDRO, 59 (67%) of them belonged to Herring’s Group B and 29 (33%) to Herring’s Group C [Table 4]. Of the 59 children belonging to the Herring’s Group B who underwent VDRO, 49 had good [Figures 2-4], 9 had fair [Figure 5], and one had poor outcome [Figure 6] according to the Catterall’s postoperative classification [Table 5]. Of the 29 children belonging to Herring’s Group C, 17 had good, 10 had fair, and 2 had poor outcome [Tables 6-8]. Three patients who had poor results and 19 children with fair results had restriction of abduction and internal rotation, limping, Trendelenburg gait, and LLD of 1–2 cm. In 66 children with good results, shortening of <1 cm was noted initially. At 6-year followup in those 66 children who had good results, LLD disappeared and Trendelenburg gait was absent, of which 49 children belong to Herring’s Group B and 17 children belong to Herring’s Group C. Remaining 22 children who had fair and poor outcome had persistent LLD and limping. Hence, VDRO improves the outcome in most of the patients in Herring’s Group B, and many children in Herring’s Group C. The procedure improved the sphericity of the head by attaining containment in 66 children (75%) having a good outcome and 19 children (21.6%) with fair outcome. This is particularly true in children belonging to the Herring’s Group B. It is a good procedure to attain containment in patients in the stage of fragmentation. It improves the epiphyseal quotient in Herring’s Group B and some of the patients in Herring’s Group C.

Age of the patient at the time of presentation was also found to have a significant association on the functional outcome of the disease (Chi-square value < 0.001). In children <9 years of age, majority of them (57) had good outcome and eight of them had fair outcome. Over the age of 9 years, majority of the patients had fair outcome and 3 (3.1%)

| Table 4: Distribution of the sample according to the Herring’s group |
|-----------------|-------|--------|--------|
| Herring’s group | n (%) | B (59) | C (29) |
| B               | 59 (67) |
| C               | 29 (33) |
| Total           | 88 (100) |

| Table 5: Relationship between Herring’s group and clinical outcome using Catterall’s postoperative classification (Chi-square test) |
|---------------------------------------------------------------|
| Herring’s group | Clinical outcome | Good | Fair | Poor | P |
|-----------------|------------------|------|------|------|---|
| B               |                  | 49 (83.1) | 9 (15.3) | 1 (1.7) | 0.04* |
| C               |                  | 17 (58.6) | 10 (34.5) | 2 (6.9)  | |
| Total           |                  | 66 (75.0) | 19 (21.6) | 3 (3.4)  |   |

*P<0.05 - significant
children had poor outcome [Tables 9-12 and Figure 7]. The sphericity of the head was significantly improved ($P < 0.001$) by attaining containment in children under 9 years of age with majority of the patients having a good to fair outcome. VDRO improves the epiphyseal quotient in most children under 9 years of age and some of the patients in children over 9 years of age. It is a good procedure to attain containment in children <9 years of age.

The gender of patient was not significantly associated with clinical outcome [Tables 13-16], so the gender of the patient did not alter the various measures of outcome after VDRO.

From these observations, it is clear that VDRO improves the clinical and radiological outcome in patients who underwent surgery during the fragmentation stage of the disease. The outcome is definitely more favorable in patients belonging to Herring’s Group B and when the surgery is done early in the course of disease and age <9 years. This study also shows that Herring’s classification is a good prognostic indicator to predict the outcome after VDRO.

In 66 children with excellent to good results, mean ATD was -12 mm [Figure 8]. Trendelenburg gait was absent in these patients. In 19 patients with fair to poor outcome, mean ATD was +6 mm indicating trochanteric overgrowth due to severe collapse of femoral head and coxa breva and in few children possibly due to failed apophysiodesis.

Two of the 88 patients had postoperative wound infection, one of them had superficial infection, which was managed with parenteral antibiotics and the other had deep infection and was treated by early implant removal. He developed secondary osteoarthritis (OA) and was later managed by total hip arthroplasty (THA). Of the 88 patients, 19 had hypertrophic scar, but most patients or parents were concerned about this. All were advised dermatology and plastic surgery consultations, but no active intervention was done. Average postoperative shortening was about 0.96 mm. However, most children tolerated shortening. Of the 30 patients, 21 had persistence of limping. This was a matter of concern for 18 children in the beginning but limping improved with time. Three of them had painful limp due to secondary OA and was managed with THA after skeletal maturity. None of the patients had nonunion of the osteotomy site nor did any of these go in for implant failure.
Results in 2 patients. They reported femoral osteotomy to be effective in both Herring’s Groups B and C, but better when done before the age of 10 years. In our study, we got similar results out of 88 children 65 were younger than 9 years of which 57 had good outcome and 8 of them had fair outcome.

Similar results have also been reported by Heikkinen and Puraen, and Hoikka et al. They studied 53 hips with early disease and 14 hips with late disease and obtained 74% good, 17% fair, and 9% poor results in patients treated with varus osteotomy.

Beer et al. published their study on the long term effect of proximal femoral VDRO in Perthes disease. Based on their study on 43 hips (Stulberg classification was used to measure the outcome), they concluded that VDRO gives good results.
Than et al., (2003), published their 26-year followup based on their study on 31 hips treated by VDRO. They obtained 87% patients with either good or fair results.\textsuperscript{11}

In our study, we observed 66 of 88 patients had good outcome, 19 patients had fair results, and only 3 of them had poor results, i.e., about 3.4% of the patients. This better outcome compared to other studies may be because of our patient selection criteria. We included only patients in the stage of fragmentation and excluded patients whose hips were not containable.

According to literature, there is no significant difference in the outcome of patients treated either by VDRO or by Salter’s osteotomy.\textsuperscript{12,20,22} VDRO is a simple and easily
reproducible surgery which can be done with equipment available in an ordinary orthopedic theater and can easily be done. On the contrary, Salter’s osteotomy is a technically demanding procedure with a potential risk of damage to the nearby neurovascular structures in the greater sciatic notch, thereby limiting the wide application of this procedure.

Somerville and many other investigators have shown that well-contained heads improve radiologically until skeletal maturity. Hence, it may turn out that VDRO still be effective in many patients belonging to Herring’s Group C. In our study out of the 29 children belonging to Herring’s Group C, more than half (17 children) had good, 10 of them had fair, and 2 had poor outcome.

The most common complication seen in our study was hypertrophic scar, but this was not a concern for most of the patients. Other complications observed were infection, shortening, persistence of limping. The major complication that has been reported in literature is shortening. Early removal of implant (1–1½ years post surgery) will leave sufficient time to remodel, especially in a young male child. Limping can be reduced to a great extent by trochanteric apophysiodesis achieved using the proximal most screw fixing the apophysis (preventing the trochanteric overgrowth leading on to functional coxa vara). None of the patients had nonunion of the osteotomy site or any of these went in for implant failure.

In our institution, results of VDRO are favorably encouraging, as it is a simple and very effective method for containment in patients in the stage of fragmentation aged <9 years. Once osteotomy is united the child can be left alone for the hip to remodel on its own during growth.

**Conclusion**

VDRO is an effective containment method of femoral head for patients belonging to the Herring’s Group B. VDRO is also effective in many patients belonging to Herring’s Group C. It improves the epiphyseal quotient in Herring’s Group B and some of the patients in Herring’s Group C. It is a good procedure to attain containment in children <9 years of age. Gender of the patient does not alter the outcome after VDRO. Trochanteric apophysiodesis reduces risk of limping.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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