Is Percutaneous Adductor Tenotomy as Effective and Safe as the Open Procedure?

Samer El Hage, MD, Rami Rachkidi, MD,* Ziad Noun, MD,† Rachid Haidar, MD,‡ Fernand Dagher, MD,* Khalil Kharrat, MD,* and Ismat Ghanem, MD**

Background: Percutaneous adductor longus tenotomy (PAT) is a frequently used procedure, yet no study has ever compared its effectiveness and safety with those of open adductor longus tenotomy (OAT). We conducted this prospective study to describe the effects of PAT and to compare them with those of OAT.

Methods: This consisted of a cross-over randomized controlled trial including 50 consecutive hips from 27 patients with cerebral palsy scheduled for adductor tenotomy in the setting of multilevel tendon lengthening/release procedures or hip surgery (femoral or Dega osteotomy) in a university hospital. A pediatric orthopaedic surgeon conducted a PAT. Another surgeon extended the wound to explore what had been cut during the PAT, and completed the tenotomy if necessary. Hip abduction (HA) was assessed by a third surgeon immediately before PAT, after PAT, and then after OAT, using a goniometer, in a standardized reproducible manner. All 3 surgeons were blinded to the others' findings. Primary end-points included the percentage of tendon/muscle portion sectioned percutaneously, and the HA measure. Comparison between HA after PAT and OAT was done using a paired *t*-test with a 95% confidence interval. The influence of anatomic variants of adductor longus origin was also assessed.

Results: Mean HA (hips flexed) measured 40.36 degrees preoperatively and increased to 50.04 degrees after PAT ($P < 0.0001$). After OAT, HA averaged 53.32 degrees with no statistical gain compared with that observed after PAT ($P = 0.2$). The tendinous portion of adductor longus was cut to an average of 98% by PAT (completely in 46 cases and more than 75% in only 4 cases). The muscular portion of adductor longus origin was cut to an average of 83.7% (completely in only 15 cases, cut to more than 75% in 26 cases, and approximately 50% in 9 cases). The gain in HA positively correlated with the extent of the tendinous portion divided ($P = 0.03$) but not with the extent of muscular portion divided. Results were independent of the anatomic variants of adductor longus origin. Partial section of adductor brevis after PAT was encountered in 6 cases. No major iatrogenic lesion was observed (obturator nerve, major vessels).

Conclusions: This is the only prospective study concerning the effects of PAT. The anatomic factor associated with gain in HA seems to be the extent of the section of the tendinous portion of adductor longus origin, which was found to be cut to more than 90% in all cases after PAT. The extent of muscular portion section does not seem to influence the gain in HA. The researchers detail the technique of percutaneous adductor tenotomy and show that when done correctly, PAT is a fast and simple procedure, as reliable and effective as the open release and without any major risks.

Level of Evidence: Level II therapeutic study—prospective comparative study.

Key Words: adductor lengthening, adductor tenotomy, percutaneous tenotomy, subcutaneous tenotomy, tendon lengthening

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Adductor longus tenotomy is a widely used procedure consisting of proximal release of the adductor longus at the anterior aspect of the pubis. It may be carried out either *de visu*—open adductor tenotomy (OAT) or percutaneously—percutaneous adductor tenotomy (PAT). Both these techniques have been used extensively in developmental dysplasia of the hip, in association with closed or open reduction, with or without associated pelvic, and/or femoral osteotomies. It has also been advocated in Perthes disease in combination with several surgical options aimed at containing the proximal femoral epiphysis within the acetabulum. PAT has been used, but to a lesser extent than the open release, in the treatment of adduction contractures in spastic cerebral palsy (CP).[1–9] This is because patients with spastic CP often exhibit contractures in other muscles, which must be addressed at the same time, such as the adductor brevis, gracilis, and psoas at its insertion or at the pelvic brim. Adductor longus tenotomy has also been described by some investigators in the treatment of chronic groin pain in athletes in whom pubalgia is caused by muscle imbalance between strong adductors and weak abdominal muscles.[10] Finally, some have even advocated the use of PAT in the adult hip fracture setting, when contralateral osteoarthritis or adduction contracture may interfere with the proper positioning of the patient on the fracture table and impede proper lateral C-arm views.[11]

PAT is known as a rapid, minimally invasive, and easy procedure. Yet, despite its extensive use for many

From the *Department of Orthopaedic Surgery, Hôtel-Dieu de France Hospital, Saint-Joseph University; †Department of Orthopaedic Surgery, Trad Hospital; and ‡Department of Orthopaedic Surgery, American University Hospital, Beirut—Lebanon.

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Reprints: Ismat Ghanem, MD, Hotel-Dieu de France Hospital, Boulevard Alfred Naccache, Achrafieh, Beirut, Lebanon. E-mail: ismat.ghanem@gmail.com.

decades, no evidence exists concerning its efficacy and safety. Moreover, and contrary to OAT, no clear description of the technique can be found in textbooks or articles. With varying techniques and no direct visual control, one may worry about accidental injury to nearby structures such as the femoral vein or the anterior branch of the obturator nerve.

The main purpose of this study was to examine what is truly cut during PAT in terms of safety and completeness, to determine its effect on abduction gain, and to compare this with the effect of OAT.

METHODS

After obtaining institutional review board approval, we conducted a prospective study on patients with CP. Patients scheduled for multilevel tendon releases or treatments of spastic hip subluxation were consecutively included in the cohort. Each patient received both the percutaneous and open procedure and each side served as case and control at the same time.

Three independent surgeons participated in the study. The first surgeon, in charge of realizing the PAT, carried out the procedure using a standardized technique. The right-handed surgeon stands to the patient's left side, delimits the adductor longus origin between his second and third left fingers, and horizontally introduces a number 15 blade underneath the tendon from lateral to medial. The blade is then turned 90 degrees upward cutting the adductor longus origin from deep to superficial. Any remaining fibers are then divided in a closed manner by back and forth movements while applying pressure with a gauze.

A second surgeon then approached the surgical field and extends the wound medially to explore what has been really cut during PAT. He reported the extent of tendinous and muscular fibers cut into 4 categories: complete cut, more than 75% cut, between 50% and 75%, and less than 50%. He also looked for iatrogenic injury to the femoral vessels, superficial external pudendal artery, anterior branch of the obturator nerve, and to neighboring muscles (adductor brevis, gracilis). The anatomic variant in the origin of adductor longus was noted. Finally, this surgeon completed the adductor longus release when necessary and proceeded with other releases depending on the case.

The third surgeon was in charge of making abduction measurements. These were done after the administration of general anesthesia for both hips in knee flexion and extension to take into account gracilis contractures. Goniometric measurements using a 1 degree Calibrated goniometer were realized preoperatively, after PAT, and then after OAT before any other releases.

Statistical analysis was done using student and χ^2 tests to look for statistical significance with confidence intervals of 95%. We looked for a difference in abduction resulting from PAT and OAT. We also searched for an association between the extent of tendinous and muscular section and the effect on abduction. Right and left sides were compared with to assess for influence of the hand-dominance of the surgeon.

RESULTS

Our series comprised 50 hips in 27 patients. Forty of the hips in 21 patients were operated in the setting of a multilevel tendon lengthening procedure. The 10 other hips from 6 patients had adductor releases in association with proximal femoral varus-derotation osteotomy (VDRO) with or without San Diego-Dega osteotomy for spastic hip subluxation or dislocation. The series was made of 18 boys and 9 girls. Six of these releases were done on the abducted side of a windswept deformity in association with a VDRO done for symmetrization purposes. These hips did not have a major limitation in preoperative abduction, but underwent adductor release to counteract the adducting effect of the associated VDRO.

Mean preoperative passive hip abduction in flexion was 40.36 degrees and went up to 50.04 degrees after the percutaneous procedure, which represents a significant improvement ($P < 0.0001$). This value barely increased to 53.32 degrees after the open procedure. This improvement was not statistically significant ($P = 0.2$) (Fig. 1).

The tendinous fibers of adductor longus origin were completely cut in 46 cases (92%) and to more than 75% in the remaining 4 cases (8%), with a mean division of 98% (Fig. 2). There was a positive association between the degree of tendinous portion cut and the gain in abduction ($P = 0.03$). The muscular part of adductor longus origin was completely cut in 15 cases (30%), to more than 75% in 26 cases (52%) and to around 50% in the remaining 9 cases (18%). There was no difference in abduction between these 3 categories ($P = 0.43$).

The most common anatomic variant encountered was the anterior tendinous/posterior muscular type, which was seen in 45 hips (90%), whereas the 5 remaining hips had a variation in which the lateral border of adductor longus origin is completely muscular. There was

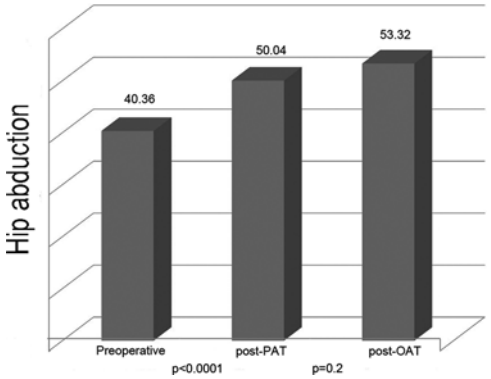

FIGURE 1. Mean abduction values after the percutaneous (PAT) and open (OAT) procedures. The difference between the preoperative value and that after PAT is significant, whereas the difference between the latter and hip abduction after OAT is statistically nonsignificant.

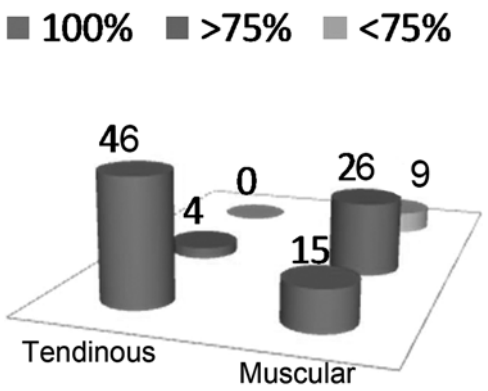

FIGURE 2. Distribution of the muscular and tendinous fibers successfully divided by the percutaneous adductor tenotomy (PAT).

no difference in terms of gain in hip abduction between the 2 types of adductor longus origin encountered.

No difference between left and right sides were noted in terms of tendinous or muscular cuts ($P = 0.22$) and effect on hip abduction ($P = 0.19$) after PAT, showing that hand-dominance of the surgeon does not affect the result.

We encountered iatrogenic lesions in 7 cases (14%). These were all made of slight cuts in the anteriormost fibers of adductor brevis. No vascular or nervous lesions were encountered.

DISCUSSION

To the researcher's knowledge, no earlier study has been undertaken to evaluate the effect of percutaneous adductor longus tenotomy on abduction despite its wide use. In the CP setting, whereas many series dealing with adductor release have been published, the vast majority of them are made of heterogeneous populations operated by both percutaneous and open procedures without distinction, with numerous associated procedures (obturator neurectomy, psoas tenotomy, osteotomies) making proper analysis and conclusions difficult.[2,12,13] Moreover, this procedure that has been used for decades is rarely clearly described in textbooks and surgical atlases, and its anatomic basis has never been clearly illustrated.

The effectiveness and safety of other percutaneous tendinous procedures have been evaluated. Achilles tendon tenotomies and lengthenings have recently been studied. Mulier et al described a case of a false aneurysm that developed after a repeat percutaneous Achilles lengthening.[14] Salamon et al carried out cadaveric triple-hemisection percutaneous Achilles tendon lengthenings.[15] They found that percutaneous Achilles tendon lengthening is a relatively accurate procedure with hemisections averaging 50% for the middle cut and 60% at the most proximal cut, and 55% at the distal cut. Some tendinous and neurovascular structures are, on average, less than 1 cm from the nearest margin of a given hemisection and are, therefore, at risk including the flexor hallucis longus, the tibial nerve, and the sural nerve. More recently, Hoefnagels et al in another cadaveric study showed that the percutaneous triple hemisection technique results in more technical failures than acceptable and suggests carrying out the technique as an open procedure.[16]

Vascular complications after percutaneous Achilles tendon tenotomy in clubfoot management using the Ponseti method have also been reported.[17] The researchers described 3 cases of serious bleeding from injury to the peroneal artery and 1 other case of injury to the lesser saphenous vein. They detail the technique of carrying out a percutaneous heel cord tenotomy and offer guidelines that may help others avoid this same complication. Another recent paper reports a pseudoaneurysm after percutaneous Achilles tendon tenotomy in a clubfoot treated with the Ponseti method.[18]

Contrary to cadaveric studies on Achilles tendon hemisection lenghtenings, we chose to carry out an in vivo experimentation to better reproduce reality. Therefore, a population composed of patients with CP was chosen as these patients are already candidates to open adductor tenotomy. Indeed, in this setting it is legitimate to carry out an OAT whereas such a procedure would seem unethical to carry on DDH patients who normally receive a PAT.

It is generally admitted that adductor longus origin is composed of a mixture of tendinous and muscular fibers, and it was legitimate to find out which part of this origin was cut during PAT and to evaluate the influence of such cuts on hip abduction. In a cadaveric study, Strauss et al showed that the origin of adductor longus muscle is composed of 37.9% tendon and 62.1% muscle tissue and that the percentage of tendon decreased to 34% at 1 cm and to 26.7% of the cross section at 2 cm from the pubic origin.[19] Tuite et al[20] described many anatomic variants in their 37 cadaveric specimens. In 90% of cases, we found the adductor longus origin to be composed of an anterior tendinous and a posterior muscular portion, with the musculotendinous junction running obliquely from proximal to distal and from lateral to medial, in concordance with the results of the cadaveric study of Tuite et al.[20] The remaining 10% had an origin composed of a completely muscular lateral part. The other variants described by Tuite et al (common origin with gracilis, bicephalic adductor longus, triangular anterior defect in the tendinous fibers) were not encountered in our study. This difference between our results and those of Tuite et al may be owing to ethnic differences between the 2 studied populations, to structural changes in the muscles of CP children, or simply represents sampling variation. Whatever the cause, anatomic variant does not seem to influence results, as all the cases presenting with the less frequent variant had a complete cut of the tendinous portion.

Evaluation of the long-term effect of PAT on abduction gain in comparison with OAT was beyond the scope of our objectives. Nevertheless, we believe that there should be no difference between the 2 procedures in terms of long-term gain in abduction and other endpoints such as prevention of hip subluxation and pain.

Although some recent papers show nonreproducible and sometimes dangerous effects of percutaneous tendon procedures,[14–18] our results seem to indicate that when done correctly, percutaneous adductor longus tenotomy achieves similar results on short term abduction gain as its open counterpart, with no major iatrogenic risks. It is therefore legitimate, efficient, and safe to carry out a PAT instead of an OAT when only adductor longus release is needed. This is more often the case in DDH and Perthes disease than in CP in which many patients also have contractures of other hip adductors such as gracilis. The increased subcutaneous fat more often encountered in DDH than in CP should be kept in mind as it may render palpation of the tendon less obvious than in children with CP.

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