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Treatment of hip subluxation in early Perthes disease by percutaneous drilling and soft tissue release

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Abstract

LCPD exhibits a proximal femoral epiphysis avascular necrosis in child's skeleton without clear or specific cause. This work was aimed at evaluating the outcomes following femoral head transphyseal drilling and soft tissue release in early stages of Perthes disease in age group 4 to 8 years old, and its effect on enhancement of the time and the progress of healing. This case study was included 20 hips in 18 patients aged from 4 to 8 years old, both sexes, diagnosed with Perthes disease, decreased range of motion (ROM) on affected hip, sublaxed head femur on affected hip and ischemic and fragmentation stages according to Waldenstrom staging. A significant relation was documented between Stulberg Classification as well as the performance of additional procedures, where those having Stulberg stage I as well as II didn't need any additional procedure while others with Stulberg III, IV and V had a revision of the drilling with adductor tenotomy. A significant relation was documented between pain as well as Stulberg classification ($P<0.05$). 7 hips were done in the ischaemic phase 3 ended with Stulberg I, 3 ended with Stulberg II, while only one ended with Stulberg 3. Thirteen hips were done in the fragmentation phase; 5 ended with Stulberg I,3 ended with Stulberg II, 2 ended with Stulberg III, 2 ended with Stulberg IV, and only one ended with Stulberg V. Percutaneous drilling in Perthes disease and soft tissue release is a simple and easy procedure done in a limited time with no scar or blood loss. The disease early stages like per-Perthes, ischaemic and early fragmentation will give better results by this technique.

Keywords: Hip Subluxation, Perthes Disease, Percutaneous Drilling, Soft Tissue Release.

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1. Introduction

LCPD represents a condition characterized by proximal femoral epiphysis avascular necrosis in child's skeleton, while the exact cause remains unknown. Its description was given by Legg, Calvé, and Perthes independently during the early 1900s [1]. It often exhibits a self-limiting process evolving as time passes with various stages. All cases develop a healing phase via necrosed epiphysis remodelling as well as re-ossification, however, some cases does not develop a spherical, covered, as well as congruent hip [2]. Perthes disease arises as a result of compromised blood flow to femoral head. Biopsies indicate different healing phases, exhibiting the occurrence of several ischemic episodes. Nevertheless, the underlying reason for these events remains unclear. Hypofibrinolytic states has been theorized, but this has only been confirmed in a limited number of cases. Additionally, its correlation to Perthes disease occurrence remains uncertain [3]. Perthes disease follows a natural progression that may be categorized into two distinct phases: evolution as well as healing. During the evolution phase, the first stage is characterized by sclerosis, where the femoral head epiphysis appears small as well as radio dense, while the epiphyseal plate exhibits irregularity, with blurred metaphysis. During this period, it is common to observe a subchondral fracture line, particularly within anterior region. Additionally, an increase in the medial joint space width often occurs due to relative cartilage overgrowth as well as synovitis. Then, the process turns to the second fragmentation phase, characterized by bony epiphysis disintegration. Such condition arises due to cysts development resulting from dead epiphyseal bone resorption [4].

The disease second phase involves epi-physis healing, exhibiting a gradual restoration of the fragmented femoral head resulting in a uniform epiphysis. Additionally, femoral head undergoes an ongoing ossification as well as growth. The bone quality is restored to its normal state, however femoral head, neck, as well as acetabulum could exhibit substantial deformations [5]. The Perthes disease optimal outcome represents a congruent, pain-free hip allowing a complete range of motion. The conventional management involved supervised neglect along with

prolonged bed-resting periods, traction, physiotherapy for maintaining mobility. Additionally, utilizing analgesia for muscular spasms relief along with movement maintenance, all of which contribute to a more favourable prognosis [6]. The active treatment's main objective is to ensure that the femoral head remains inside the acetabulum, thus facilitating femoral head remodelling to match the acetabulum shape [7]. Lopes et al used a technique for the management of LCPD, performing transphyseal neck head drilling (TNHD). Their protocol to treat LCPD among children whose ages are above five years, involves performing a TNHD during the necrotic stage as well as utilizing an abduction flexion brace for hip protection [8]. This work was aimed at evaluating the transphyseal drilling outcomes for the femoral head and soft tissue release in early stages of Perthes disease in age group 4 to 8 years old, and its effect on enhancement of the time and the progress of healing.

2. Patients and Methods

Our case study involved 20 hips (16 unilateral and 2 bilateral) in 18 patients aged from 4 to 8 years old, both sexes, diagnosed with Perthes disease, decreased range of motion (ROM) on affected hip, sublaxed head femur on affected hip and ischemic and fragmentation stages according to Waldenstrom staging. The study was done in the period between 2019 and 2021 after approval from the Ethical Committee Cairo University and El-Helal hospital, Cairo, Egypt. All patients' relatives were asked to fill an informed consent. Exclusion criteria were age above 8 years, avascular necrosis (AVN) after blood disease (e.g. Sickle cell anemia) and healed Perthes. All participants went through a comprehensive medical history, clinical assessment, laboratory testing [preoperative (CBC), (PT), (PTT) as well as (INR), preoperative haemoglobin (HB), protein C and protein S in selected cases (those with bilateral hip affection and radiographic diagnosis [The AP and frog lateral views among children should involve an x-ray of both hips so the pelvic position as well as horizontal situation could be assessed. Additionally, a few guidelines was facilitated a general assessment of a child's AP views: (head's shape, as well as size, head congruity, neck shaft angle, neck length and trochanteric over-growth]. All the patients received a single dose of prophylactic antibiotic first generation cephalosporin 50 mg/kg within one hour before surgery.

2.1 Operative Technique

All patients were operated under general anesthesia. On a radiolucent operating table, the patient's posture was supine. Examination of ROM of both hips under general anesthesia is done and decrease in muscle spasm is usually noted. Sterilization and draping are done. Under image intensifier and the use of 2 mm K-wires percutaneous pinning is done in 3 different sites with three different directions crossing the physeal plate targeting the affected part of the head. The first one is directed superiorly in the head through lateral subtrochantric entry, the second K-wire is directed centrally within neck as well as head, and the last K-wire is directed inferior to the central one, then percutaneous tenotomy of adductor longus muscle is done if needed. And or iliopsoas muscle release when a flexion deformity exists. Above knee abduction cast is then done (Broom-stick cast). After 6 weeks, cast is removed, an X- ray is done in the first follow-up visit Figure 1.

2.2 Postoperative Stage

In the recovery Room: Patients underwent observation, then pulse oxymeter was employed for recording pulse as well as oxygen saturation. Within the Ward: Patients received intravenous first-generation cephalosporin 50mg/kg/day in two divided doses for one day postoperatively, then oral antibiotic after discharge for 2 days. Post-operative radiographs (Pelvic AP projection exhibiting both hips as well as the affected hip's lateral view) were done. After discharge: All patients had clinical and radiographic evaluation at regular periods during their follow up (period ranged from 12 to 24 months).

2.3 Statistical analysis

Data went through a statistical analysis utilizing SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were displayed as mean as well as standard deviation (SD). Qualitative variables were displayed as frequency as well as percentage (%).

3. Results and Discussion

LCPD represents a condition affecting the hip among children, defined by femoral head epiphysis bone necrosis. Additionally, it is through to be caused by a lack of blood supply to the bone, leading to tissue death [9, 10]. Wiig et al conducted a research, comparing the effectiveness of three treatment modalities for LCP, involving physiotherapy, orthotics, as well as femoral osteotomy. The group utilizing the Scottish Rite orthosis exhibited the least successful outcomes for children whose ages were below as well as over six years[11]. Martinez et al. conducted a research on the Atlanta Scottish Rite orthosis that advised against weight-bearing braces usage while treating LCPD.[12]. Regarding their prospective research, Herring et al. examined the hips of 345 children whose ages fell betwen 6-12 years undergoing a treatment utilizing five different approaches. It exhibited no discernible variations among the three groups: those who received no therapy, those utilizing braces, as well as those who underwent (ROM) exercises[13]. Ishida et al. [14] addressed, the radiological outcomes, as assessed by Stulberg criteria, were superior for those treated before the age of seven. However, such age did not exhibit any impact on clinical outcomes. Wenger et al. [15] conducted a final follow-up on 40 individuals having triple pelvic osteotomy. They found that 42% of the patients achieved excellent outcomes (Stulberg I and II), 47% exhibited intermediate results (Stulberg III), and 11% exhibited bad results (Stulberg IV and V). The outcomes were superior in Herring B hips as opposed to Herring C hips; patients having treatment before the age of 8 exhibited more favorable results as opposed to older ones. Twenty-eight hospitals in Norway were mandated to report all newly diagnosed cases of Perthes disease. About 425 patients were reported then monitored for a duration of five years, during which cases were observed. The current investigation comprised 368 individuals having unilateral disease. The hips underwent radiological categorization utilizing a modified two-group Catterall classification as well as the lateral pillar classification.

Case 1: Male, 5 years old, side: left, presentation: Limping and pain in left hip. Figure 1

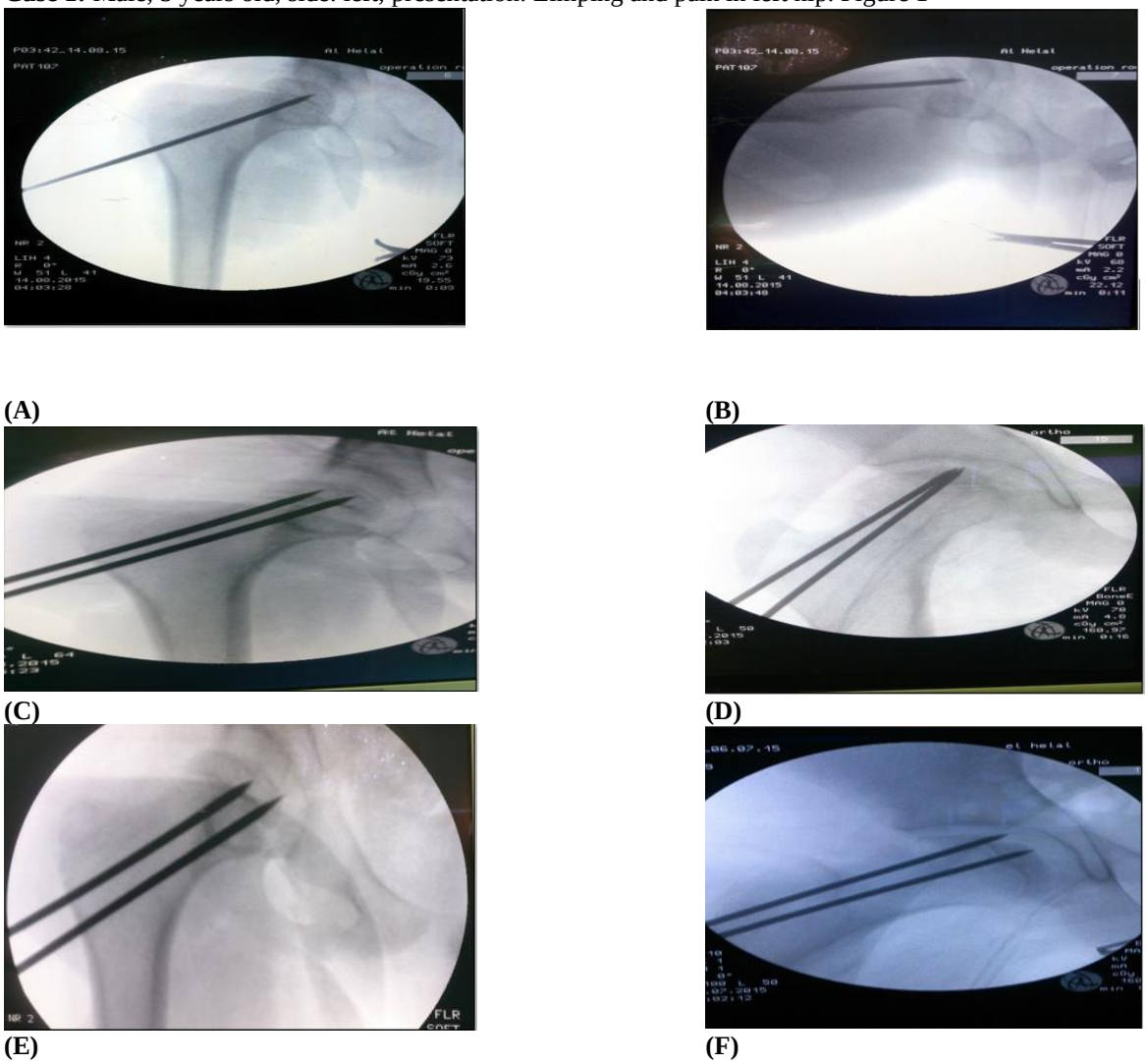


Figure 1: (A)First K-wire insertion under image intensifier AP view, (B) Insertion of the first K-wire under image intensifier in lateral view, (C) Insertion of the second K-wire in the AP view, (D) Insertion of the second K-wire in the lateral view, (E) Insertion of the Third K-wire in the AP view

Table 1: Distribution of age in patient group and follow up period

	N=18
Age at operation (Years)	5.450±1.317
Follow up by months	18.000±6.156

Data are presented as mean ± SD.

Table 2: Radiological results according to Stulberg Classification and percentage of hips with drilling only to those who had an additional procedure

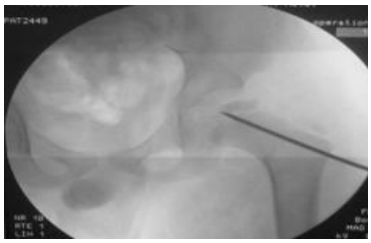
	N=20
I	8(40.0%)
II	6(30.0%)
III	3(15.0%)
IV	2(10.0%)
V	1 (5.0%)
Additional procedure	
No	14(70.0%)
Revision drilling	1(5.0%)
Iliopsoas tenotomy	1(5.0%)
Revision and adductor Tenotomy	3(15.0%)
Salter osteotomy	1(5.0%)

Data are presented as frequency (%), ROM: Range of motion.

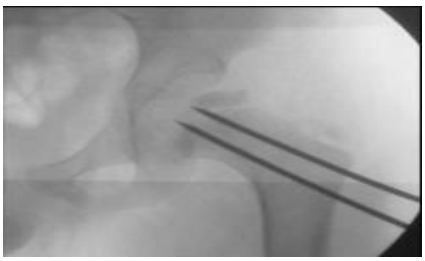
Pre-operative X- rays

(A)

Intra-operative



(B)



(C)

(D)

(E)

(F)

Follow up X-rays

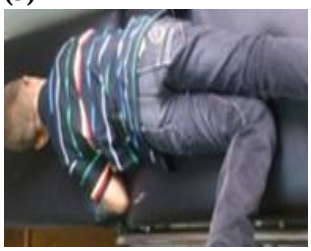
(H)

(I)

(J)

(J)

(K)



(L)

(M)

(N)

(O)

Figure 2: (A) Fragmentation stage, (B) First K-wire in AP view, (C) Second K- wire in AP view, (D) Lateral view, (E) Percutaneous abductor tenotomy, (F) Postoperative abduction brace, (H) 6 month follow up , (I) 1-year-follow-up, (J,K,L)Range of motion of case 1

Table 3: Correlation between Stulberg classification and the patients who had additional procedures, between pain and Stulberg classification

Additional procedure	N=20					P
	Stulberg classification (post-op)					
	I	II	III	IV	V	
No	8(100.0%)	3(50.0%)	3(100.0%)	0(0.0%)	0(0.0%)	**0.033***
Revision	0(0.0%)	1(16.67%)	0(0.0%)	0(0.0%)	0(0.0%)	
iliopsoas tenotomy	0(0.0%)	1(16.67%)	0(0.0%)	0(0.0%)	0(0.0%)	
Revision and adductor Tenotomy	0(0.0%)	0(0.0%)	0(0.0%)	2(100.0%)	1(100.0%)	
Salter osteotomy	0(0.0%)	1(16.67%)	0(0.0%)	0(0.0%)	0(0.0%)	
Pain	Stulberg classification (post-op)					
Free	8(100.0%)	6(100.0%)	2(66.67%)	0(0.0%)	0(0.0%)	**0.003***
Pain	0(0.0%)	0(0.0%)	1(33.33%)	2(100.0%)	1(100.0%)	

Data are presented as frequency (%), *significant p value <0.05.

Table 4: Relation between Waldenstrom stage pre-op and Herring lateral pillar classification pre-op and Stulberg classification post-operative

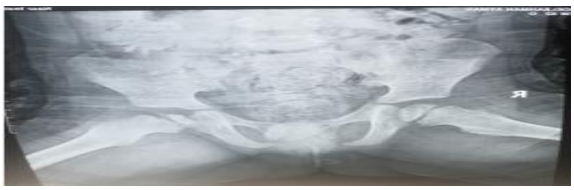
Stulberg classification post-op)	Waldenstrom Stage (pre-op)		
	Ischemic	Fragmentation	
	N=20		P-value
I	3(42.86%)	5(38.46%)	0.693
II	3(42.86%)	3(23.0%)	
III	1(14.29%)	2(15.38%)	
IV	0(0.0%)	2(15.38%)	
V	0(0.0%)	1(7.69%)	

Data are presented as frequency (%), *significant p value <0.05.

Case 2: Male, 4 years old, side: left, presentation: Pain and limping in left hip since two months, Waldensrtom stage: fragmentation. **Figure 2**

Pre-operative X- rays

(A)



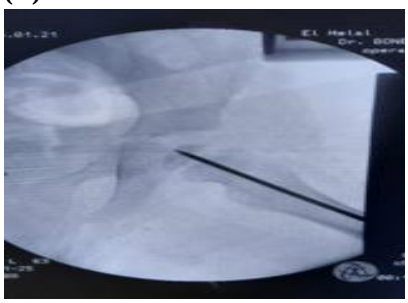
(B)

Intra operative

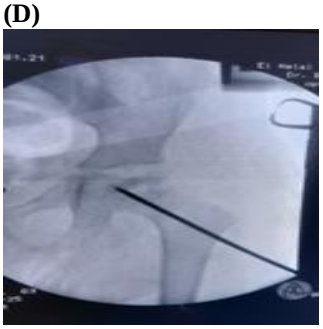
(C)

(D)

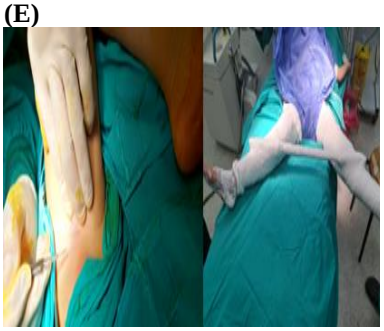
(E)



(F)

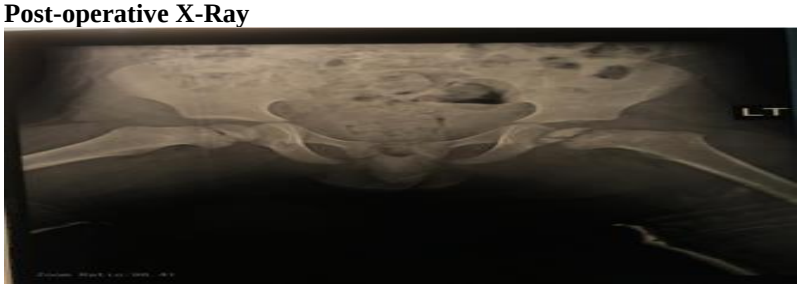


(G)



(H)

Post-operative X-Ray



(I)

Follow up

(J)

(K)

(L)

(M)

(N)

Figure 3: (A, B) Pre-operative X- rays, (C,D,E,F,G,H) Intra operative, (I) Post-operative X-Ray, (J, K) Follow up X-ray, (L,M,N)Range of motion of case 2

Out of the total patients, 358 (97%) participated in the five-year follow-up. During this follow-up, a modified three-group Stulberg classification was utilized as a radiological outcome measure. Among the 152 patients diagnosed with > 50% femoral head necrosis as well as aged six years or older, surgeons at various institutions selected one of three treatment approaches: physiotherapy (55 patients), the Scottish Rite abduction orthosis [16], as well as proximal femoral varus osteotomy. Out of total hips, 146 (96%) were accessible during a five-year follow-up period [11]. The most significant factor while predicting the outcome was the extent of femoral head involvement, with an (OR) of 7.76 as well as a 95% (CI) ranging from 2.82 to 21.37. Age at diagnosis also exhibited a role, with (OR) of 0.98 and a 95% (CI) ranging from 0.92 to 0.99. Additionally, the lateral pillar classification exhibited an impact, with (OR) of 0.62 as well as a 95% (CI) ranging from 0.40 to 0.98. Among children exhibitng more than 50% femoral head necrosis whose ages were older than six, proximal femoral varus osteotomy exhibited substantially superior results as opposed to orthosis ($p = 0.001$) or physiotherapy ($p = 0.001$). No statistically significant variations were documented between the physiotherapy as well as orthosis groups ($p = 0.36$). Additionally, no variation was detected regarding outcomes following any of these therapies among children younger than six ($p = 0.73$). The mean follow-up period exhibited 50.9±15.3months. Before the surgical procedure, two hips exhibited perfect confinement, while 14 hips showed subluxation. Out of the total of 16 hips, 11 hips showed perfect containment while the remaining 5 hips exhibited subluxation at the final examination.

Preoperatively six individuals exhibited a normal gait, while ten individuals exhibited a limp. While performing final examination, twelve indfviduals exhibited a normal gait, while four still had a limp. Preopertatively, ten individuals exhibited an average length discrepancy of 1.2 cm, while following final examination, six individuals exhibited an average length discrepancy of 0.7 cm. Based on Herring's lateral column classification, preooperatively, there were 4 (25%) hips classified as type B, 8 (50%) hips classified as type B/C, as well as 4 (25%) hips classified as type C [17]. The study's result addressed, apnea-hypopnea index (AHI) among patients reduced from group A to group C. Additionally, the femur head containment was smallest when the degree of the epiphysis collapse was greater. Within group B, six individuals exhibited AHI of 0.7, and in group C five patients had AHI index0. 6. Regarding the prospective multicentre Herring et al. [13] study the lateral pillar classification as well as the disease age of onset strongly linked to the LCPD therapy's results. Those within groups B as well as C exhibited a more favorable outcome with operative theraoy as well as the age of eight years. Regarding this research, based on the disease age of onset, more than 50% of individuals were involved within the group six to eight years, correlating with Herring's result.

In our study: 20 hips were treated by percutaneous drilling using K-wires and percutaneous adductor tenotomy kept in abduction cast for 4 weeks postoperative. 7 were within Ischaemic Stage as well as 13 were within fragmentation stage. Follow-up duration fell between 12 and 24 months with a mean 18.0. In this study we used the Waldenstrom staging for the pre-operative assessment and Stulberg Classification for the post-operative assessment, although it is a classification of Perthes disease's end result, best addressed for determining the femoral head's shape at skeletal maturity but we use it as a predictive study of the femoral head's shape as well as size after drilling, yet we have to declare that its reliability should be completed by its assessment in a longer term follow up reaching skeletal maturity. 13 hips out of 20 were presented in the fragmentation stage so Herring lateral pillar classification can be applied on these patients. Three were classified as Herring A, whereas 9 were classified as Herring B and 1 was C. In the fragmentation group ,5 hips ended by Stulberg I, 3 ended by Stulberg II which is considered a good result in a period ranging from 9 months to 18 months although they presented in the fragmentation stage. 5 of them were >6 years. Eight hips ended by Stulberg I (40%), 6 hips ended by Stulberg II (20%), 3 hips ended by Stulberg III (15%), 2 hips ended by Stulberg IV and one hip ended by Stulberg V. 14 hips were free of pain with full ROM and normal gait, the other six hips were in 4 patients and underwent additional procedure to improve their clinical outcome. Bilateral cases had a repeated attack of pain with no improvement of gait, by careful family history we recognized that the family had positive history of blood disease, abortion and similar attacks of hip pain, by consultation of haematologist she recommended a complete blood picture, bleeding profile including protein C and S, and molecular biology study, that showed in these cases a deficiency in protein C and S and also a hypercoagulable state though she adjusted a dose of anticoagulant for these children for life [18]. Percutaneous drilling in LCPD does not alters the pathology of the disease but it shortens its time till reaching the complete healing of the femoral head, it decreases the pain dramatically and improves the ROM of the hip. As it is a simple technique, it can be used as an additional procedure with any other surgeries. It has a very good prognostic results if the patient was presented and discovered in an early stage, however its results with the late presentations of the disease do not differ than other methods of treatment but the patient reaches the healing stage in shorter time [19]. Limitations of our study was small sample size; further research involving more participants would allow to compare Herring groups with various ages.

The mean age exhibited 5.450±1.317 y, while the mean of follow up period was 18.000±6.156 Table 1. After a follow up period, eight hips (40%) were Stulberg I, six hips (30%) were Stulberg II, three hips were Stulberg III, 2 hips were Stulberg IV while only 1 was Stulberg V. Six hips in four patients underwent additional procedures after the appearance of recurrent attacks of pain and decreased ROM. A significant relation was documented between Stulberg Classification as well as the performance of additional procedures, where those with Stulberg stage I as well as II didn't need any additional procedure while those with Stulberg III, IV and V had a revision of the drilling with adductor tenotomy. A significant relation was documented between pain and Stulberg classification ($P<0.05$) Table 3. 7 hips were done in the ischaemic phase 3 ended with Stulberg I, 3 ended with Stulberg II, while only one ended with Stulberg 3. Thirteen hips were done in the fragmentation phase; 5 ended with Stulberg I,3 ended with Stulberg II, 2 ended with Stulberg III, 2 ended with Stulberg IV, and only one ended with Stulberg V Table 4.

4. Conclusions

Percutaneous drilling in Perthes disease and soft tissue release is a simple and easy procedure done in a limited time with no scar or blood loss. Early stages of the disease like the per-Perthes, ischaemic and early fragmentation will give better results by this technique. Bilateral cases of Perthes disease will give poor result and we must take a careful family history of in these cases.

In bilateral cases you must suspect blood disease involving Protein C and Protein S deficiency as well as Hyper-coagulable state. In unilateral cases with a hypercoagulable state, we may drill the contralateral hip as a prophylactic procedure. Percutaneous drilling and soft tissue release in Perthes disease does not differ in the result.

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Nil

Conflict of Interest
Nil

References

[1] F. Wagner, B. Weiß, B.M. Holzapfel, C.M. Ziegler, B. Heimkes. (2023). Functional adaptation after femoral intertrochanteric valgus osteotomy in Legg-Calvé-Perthes disease. Scientific reports. 13(1), 20538.

[2] R.T. Morrissy, B.J. Giavedoni, C. Coulter-O'Berry. (2006). The child with a limb deficiency. Lovell & Winter's Pediatric Orthopaedics Philadelphia, PA: Lippincott Williams & Wilkins. 8:165-95.

[3] S. De Salvo, V. Pavone, S. Coco, E. Dell'Agli, C. Blatti, G. Testa. (2022). Benign bone tumors: an overview of what we know today. Journal of Clinical Medicine. 11(3): 699.

[4] J. Malghem, F. Lecouvet, B. Vande Berg, T. Kirchgesner, P. Omoumi. (2023). Subchondral insufficiency fractures, subchondral insufficiency fractures with osteonecrosis, and other apparently spontaneous subchondral bone lesions of the knee—pathogenesis and diagnosis at imaging. Insights into Imaging, 14(1), 164.

[5] J. Chell, S. Dhar. (2004). Perthes disease. Surgery (Oxford). 22(1), 18-20.

[6] J. Wagner, B. Weiß, B.M. Holzapfel, C.M. Ziegler, B. Heimkes. (2023). Functional adaptation after femoral intertrochanteric valgus osteotomy in Legg–Calvé–Perthes disease. Scientific Reports. 13(1), 20538.

[7] J. Serino III, J. Rasio, M. Kogan. (2022). Legg-Calvé-Perthes Disease. In Hip Arthroscopy and Hip Joint Preservation Surgery (pp. 439-467). Cham: Springer International Publishing.

[8] N.C. Lopes, C. Escalda, C. Villacreses. (2011). Prevention of legg-calve-perthes disease. transphyseal neck-head drilling. Rev Port Orthop Trauma. 19, 223-238.

[9] K.-W. Wu, T.-M. Wang, S.-C. Huang, K.N. Kuo. (2012). Overview of surgical treatments in Legg-Calvé-Perthes disease. Formosan Journal of Musculoskeletal Disorders. 3(4): 111-115.

[10] E. Segev, E. Ezra, S. Wientroub, M. Yaniv, S. Hayek, Y. Hemo. (2007). Treatment of severe late-onset Perthes' disease with soft tissue release and articulated hip distraction: revisited at skeletal maturity. Journal of Children's Orthopaedics. 1(4), 229-235.

[11] O. Wiig, T. Terjesen, S. Svenningsen. (2008). Prognostic factors and outcome of treatment in Perthes' disease: a prospective study of 368 patients with five-year follow-up. The Journal of Bone & Joint Surgery British Volume. 90(10), 1364-1371.

[12] A.G. Martinez, S.L. Weinstein, F.R. Dietz. (1992). The weight-bearing abduction brace for the treatment of Legg-Perthes disease. The Journal of Bone and Joint Surgery. 74(1), 12-21.

[13] J.A. Herring, H.T. Kim, R. Browne. (2004). Legg-Calvé-Perthes disease: Part I: Classification of radiographs with use of the modified lateral pillar and Stulberg classifications. The Journal of Bone and Joint Surgery. 86(10), 2103-2120.

[14] A. Ishida, S.S. Kuwajima, J. Laredo Filho, C. Milani. (2004). Salter innominate osteotomy in the treatment of severe Legg-Calvé-Perthes disease: clinical and radiographic results in 32 patients (37 hips) at skeletal maturity. Journal of Pediatric orthopaedics. 24(3), 257-264.

[15] H.K. Kim. (2012). Pathophysiology and new strategies for the treatment of Legg-Calvé-Perthes disease. The Journal of Bone and Joint Surgery. 94(7), 659-669.

[16] T. Atsumi, K. Yamano, M. Muraki, S. Yoshihara, T. Kajihara. (2000). The blood supply of the lateral epiphyseal arteries in Perthes' disease. The Journal of Bone & Joint Surgery British Volume. 82(3), 392-398.

[17] M. Bulut, A. Demirts, B.Y. UçAR, İ. AzBOY, C. Alemdar, L. Karakurt. (2014). Salter pelvic osteotomy in the treatment of Legg-Calve-Perthes disease: the medium-term results. Acta Orthop Belg. 80(1): 56-62.

[18] A. Osuna, A. Pérez-Uñate (2023). Resolution of Asthma symptoms and Improvements in Gait Parameters in a paediatric patient with Sever's Disease receiving Chiropractic care: A case report.

[19] M. Eidelman, P. Kotlarsky. (2023). Does transepiphyseal drilling and closure of the greater trochanter in early Legg-Calve-Perthes disease improve natural history?. Musculoskeletal surgery. 107(3), 279-285.