



## Hip preservation surgery for adolescents and young adults with Post-Perthes Sequelae

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**Background :** Impingement ensures a narrow arc of pathologic loading in adolescent hips with sequelae of Perthes Disease. Proper surgical interference when the hip is still in the pre-arthritis stage restores function and protects the young hip from early degenerative changes.

**Methods :** Osteochondroplasty at the femoral head-neck junction and relative lengthening of the femoral neck by distal transfer of the greater trochanter was performed for 12 adolescents with combined intra-articular/extra-articular impingement due to sequelae of Perthes disease in terms of coxa magna, coxa plana, coxa brevis, with an overriding greater trochanter. The safe surgical hip dislocation approach was performed in all cases. Patients were followed for an average of 24 months.

**Results :** The Harris hip scores improved from an average of 58 preoperatively (range 50 to 69) to 94 postoperatively (range 91 to 97) at latest follow up. The range of hip flexion improved from a preoperative value of 84.2° (range, 60 to 105°) to value of 120.8° (range, 95 to 130°). Changes in hip flexion averaged 28.6° (range, 15 to 45°). Mean internal rotation increased to 26° ± 12°, and abduction to 38° ± 11°. Alpha angle improved to 40° ± 8°. The mean of center-trochanteric distance improved from an average of -18 mm to -1 mm. No osteonecrosis or chondrolysis was noted up to the time of the latest follow up.

**Conclusion :** Elimination of narrow arc of pathologic loading due to impingement is the main advantage of the proposed surgical technique. Other advantages include increased abductor lever arm and restoration

of hip joint range of motion with normalization of the loading conditions, and hence future development of degenerative arthritis and the anticipated need for a future joint replacement surgery could be prevented or delayed. Femoral head vascularity is well maintained with the proven safety of the presented surgical approach.

**Keywords :** Perthes disease ; osteochondroplasty ; hip impingement ; surgical hip dislocation ; relative neck lengthening ; trochanteric advancement ; post-Perthes sequelae.

### INTRODUCTION

In Perthes disease, the resultant femoral head deformity may lead to abnormal mechanical function of the hip. The morphology of the proximal femur after healed Perthes disease is the single most important factor predicting the long-term outcome (9, 14, 20).

Typically, the deformities include a high-riding greater trochanter, a short femoral neck, and an

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aspherical femoral head-neck junction. Complex deformities of the proximal femur can cause both intra-articular and extra-articular femoro-acetabular impingement, which can lead to degenerative hip pain, restricted range of motion, and impaired abductor function (1,3,13,18).

The resulting deformities include: coxa vara (decreased angle of the femoral shaft to center of the femoral head resulting in a shortened leg), coxa plana or magna (enlarged, flattened, mushroom shaped head), and a relative overgrowth of the greater trochanter. The prominent trochanter paired with a shortened femoral neck and mushroom shaped femoral head can lead to femoro-acetabular impingement with a consequent chondrolabral damage (10,23).

The proximal femoral morphological abnormalities characteristic of Perthes disease as a group contribute to and are a well-known cause of femoro-acetabular impingement (FAI) (7). The mushroom shaped head with decreased head/neck offset leads to abutment within the acetabulum or upon the acetabular rim that frequently leads to intra-articular damage (19,24).

The coxa brevis (short, thickened femoral neck) not only contributes to FAI but also plays a role in a reduction of the abductor lever arm. This leads to a deficiency of abductor strength, contributing to the limp and exercise induced fatigue and lateral pain associated with Perthes disease.

More recently, it has shown that high greater trochanter to femoral head center relationship (center trochanteric distance) caused by either trochanteric overgrowth or a varus femoral neck is associated with progression of osteoarthritis (4).

Impingement ensures a narrow arc of pathologic loading in adolescent hips with sequelae of Perthes Disease. Proper surgical interference when the hip is still in the pre-arthritis stage restores function and protects the young hip from early degenerative changes. Accurate estimation of the biomechanical error combined with careful understanding of the hip joint biology is the cornerstone for success of hip preservation surgery performed to save the young hip from post Perthes sequelae.

The safe surgical hip dislocation approach was initially described by Ganz et al. (6), after studies

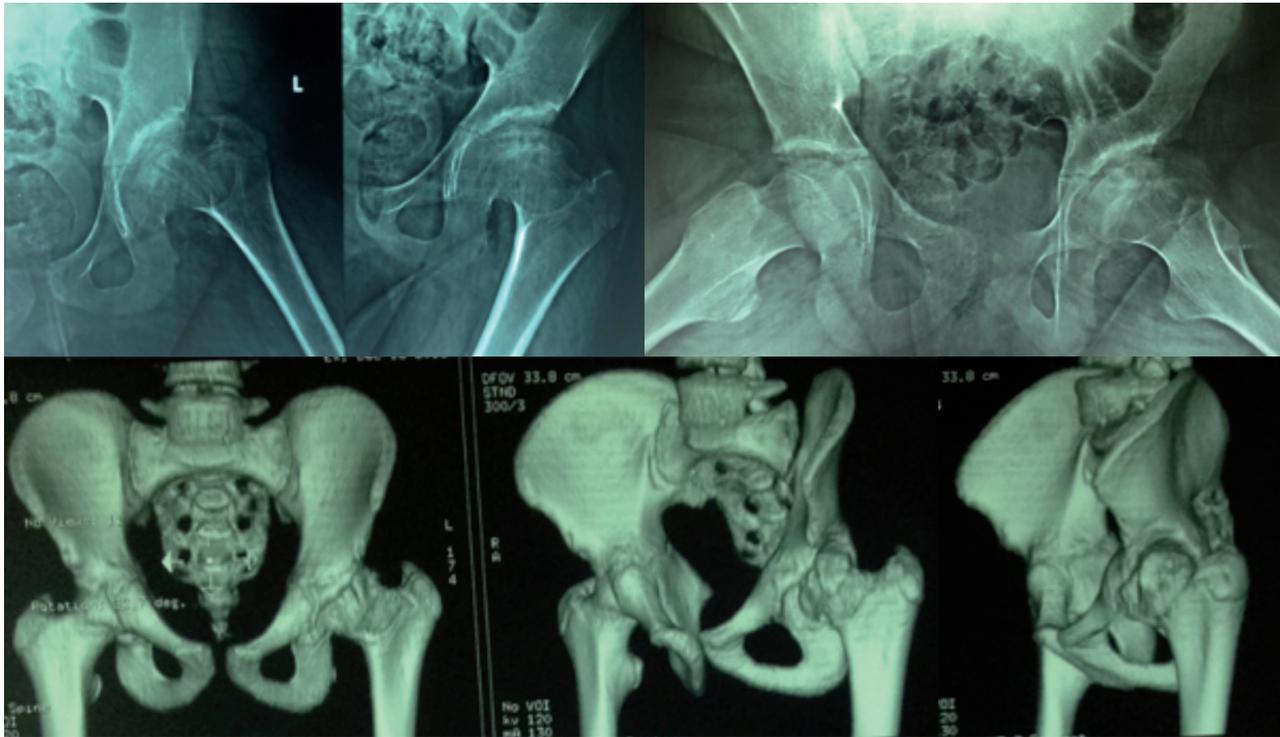
on the blood supply to the femoral head (8). This approach allows complete access to the femoral head and acetabulum with minimal risk of avascular necrosis of the femoral head (6). In the management of post-Perthes sequelae, the approach allows complete dynamic evaluation of hip motion to determine the areas of impingement (anterior, lateral, antero-lateral or global), and hence it facilitates the correction of the cam deformity by means of a head-neck osteochondroplasty. Relative femoral neck lengthening or trochanteric advancement to correct extra-articular impingement due to a high-riding greater trochanter and a short wide neck can be performed. Finally, correction of all femoral deformities through a single surgical approach with a low risk of avascular necrosis to the femoral head is possible (3,18,23).

The main goal is to improve hip mechanics (eliminate femoro-acetabular impingement and improve abductor lever arm), relieve pain, improve hip motion, improve hip function for daily living, and enhance the quality of life and physical activity level. The Aim of the current study is to evaluate the clinical and radiographic outcome of the combined management of intraarticular and extra-articular impingement in adolescents or young adults with sequelae of Perthes disease by femoral head osteochondroplasty and relative neck lengthening via the safe surgical hip dislocation approach.

## PATIENTS AND METHODS

Osteochondroplasty at the femoral head-neck junction and relative lengthening of the femoral neck by distal transfer of the greater trochanter was performed for 12 adolescents (9 males, 3 females) with combined intra-articular/extra-articular impingement due to sequelae of Perthes disease in terms of; coxa magna, coxa plana, coxa brevia, with an overriding greater trochanter (Fig.1). The average age at the time of surgery was 15.9 years. The safe surgical hip dislocation approach was performed in all cases. Patients were followed for an average of 24 months.

Inclusion criteria are symptomatic adolescent or young adult patients (pain, limp) with sequelae of Perthes disease, and positive anterior impingement



**Fig. 1.** — Radiographic sequelae of Perthes disease demonstrating coxa brevia, coxa vara, coxa plana, coxa magna, over-riding trochanter, cam-type femoro-acetabular impingement, and extra-articular impingement by the high riding trochanter.

test. The typical presenting symptom is hip (groin, lateral) pain aggravated by hip flexion. Lateral pain and abductor fatigue is also common. Preserved joint space with no signs of premature osteoarthritis.

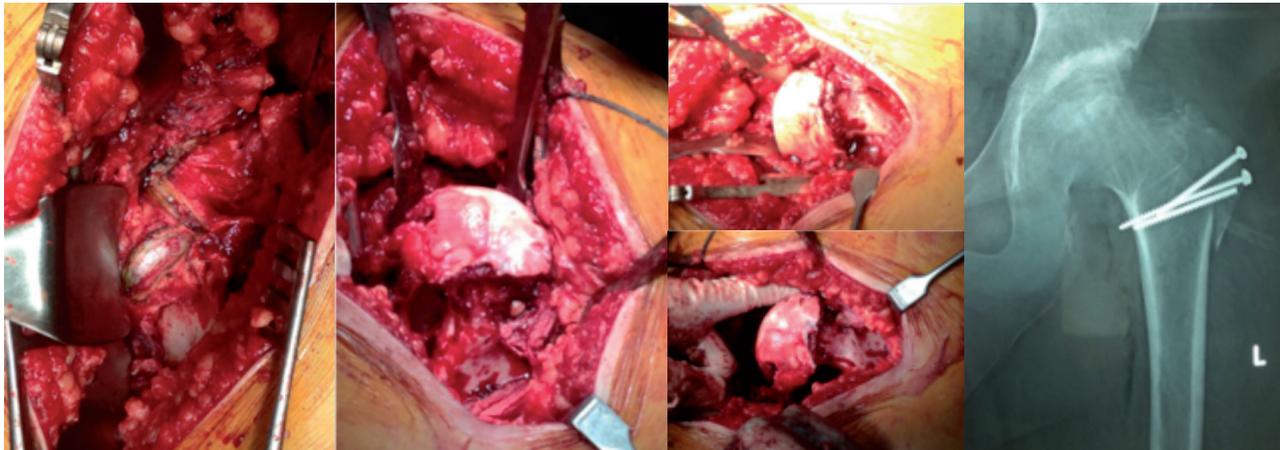
Harris hip scores, hip range of motion (flexion, internal rotation, abduction, external rotation), and impingement test results were recorded for all patients preoperatively and at the latest follow up. Radiographs demonstrated a shortened femoral neck (coxa brevis) in varus (coxa vara) as well as a flat, mushroom shaped head (coxa magna), and a relative overgrowth of the trochanter with a decreased or negative center-trochanteric distance (CTD) and increased alpha angle (AA). Mean AA for all patients were compared on preoperative and postoperative radiographs. Additionally, the CTD was measured pre and postoperatively which is recorded in millimeters, indicating if the tip of the trochanter is above or below the level of the center of the femoral head. Omeroglu et al. (15) described pathological CTD as a radiographic predictor of secondary osteoarthritis.

### Surgical Technique

The safe surgical dislocation approach was performed for all patients with a digastric trochanteric flip osteotomy and Z-shaped anterior capsulotomy as described by Ganz et al. (6)

At this point, hip range of motion is assessed including flexion as well as internal and external rotation which helps to identify areas of impingement. The ligamentum teres was not necessarily transected in some cases to fully dislocate the femoral head, as an access to the cam lesion was possible with a degree of femoral head subluxation good enough to carry out the osteochondroplasty procedure (Fig. 2).

Special attention was given to identifying femoral head-neck morphology including offset, as well as severity and location of damage to the femoral and acetabular articular cartilage and the acetabular labrum. The cam at the femoral head-neck junction was resected with the use of curved osteotomes, then a high-speed burr was used to finely contour and improve the head-neck offset (Fig. 3). The fem-



**Fig. 2.** — The Z-shaped capsulotomy and osteochondroplasty at the head neck junction with cam resection, restoration of femoral head sphericity, and proper head-neck offset.

oral head was returned to the acetabulum and correction of impingement was confirmed.

The high-speed burr was also used to create a smooth bleeding bony bed along the lateral surface of the proximal femoral trochanteric osteotomy site for stable positioning of the distalized greater trochanter. Using a Spanish clamp with the hip abducted, the trochanteric fragment was advanced distally and inspected for position using fluoroscopy to ensure a satisfactory increase in the CTD (Fig. 4). Attention should be made to the thickness of the trochanteric fragment and the degree trochanteric prominence after distalization.

After fluoroscopic confirmation of satisfactory distalization, two 4.5 mm fully threaded, large-fragment cortical lag screws were placed with washers. After distalization of the trochanteric fragment, any remaining spike or bulge of the stable trochanter at the superior base of the femoral neck was contoured to finely adjust the newly formed anterior and superior femoral neck-trochanter transition. This is done with caution to protect the blood supply. The Z-shaped capsular incision was meticulously repaired without tension using interrupted absorbable sutures prior to trochanteric fixation. Finally, closure of the fascia, subcutaneous, and skin layers was performed.

Postoperatively, continuous passive motion was initiated and flexion increased gradually during the

first week to prevent adhesions and promote articular cartilage nutrition. Partial weight bearing (toe-touch) ambulation on crutches was allowed during the second postoperative week. Stationary bike exercises started during the third week to gradually increase the range of hip flexion and promote the recovery of muscle power.

## RESULTS

The Harris hip scores improved from an average of 58 preoperatively (range 50 to 69) to 94 postoperatively (range 91 to 97) at latest follow up.

The range of hip flexion improved from a preoperative value of 84.2° (range, 60 to 105°) to value of 120.8° (range, 95 to 130°). Changes in hip flexion averaged 28.6° (range, 15 to 45°).

Mean internal rotation increased to 26° ± 12°, external rotation to 32° ± 13°, and abduction to 38° ± 11°. The proportion of positive anterior impingement tests decreased from 91.6 % preoperatively to 16.4%.

Alpha angle (AA) improved to 40° ± 8°. The Center-Trochanteric Distance (CTD) was recorded in millimeters pre and postoperatively, indicating if the tip of the trochanter is above or below the level of the center of the femoral head. The mean of center-trochanteric distance improved from an average of -18 mm to -1 mm (Fig. 5).

Continuous passive motion started an average of 2.7 days (range, 1.6 to 4 days) after surgery, and toe touch ambulation on crutches started an average of 8.3 days (range, 5 to 10 days) after surgery.

There was no increase in hip pain or stiffness after surgery. There was no postoperative infection. No osteonecrosis or chondrolysis was noted up to the time of the latest follow up.

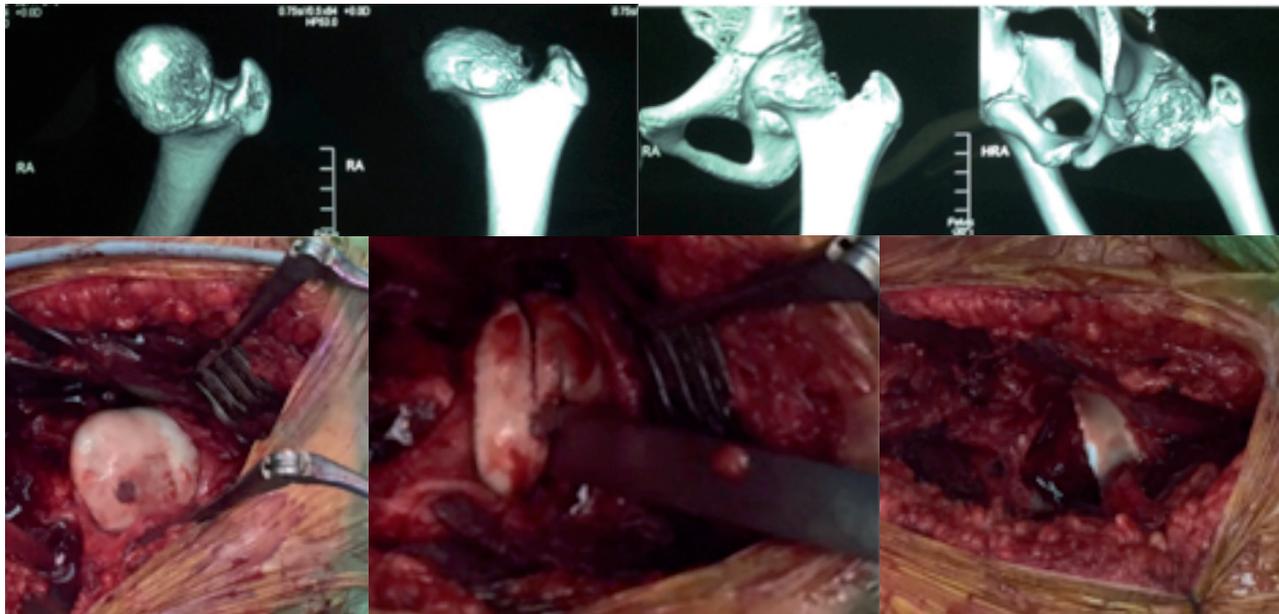
### DISCUSSION

Extra-articular procedures are commonly performed to treat most pediatric hip disorders, such as, proximal femoral osteotomy, pelvic osteotomy, or soft tissue release. However, sometimes a direct approach to the femoral head or acetabulum is indicated in serious conditions or residual stages in which further remodeling cannot be expected. The surgical hip dislocation approach proposed by Ganz et al. (14) is very useful in such cases. This approach allows for a direct access to the intra-articular lesion as well as the underlying pathology and enables preservation of the femoral head blood supply. Ganz et al. (6) reported their experience using this approach in 213 hips over the course of seven years.

In the management of post-Perthes sequelae, the safe surgical hip dislocation approach offered several advantages. As the abductor is detached by trochanter flip osteotomy, rigid fixation of this flip fragment by two 4.5 mm screws with washers restores immediate stability and allows for early mobilization of the patient. Moreover, by replacing this fragment to a point distal than the osteotomy site, a trochanteric transfer effect can be achieved. The approach also enables more accurate contouring of the femoral head-neck junction and dynamic observation of the intra-articular impingement (5,16,17).

Despite the extensive dissection around the hip joint, and the partial or complete dislocation of the femoral head, the postoperative rehabilitation was quite fast for the dimension of surgery. The postoperative protocol was to early mobilize the hip joint on a continuous passive motion device and to encourage partial weight-bearing and stationary bike rides. The main goal was to prevent adhesions, ensure articular cartilage nutrition, increase the hip range of motion, and promote recovery of muscle power with an overall improved functional result.

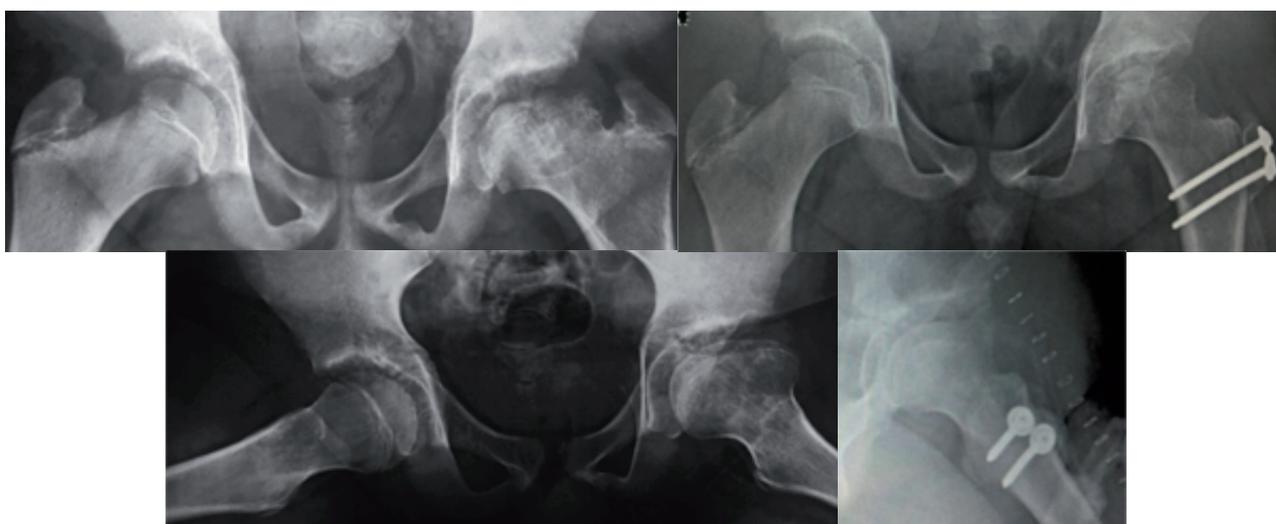
Krueger et al. (11) reported that persistent pain in patients with surgical dislocation of the hip with



**Fig. 3.** — Cam resection is started with curved osteotomes then completed with a high speed burr to finely contour the head-neck junction and restore the proper head-neck offset.



**Fig. 4.** — Relative/functional femoral neck lengthening achieved by distal advancement of the digastric trochanteric flip osteotomy that was created as part of the initial surgical exposure.



**Fig. 5.** — Improved radiographic parameters, namely the Center Trochanteric Distance (CTD) and Alpha Angle (AA).

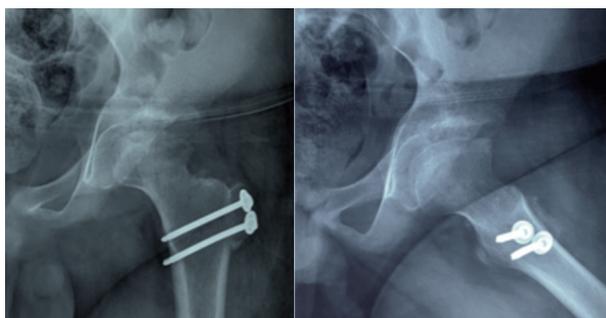
no evidence of cartilaginous or osseous alterations. The pain was ascribed to the formation of intra-articular adhesions.

Tannast et al. (22) used a CT-based virtual dynamic motion analysis to simulate the individual motion for 13 hips with sequelae Perthes disease, 22 hips with FAI, and 27 normal hips. They determined the motion and impingement pattern of each hip for the anterior (flexion, adduction, internal rotation) and the posterior impingement tests (extension, adduction, external rotation). Combined Intra- and extra-articular impingement was found to be more frequent in Perthes disease (79% and 86%, respectively) compared with normal (15%, 15%) and FAI hips (36%, 14%). Hips with Perthes disease had decreased amplitude for all hip motions (flexion, ex-

tension, abduction, adduction, internal and external rotation) compared with FAI or normal hips. They concluded that hips with Perthes disease show a decreased ROM as a result of a higher prevalence of intra- and extra-articular FAI.

In the current series, relative femoral neck lengthening with osteochondroplasty at the head-neck junction in post-Perthes hips with complex proximal femoral deformities resulted in reduced pain, improved function, and greater abductor strength. The author believes that the improvement in hip function may be related to the elimination of impingement with a resultant increase in hip range of motion and the mechanical advantage provided by the new abductor lever arm. In addition, the reduction of pain is the result of simultaneous correction

of intra- and extra-articular impingement. Most importantly, there were no long-term complications and no incidence of avascular necrosis of the femoral head (Fig. 6). Development of premature hip osteoarthritis was not noted in any hips in this series till the time of latest follow up.



**Fig. 6.** — Management of Combined Intra-articular/Extra-articular Impingement in Adolescents with Sequelae of Perthes Disease by femoral head Osteochondroplasty and Relative Neck Lengthening (Radiographic Outcome).

The coupling of relative neck lengthening, osteochondroplasty, with surgical dislocation is capable of addressing most of the pathology associated with Perthes disease, especially in hips with only a mild acetabular deficiency. Trochanteric advancement improves the abductor lever arm leading to more normal abductor muscle function. This is proved by the absence of limp in the majority of patients post-operatively. The extra-articular lateral impingement secondary to the reduced CTD is also improved. The safe surgical hip dislocation also permits complete treatment of acetabular chondrolabral pathology resulting from FAI, and grafting of any concomitant osteochondritis desiccans of the femoral head by osteochondral grafts from the osteochondroplasty performed at the head-neck junction. (3,12)

Limitations of the current study included the relatively small number of patients and with a short term clinical and radiographic follow up. However, many patients with sequelae of Perthes disease develop significant symptoms and physical limitations during early adulthood, adolescence, or even late childhood. Moreover, surgical options are limited for this young group of patients with joint preservation being preferable whenever possible to halt

or delay the progression to secondary osteoarthritis and the anticipated need for total joint arthroplasty

The surgical technique does not address the correction of leg length discrepancy. However, compared to other options such as the proximal femoral valgus producing osteotomy, the recovery is shorter and less morbid with less potential for complications while improvement in abductor function helps with the associated limp. Another limitation is that acetabular dysplasia is not addressed. However, many patients with Perthes have both morphology and symptoms that can be improved by isolated treatment of the femoral side of the hip. Developmentally, the acetabulum forms by guidance from the femoral head and even in the dysmorphic hips associated with Perthes disease the majority of acetabula are not grossly dysplastic. (3,12)

The author believes with current literature (1,2,21), that relative neck lengthening with simultaneous correction of intra- and extra-articular impingement in post-Perthes patients with a complex deformity of the proximal femur offered the benefits of (1) improved hip pain and function; (2) improved radiographic parameters of the proximal femur; (3) minimal or no significant complications requiring subsequent surgeries; and (4) progression of OA or conversion to hip replacement could be potentially prevented or at least delayed.

In Conclusion, elimination of the narrow arc of pathologic loading due to impingement is the main advantage of the proposed surgical technique. Other advantages include increased abductor lever arm and restoration of hip joint range of motion with normalization of the loading conditions, and hence future development of degenerative arthritis and the anticipated need for a future joint replacement surgery could be prevented or delayed. Femoral head vascularity is well maintained with the proven safety of the presented surgical approach.

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