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ORIGINAL ARTICLE

Legg-Calvé-Perthes disease: role of isolated adductor tenotomy?

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Abstract

Background The aim of the study was to compare the radiological results at maturity of patients with Legg-Calve-Perthes disease, treated either by a uniform conservative treatment or by an adductor longus tenotomy.

Methods The study cohort comprised 349 hips, mean age 4.4 years. Patients were classified in two different groups depending on the treatment performed. The conservative group (Group I) consisted of 318 hips that had been treated by physical therapy and abduction cast/brace, with a mean age 4.3 years (range 1–10). The tenotomy group (Group II) consisted of 31 hips (treated conservatively but developed an adduction contracture limited to 30°), which had been treated by *adductor longus* tenotomy with a mean age of 6.2 years (range 2–9). Hip range of motion and radiographic studies were performed at the time of admission. The extent of femoral epiphyseal involvement was assessed at each follow-up by the method of Herring. The final outcomes were assessed at skeletal maturity according to the Stulberg classification system.

Results Only one patient (two hips) from Group II experienced an improvement in abduction, which was maintained throughout the follow-up until complete the healing of Legg-Calvé-Perthes disease was achieved. In the remaining 29 hips, we observed a progressive loss of ROM previous to 4.3 months from the tenotomy. According to the Stulberg classification, we did not find differences between both groups at final follow-up ($p > 0.05$).

Conclusions These preliminary data suggest that the isolated tenotomy of the *adductor longus* tendon does not modify the natural evolution of Legg-Calvé-Perthes disease.

Keywords Legg-Calve-Perthes disease · Tenotomy · Adductor longus · Conservative treatment

Introduction

Legg-Calve-Perthes disease (LCPD) is a self-limiting condition of the immature hip characterized by aseptic necrosis of the femoral head, followed by a subchondral fracture, fragmentation, revascularization, and remodeling [1–4]. The condition is a disease of children in which the essential lesion is not simply ischemia, but also includes the resulting process of resorption, collapse and repair, which may result in a painful, poorly functioning hip. Treatment is largely a matter of the physician's personal preference, as the literature offers little scientific evidence to suggest the superiority of one treatment over another or even to conclusively establish the efficacy of any treatment over the natural history of the disease. The treatment options for late-onset LCPD vary significantly. Conservative treatment includes rest, physical therapy, bracing/casting, and, sometimes, adductor tenotomy [5–8]. Surgical treatment includes femoral [9–11] and/or pelvic osteotomy

The study was conducted in Hospital Universitario Niño Jesus, Madrid, Spain.

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[7, 12, 13]. The short-term goal of treatment is the maintenance of hip range of motion and containment of the femoral head [14–16]. The ultimate goal is the preservation of hip congruency and sphericity of the femoral head [1, 17, 18]. In spite of the various treatment options, uncertainty persists as to the optimal treatment method.

A common clinical scenario during treatment for early Perthes' disease is a patient who develops progressive loss of range of hip motion (ROM) or has inability to regain hip ROM despite a variety of management techniques. Bed rest and traction have been suggested as methods to restore hip ROM in Perthes' disease, but no data have been presented that objectively document hip ROM change pre- and post-traction treatment [19–21]. Adductor longus (AL) tenotomy has also been performed in cases of adduction contracture in an attempt to restore hip motion and avoid subsequent femoral head dislocation. However, there is no evidence in the literature concerning the results of this technique.

Our aim was to determine whether AL tenotomy affects the natural history of LCPD comparing the radiological results at maturity of patients with LCPD, treated either by a uniform conservative treatment or by an AL tenotomy.

Materials and methods

Patients

After obtaining approval from the institutional review board, the pediatric database at a major research orthopedic hospital was consulted to find all children diagnosed with LCPD during a 30-year period. Medical charts were retrospectively reviewed for sex, laterality, age, clinical presentation, treatment, and clinical outcome.

We identified 480 children diagnosed with LCPD during a 30-year period. Of those, 349 met the inclusion criteria of whom 220 were male and 48 were female. A total of 131 patients were not included of who 32 had incomplete clinical and radiographic follow-up and 99 were treated surgically (femoral or pelvic osteotomy). The average age at onset of symptoms was 4.8 years (range 1.6–10.3). The right side was affected in 184 hips and left in 165. Bilateral LCPD was present in 95 patients (23 % bilaterally), but in 14 of these, we only included one side due to incomplete follow-up of the contralateral.

Depending on the treatment, the patients were classified into two different groups, although randomization was not done. The conservative group (Group I) consisted of 318 hips (mean age 4.3; range 1–10) that had been treated by physical therapy and abduction cast/brace. Of these, 263 hips were from male and 83 were from female.

The AL tenotomy group (Group II) consisted of 31 hips (mean age 6.2; range 2–9) from 31 patients, which had been treated conservatively but developed an adduction contracture limited to 30°. Of these, 22 hips were from male and 9 hips were from female. In all these patients, we performed an AL tendon tenotomy due to persistence limit range of motion despite the physical treatment and abduction brace/cast.

Clinical assessment

The assessed clinical parameter was hip ROM. Measurements were taken preoperatively at 2, 4, 6, 9, 12 months postoperatively and at least every year until final growth. A standard universal goniometer was used for measurements with scales marked by 1-degree increments. Measurements of hip abduction and adduction were taken with the child supine and the hips in full extension and in neutral rotation; 0° was in the midline orientation, with the two anterior superior iliac spines defining the axis of the pelvis. Hip rotation was measured with the child prone, pelvis flat, and knees flexed at 90°, allowing the legs to move apart under the force of gravity.

Radiological assessment

Anteroposterior (AP) and frog lateral radiographs of both hips were obtained at the time of admission, and the extent of femoral epiphyseal involvement was assessed at each follow-up by the method of Herring. The Herring classification was used in order to ascertain that both groups were radiographically comparable. We determined the time of beginning of LCPD, the time when initial radiographic changes were observed, and the end of the disease determined by the complete recovery of bone density of the femoral head.

The final outcomes were assessed at skeletal maturity (AP and frog lateral radiographs) according to the Stulberg classification system (18). Class I and II hips were graded as good, while class III, IV, and V hips were rated as poor. The average duration LCPD was determined from the initial detection of radiographic changes until complete femoral head density was observed in both hip views.

Surgical treatment

The criteria to perform the AL tenotomy were based on the failure of non-operative treatment in patients with persistent palpable adductor contracture and a limited ROM in abduction or internal rotation of at least 30° compared to the contralateral healthy side. Soft tissue release around the hip was done through a transverse skin incision made 1–3 cm distal to the inguinal crease. The fascia over the

AL tendon was opened longitudinally, and the tendon was then transected, taking care to avoid injury to the anterior branch of the obturator nerve below. Postoperatively, all patients were kept in a Petrie cast during 6 weeks. Then, assisted physical therapy for hip and knee range of motion was begun. Subsequently, patients progressively started bipedestation and walking.

Statistics

Data were analyzed using SPSS 15 (SPSS Inc., Chicago, IL, USA). Analysis of variance (ANOVA) test (quantitative variables) and the Chi-squared test (qualitative variables) were performed. The results were expressed as the mean with the 95 % confidence interval (CI) and the median. A p value of <0.05 was considered to be significant.

Results

We did not find significant differences between groups ($p > 0.05$) in sex. However, the difference observed in age (4.3 in Group I; 6.2 in Group II) was statistically significant ($p < 0.05$). The mean duration of LCPD was 75.9 (range 48–102) months in Group I and 76.6 (range 51–101) months in Group II ($p = 0.91$).

Only one patient (2 hips) from Group 2 ($n = 30$; 31 hips), in whom bilateral tenotomy was performed, experienced an improvement in abduction, which was maintained throughout the follow-up until complete healing of LCPD was achieved. In the remaining cases, we observed a progressive loss of ROM previous to 4.3 (range 1–11) months from the tenotomy.

The results of the radiological measurements are given in Table 1. According to the Herring classification, both groups were comparable; in Group 1 ($n = 318$), 47 hips were classified as type A, 188 hips as type B, and 83 hips as type C. In Group 2 ($n = 31$), 3 hips were classified as type A, 20 hips as type B, and 8 hips as type C. The differences between these two groups with regard to disease severity were not statistically significant ($p = 0.72$).

Table 1 Patient distribution according to Herring classification

	Herring classification			Total hips
	A	B	C	
Group I (Conservative)	47 (15 %)	188 (60 %)	83 (26 %)	318
Group II (Tenotomy)	3 (10 %)	20 (64 %)	8 (26 %)	31
Total	50	208	91	349

$p = 0.72$

Table 2 Final radiologic results based on Stulberg classification

	Stulberg classification			
	I and II	III, IV and V	Non-classified	Total hips
Group I (Conservative)	156 (64 %)	89 (36 %)	73	318
Group II (Tenotomy)	14 (61 %)	9 (39 %)	8	31
Total	170	98	81	349

$p = 0.86$

The final radiographic outcome was based on the Stulberg classification (Table 2). The results obtained in Group I showed that 82 patients were classified as type I, 74 patients as type II, 58 patients as type III, 24 patients as type IV, and 7 patients as type V. In Group II, 5 patients were classified as type I, 9 patients as type II, 7 patients as type III, 1 patient as type IV, and 1 patient as type V. A total of 81 patients did not finish the process and were therefore not classified. According to the Stulberg [18] classification, we observed similar outcomes in the group treated conservatively compared with the group treated by AL tenotomy ($p = 0.86$). The mean follow-up in patients who were completely cured ($n = 268$) was 11.7 years (range 4–35).

Discussion

The indications for surgical treatment in Perthes' disease remain controversial despite several reports comparing the results of conservative and surgical treatment [6, 23–27]. Traditionally, containment methods have been the most widely accepted treatment for LCPD. The objective of containment treatment in Perthes' disease is to hold the femoral head in the acetabulum during the period of "biologic plasticity," while necrotic bone is resorbed and living bone is restored through the process of "creeping substitution" [28]. Femoral varus derotational osteotomy (VDRO) is often used in the treatment for LCPD. Significant remodeling occurs following VDRO, sometimes up to 60 % of the preoperative angle [29–32]. Arkader et al. [33] in a recent retrospective study found no statistical differences between surgical and conservative treatment. Regardless of the results obtained, they observed a trend toward better radiographic outcomes when VDRO was performed early in the disease process. However, their retrospective study has several limitations, such as an insufficient size that could limit its power to demonstrate differences between groups. Kamegaya et al. [34], in a study using matched pairs of conservatively and surgically treated LCPD patients including only patients classified at presentation as Catterall group III and IV, concluded that surgical treatment can improve the sphericity of the femoral head and provide greater acetabular cover than conservative treatment.

Perthes suggested that "Loss of motion is the result of mechanical relationships which result from the incongruity of the joint surfaces, and reflex muscle spasms or joint adhesions play no role" [35]. Many factors have been proposed as being responsible for the loss of hip ROM in LCPD. Pain due to synovitis, subchondral fracture, and/or muscle spasm is thought to lead to abnormal hip posture during gait with the progressive development of secondary contractures of the adductors, psoas, and hip capsule. Recently, Stanitski et al. [36] showed that the loss of hip ROM in patients with early Perthes' disease without intra-articular incongruity was due to pain and muscle spasm. Limited hip motion early in the disease is due to muscle spasm and synovitis; the affected leg may appear significantly shorter due to an adduction contracture. This synovitis leads to a joint effusion, which in turn activates the joint mechanoreceptors to contract all the hip adductor muscles as a mechanism against pain. Although this mechanism apparently implies the isolated contraction of the AL muscle, which is the most superficial, it also involves the contraction of the other adductor muscles.

The medial adductor compartment of the thigh consists of the adductor magnus, the brevis and longus, and the gracilis muscles, which are mainly innervated by the obturator nerve. All arise from the pelvic floor and the medial aspect of the ipsilateral pelvic ring, symphysis pubis, inferior pubic ramus, ischium, and obturator fascia. They attach distally to the linear aspera and the medial aspect of the distal femur. Therefore, it seems that the isolated tenotomy of the AL tendon would be an insufficient treatment to release the contracted hip in LCPD patients, since the other adductor muscles remain intact.

In an attempt to relieve the pain associated with various hip conditions, division of the obturator nerve or obturator neurectomy has been performed [37]. Obturator neurectomy is an old and familiar procedure for the relief of adductor spasm in spastic paralysis. The main risk of obturator neurectomy is an abduction contracture. However, it is unclear whether the abduction contractures noted in the past were due to the neurectomy or to the spica casting and abduction bracing commonly used after muscle lengthening. Although this treatment is rarely used nowadays because of the many potential side effects described in the literature [38], it could be indicated in LCPD patients who develop adduction contracture, as it allows the release of the whole adductor muscle compartment.

Botulinum toxin (BTX-A) has been used for treatment of spasticity in children with cerebral palsy for more than a decade. Baker et al. [39] investigated its effects in a randomized, double-blind, placebo-controlled study. A group of children with diplegic cerebral palsy received placebo or one of the range of doses of botulinum toxin. The results showed that the drug's effect on reducing spasticity was significant and, to some extent, was dose related. Treatment with botulinum toxin in LCPD, combined with intensive physiotherapy, may increase the hip range of motion in abduction and thereby improve containment. Although there is no evidence in the literature about the use of BTX-A in LCPD, it could be a reasonable alternative to soft tissue release since it constitutes a minimally invasive technique, and it can be repeated every 4–6 months.

The improved hip ROM observed in our patients after the AL tenotomy could be explained by the pre- and postoperative bed rest and the use of the Petrie cast for 6 weeks after surgery. It is well known that muscle tenotomy results in decreased muscle length and corresponding sarcomere length, a change in the neural output from muscle receptors altering EMG activity. From a clinical standpoint, early tendon repair and mobilization is the best method to avoid pathological changes in the corresponding muscle by restoring the muscle to its original length. The idea of early primary tendon repair and mobilization to permit a smooth gliding surface has become a standard part of management of tendon injuries [40–42].

Although both groups are comparable except for age (4.3 in Group I; 6.2 in Group II), this difference may not be relevant thus the age considered as risky is 8 years old. The results of the present study show the recurrence of adductor contracture at a mean of 4.5 months after surgery. Considering that patients were kept in a Petrie cast during 1.5 months, the specific effect of the AL tenotomy only lasts 3 months. Therefore, the effect of the improved range of motion obtained after the AL tenotomy lasts 3 months. However, the average duration of the different stages of LCPD is longer than this period. Herring et al. [22] reported a range of duration of 5–12 months of the fragmentation stage. Therefore, if the effect of the AL tenotomy is shorter than the period of fragmentation, it should have little impact on the evolution of LCPD. Long-term results show no difference between patients in whom tenotomy was performed and those treated conservatively. Therefore, it seems that the AL tenotomy does not change the natural evolution of LCPD as it does not affect neither length of the disease nor final morphologic results. The Stulberg classification-based final results are very similar between groups, and both good and bad results are consistent ($p = 0.86$).

Unless further studies supporting this technique throw encouraging results, based on the results of our study, we do not recommend performing the AL tenotomy in LCPD children.

Conclusion

The AL tenotomy does not change the natural evolution of LCPD as it does not affect neither length of the disease nor final morphologic results based on Stulberg classification.

Conflict of interest The authors report that they have no conflict of interest.

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