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Research Article

Operating Two Different Techniques for Pediatric Knee Stiffness in Swing Phase

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Abstract

Objective: To analyze 2 surgical techniques in the treatment of rectus femoris in children.

Materials and Methods: Data were analyzed on 208 patients (218 knees) from July 2008 to December 2020. Clinical signs were knee stiffness in the swing phase, positive Ely and Ober test, abnormal knee and hip flexion angles. Patients were operated on according to one of two variants: Variant A, to release the proximal tendon; and Variant B, to release the medial axis of the rectus femoris.

Results: There were 208 patients (218 knees). There were 132 females (63.5%) and 76 males (36.5%). The left knee was affected in 51 patients (24.5%) and the right knee in 157 patients (75.5%). The mean age at the time of surgery was 7 years, 8 months. The mean follow-up period was 8 years, 3 months. Postoperatively, the knee flexion angle with a positive Ely test result was significantly improved. Long-term follow-up showed excellent results in 148 knees (67.8%), good results in 35 knees (16.1%), fair results in 17 knees (7.8%), poor results in 18 knees (8.3%). The postoperative results of the two techniques were similar (Pvaluate = 0.26870)

Conclusion: Overall, surgical treatment of knee stiffness in the swing stage due to rectus femoris fibrosis by a simple and safe surgical procedure significantly improved knee and hip function, stooped gait, and anterior pelvic tilt.

Keywords: *Intramuscular Antibiotic Injection; Fibroma; Fibroma and Contracture; Stiffness; Surgical Treatment*

Introduction

Rectus femoris contracture can develop secondary to congenital fibrosis, intramuscular injections, or trauma, resulting in muscle fibrosis [2,3,5,8,13,17,26,28,29,31,32]. In Eastern countries, it is common practice to perform a series of intramuscular injections in patients with fever, pain, or infection [5,6,20,24]. Rectus femoris fibrosis has been identified intraoperatively as a fibrous band within the muscle, and its structure has been confirmed histopathologically. Long-term fibrosis of the rectus femoris causes dimpling of the skin, palpable rectus femoris contracture, cosmetic problems, and knee stiffness during swing. Patients tend to stoop, tilt the pelvis forward, abduct the hip, and extend the knee during lateral rotation.

Aim of the Study

The aim of this study were to evaluate and compare the long-term results of two surgical techniques for fibrous rectus femoris muscle with knee stiffness in swing phase.

Materials and Methods

A retrospective study was conducted to evaluate the outcomes of surgical techniques performed between August 2008 and November 2020 on 219 patients with rectus femoris (RFM). Eleven patients (11 knees) were excluded from the study due to insufficient follow-up. The remaining 208 patients (218 knees) formed the basis for this study. There were 132 females (63.5%) and 76 males (36.5%). Unilateral involvement was most common, with the left knee affected in 51 patients (24.5%) and the right knee in 157 patients (75.5%). Both knees were affected in 10 patients (5.2%). In 18 patients, the condition also involved the triceps and deltoid muscles, possibly due to a similar process.

From January 2008 to November 2014, we performed Surgery in two Variants: Variant A, involving 96 patients (102 knees); and from December 2014 to December 2020, Variant B, including 112 patients (116 knees).

Informed consent was obtained from all participants. The study was approved by the Ethics Review Committee of our Institute and was conducted according to the principles of the Declaration of Helsinki.

Preoperatively, information was collected on the type and amount of medication injected, history of trauma, age at symptom onset, duration of symptoms, associated contractures, local skin changes (cf. figure 1), pain, cosmetic problems, and changes in functional activities.

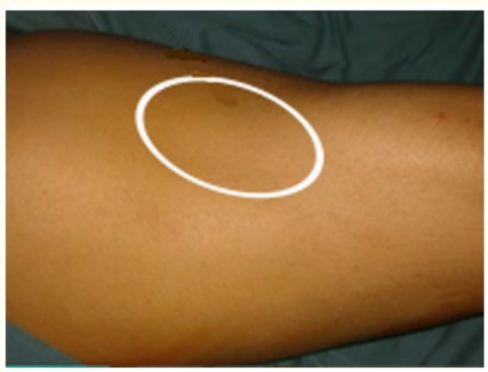

Figure 1: *Palpable rectus femoris muscle contracture.*

We measured the flexion and extension angles of the knee with a goniometer.

Ely test determination (cf. figure 2): to determine whether the rectus femoris is contracted: turn the patient prone and perform the prone rectus femoris with the hips extended and the knees flexed. If the rectus femoris is contracted, the hips will flex and the buttocks will lift off the table [15].

Ober test (cf. figure 3): This is a clinical test to determine latissimus dorsi contraction. The patient lies on the unaffected side with the lower knee flexed to help reduce the physiological curvature of the lumbar spine. The examiner raises the upper leg that is flexed or extended at the ankle while stabilizing the pelvis with the other hand, then abducts and extends the hip allowing the iliotibial band (ITB) to move posteriorly over the greater trochanter. The examiner then slowly lowers the upper leg. If the leg drops to the table, the test is negative; if the leg remains abducted, the test is positive [27].

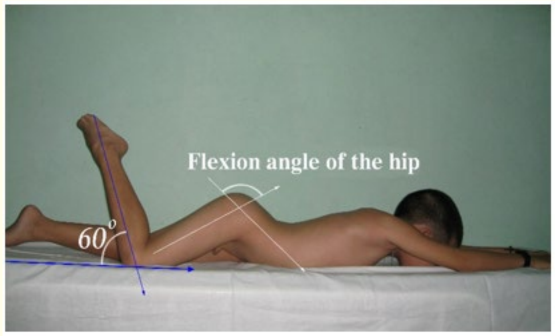

Figure 2: *Ely (test) positive the hips will flex and the buttocks will rise off the table.*

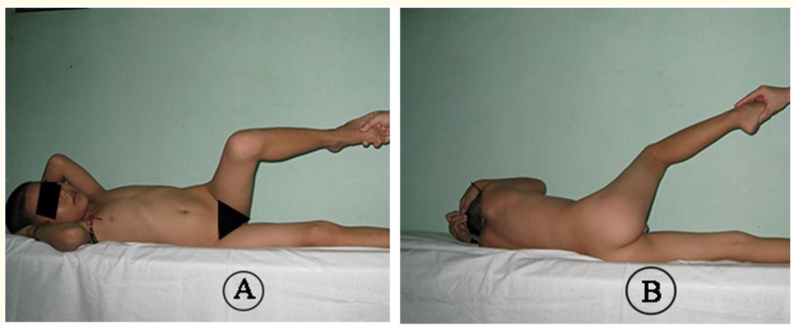

Figure 3: *Determining Ober test. The examiner then slowly lowers the upper leg. If the leg drops to the table, the test is negative; if it remains abducted, the test is positive.*

Radiography of the hips and knees was done all cases (cf. figure 4 and 5).

Figure 4: *Preoperatively, X-ray normal hip.*

Figure 5: *Preoperatively, X-ray normal knee.*

Systematic ultrasound was performed to confirm fibrous rectus femoris muscle (cf. figure 6).

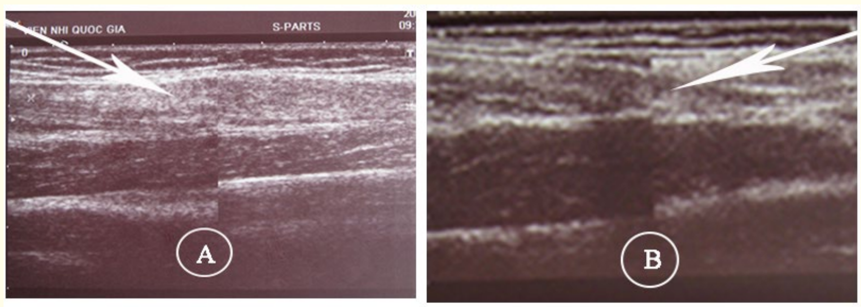

Figure 6A and 6B: *Systematic ultrasound. A: Fibrous muscle. B: Fibrous Fascia latae.*

The severity was classified according to criteria shown in table 1.

	Severe	Moderate	Mild
Ely test positive at flexion angle of the knee of	≤ 15°	≤ 60° - > 15°	> 60°
Flexion angle of the hip when knee flexed 60°	≥ 30°	≥ 15° - < 30°	< 15°
Ober test positive	Yes	Yes	Yes
Knee stiffness in swing phase	Yes	Yes	Yes
Tendency for a crouch gait, anterior pelvic tilt in swing phase	Yes	Yes	Yes

Table 1

One surgeon (the author) performed all operations.

Operative procedure

For each patient, we used only one of two variations of the technique.

Variation A, release of the rectus femoris proximalis

First step: To perform the Sage anterior hip exposure maneuver [15], place the patient in the supine position with a slight elevation of the buttocks. Through the lower end of the iliofemoral approach, divide the anterior thigh fascia at the anterior superior iliac spine, taking care not to damage the lateral femoral cutaneous nerve in this area (cf. figure 7).

Figure 7: *Skin incision.*

At the anterior superior spine, separate the origin of the lumbar spine and the anterior border of the vastus lateralis. Retract the lumbar spine and the vastus lateralis and elevate the latter approximately 8 cm above the anterior border of the external iliac wing. Locate the straight head of the rectus femoris at its insertion on the anterior inferior iliac spine, between the medial border of the vastus lateralis and the external iliac bone. Expose the straight head distally until the Y bifurcation into the straight head and reflex head is found. By sharp and blunt dissection, clear the reflex head toward its origin above the superior hip capsule. Release its insertion from the capsule and mark it with sutures. Follow the reflex head back to the Y bifurcation and separate it longitudinally along the course of its fibers distally toward the musculotendinous junction for at least 3 cm. Release the rectus femoris tendon at the level of the inferior border of the Y bifurcation (cf. figure 8). Then test the Ely (test) by extending the hip and flexing the knee (cf. figure 9).

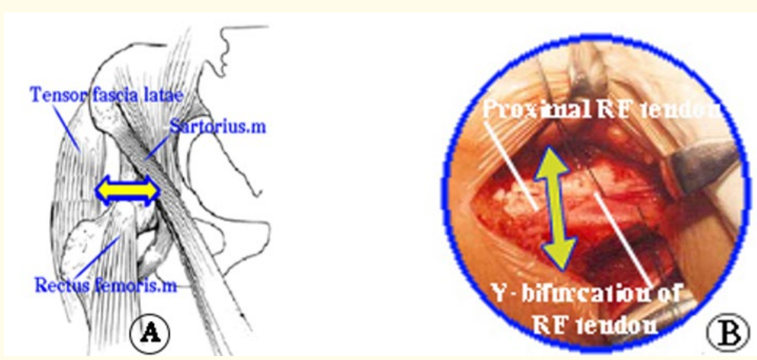

Figure 8A and 8B: *A: Release of the rectus femoris tendon at the level the inferior edge of the Y-bifurcation. B: Release of the rectus femoris tendon.*

Figure 9: *Check Ely (test) with extend the hip and flex the knee before final operation.*

The second step, divide the iliotibial line: Make a lateral incision parallel to the femoral shaft, starting at the proximal femoral condyle and extending proximally approximately 5 cm. Proceed along the incision at the anterior edge of the iliotibial line, exposing and dividing the iliotibial line (cf. figure 10). Perform the Ober test (check) (cf. figure 11). After completion of the release, coagulate all sources of bleeding to achieve complete hemostasis. Close the skin without drainage.

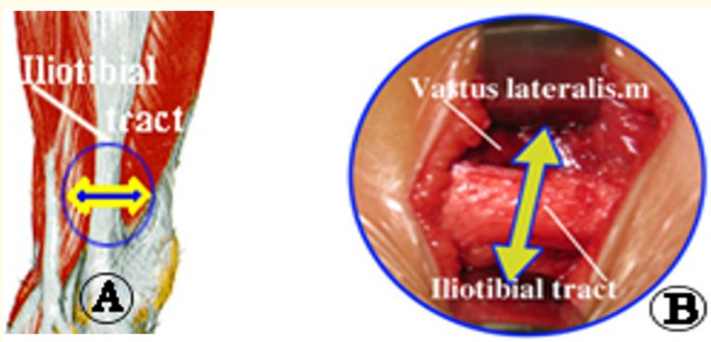

Figure 10A and 10B: *A: Check and B: Perform along incision of anterior margin Iliotibial tract, to expose and divide iliotibial tract.*

Figure 11: *Check Ober (test), abducts and extends the hip, then slowly lowers the upper leg, before final operation.*

Variant B, release middle rectus femoris muscle (Figure 12)

The first step: To perform the Thompson anterior exposure [35], place the patient in the supine position with slight elevation below the buttocks. Make a skin incision over the middle third of the femur in a straight line between the anterior superior iliac spine and the lateral border of the patella 5 cm**.** Incise the superficial and deep fascia and separate the rectus femoris, vastus lateralis, and vastus medialis along their intermuscular septa. The vastus medialis is thus visualized. Then, expose and elevate the rectus femoris with a periosteal elevator or with the surgeon's fingers and perform a release of the rectus femoris at the medial part of the muscle (cf. figure 12A and 12B). Then, perform the Ely test with the hip extended and the knee flexed (cf. figure 9).

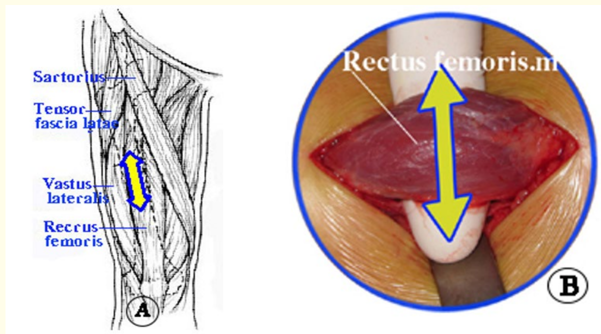

Figure 12A and 12B: *A: Check and B: Release of the rectus femoris muscle at the middle shaft of muscle.*

The second, divide fascia latae (cf. figure 13): To separate the rectus femoris and vastus lateralis and subcutaneously. Divide the vastus lateralis at a level opposite the midline of the divided rectus femoris (cf. figure 12). To test the Ober test (cf. figure 11).

After completion of the release, coagulate all sources of bleeding to achieve complete hemostasis. Close the skin without drainage.

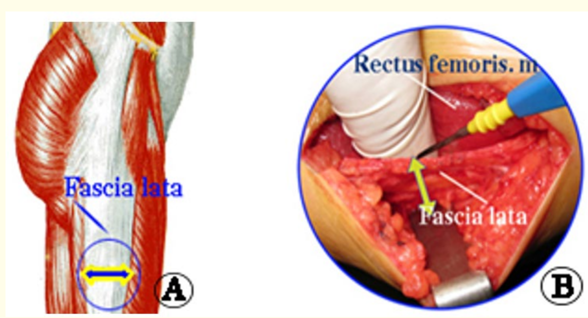

Figure 13A and 13B: *A: Check and B: Release of the Fascia lata.*

Postoperative rehabilitation

Hip and knee exercises were performed starting on the third postoperative day. During the first two weeks, the hip was kept in a neutral position (0°) and passive knee flexion was performed up to 90° with the help of a physical therapist. After two weeks, the knee range of motion was increased to 120° and after three weeks, the range of motion was increased to normal. The knee was allowed to fully flex between the fourth and sixth postoperative weeks.

Postoperatively, we recorded the following information: skin dimple, range of motion, knee flexion and extension angle, Ely and Ober test, manual muscle testing results according to the Jones classification, and complications.

We evaluated patients independently at one week, three weeks, six weeks, three months, and every six months thereafter.

Results	Ely test positive at Flexion angle of the knee of	Flexion angle of the hip (With knee flexed 60°)	Ober test	ARC of active and passive flexion-extension of the knee	Knee stiffness in swing phase	Tendency for a crouch gait, anterior pelvic tilt.
Excellent	≥ 90°	0° - ≤ 5°	Negative	≥ 120°	No	No
Good	≥ 60° - < 90°	> 5° - < 15°	Negative	≥ 90° - < 120°	No	No
Fair	≥ 45° - < 60°	≥ 15° - < 30°	Negative	≥ 45° - < 90°	No	No
Poor	< 45°	≥ 30°	Positive	< 45°	Yes	Yes

Table 2: *Criteria used to assess surgical results.*

Results

From July 2008 to December 2020, 208 patients (218 knees) underwent surgery. In all patients, the rectus femoris muscle developed after multiple antibiotic injections into the anterior thigh. Most of these injections were given in the first 24 months of life. The pharmaceutical agents injected were all antibiotics: penicillin in 168 cases (80.8%), penicillin and gentamycin in 29 cases (13.9%), others (lincomycin, streptomycin, cloxacillin) in 11 surgeries (5.3%). In 145 patients (69.7% [148 knees]), the rectus femoris muscle developed between the ages of 3 and 6 years. In 45 patients (21.6% [47 knees]), the rectus femoris developed between the ages of 7 and 11 years and in 18 patients (8.7% [13 knees]).

No patient had a history of birth trauma, direct trauma, or other congenital anomalies.

The mean age at the time of surgery was 7 years 8 months (range: 4 years, 2 months to 16 years, 9 months).

The mean follow-up period was 8 years, 3 months (range: 5 years, 4 months to 16 years, 9 months).

All patients tended to walk with a stooped posture, anterior pelvic tilt, hip abduction, and knee extension with lateral rotation of the leg (218 knees) (cf. figure 14).

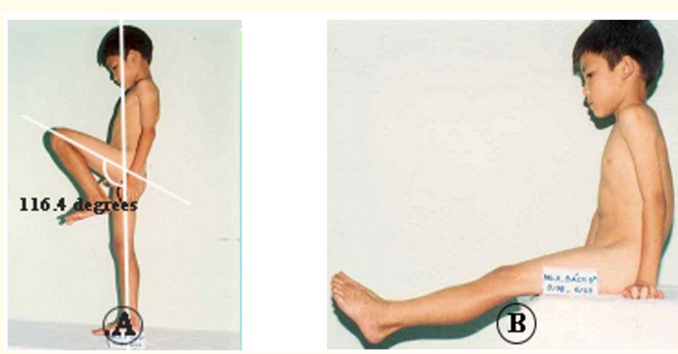

Figure 14A and 14B: *Postoperative 5 years 5 months. A: Flexor knee 116.4°. B: Full extension.*

Preoperatively, manual muscle strength was tested with the knee in flexion and extension and was normal in all patients. Three months after the procedure, manual muscle strength did not decrease. Postoperatively, all patients recovered muscle strength equal to or better than 4 Jones classification points.

Preoperatively, hip and knee radiographs were normal in all patients (cf. figure 4 and 5).

Ultrasound showed rectus femoris fibrosis in all patients (cf. figure 6).

Range of motion including knee flexion and extension angles was measured while the patient was sitting on a stool:

- Preoperative knee range of motion, average 132 degrees (range, 125 degrees to 135 degrees).
- Postoperative knee range of motion, average 135 degrees (range, 132 degrees to 145 degrees).
- Preoperative and postoperative knee extension angles were normal in all patients, indicating normal hamstrings.

Postoperatively, knee flexion angles with positive Ely test results were significantly improved (above 60° in 203 knees - 94.1%).

	Flexion angle of the knee			**Total**
	≤ 15°	**> 15° - ≤ 60°**	**> 60°**	
Preoperation	196 (89.9%)	22 (10.1%)	0	218
Postoperation	5 (2.3%)	15 (6.9%)	198 (90.8%)	218

Table 3: *Flexion angle of the knee at which Ely test was positive (cf. figure 3).*

Postoperatively, flexion angle of the hip when flexion angle of the Knees in which the Ely test remained positive were 20 knees (9.2%).

	Flexion angle of the Hip (With knee flexed 60°)			**Total**
	≥ 30°	**≥ 15° - < 30°**	**< 15°**	
Preoperation	184 (84.4%)	34 (15.6%)	0	218
Postoperation	12 (5.5%)	4 (1.8%)	202 (92.7%)	218

Table 4: *Flexion angle of the hip with knee flexed 60° (cf. figure 2).*

Postoperatively, flexion angle of the Hip (With knee flexed 60°) less than 15° Improvement were 202 knees (92.7%).

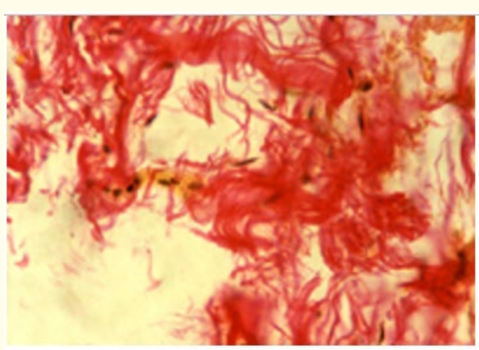

Figure 15: *Muscle biopsy showed fibrous tissue.*

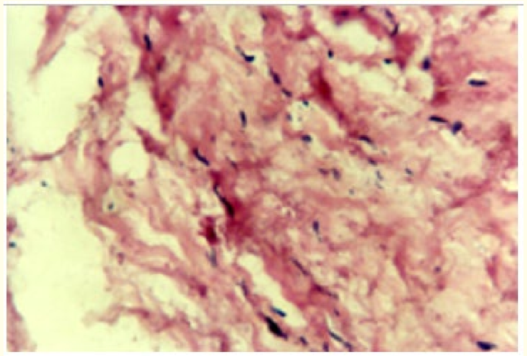

Figure 15: *Fibrous femoral fascia.*

Preoperatively, skin dimpling on the anteromedial thigh, which became more evident with knee flexion, and rectus femoris contracture were palpable in 177 thighs (81.2%) (cf. figure 1). Postoperatively, skin dimpling completely disappeared in all patients. However, palpable rectus femoris contracture remained in 24 knees (11.1%).

	Postoperative results				P
	Excellent	**Good**	**Fair**	**Poor**	
Variant A n= 102 knees	47 (46.1%)	23 (22.5%)	15 (14.7%)	17 (16.7%)	0.268703
Variant B n= 116 knees	101 (87.1%)	12 (10.3%)	2 (1.7%)	1 (0.9%)	
Total 218knees	148 (67.8%)	35 (16.1%)	17 (7.8%)	18 (8.3%)	

Table 5: *Comparing postoperative results of two surgical techniques.*

Long-term follow-up showed excellent results in 148 knees (67.8%) [143 patients], good results in 35 knees (16.1%) [33 patients], fair results in 17 knees (7.8%) [16 patients]) and poor results in 18 knees (8.3%) [16 patients]).

Comparison variant A/variant B with (Excellent + Good + Fair) Pvaluate = 0.268703.

The two surgical techniques were similar.

Comparison variant A/variant B with (Excellent + Good) Pvaluate = 0.149809525.

The two surgical techniques were similar.

No comparison significance.

Complications

- Neuromuscular injury: No.
- Wound infection: No.

Discussion

Normal gait

The orthopedist must have a good understanding of normal gait before analyzing the patient's gait and identifying any pathologies. The various and in some cases complex movements during walking are designed to move the body's center of gravity forward as smoothly as possible and without deviating from the direction of walking. At the same time, external forces (such as gravity and mass movements) are controlled in such a way that forward movement occurs with minimal cost. To achieve this goal, the foot must perform a series of movements in an orderly sequence. The foot moves mainly in a vertical plane relative to the leg axis. Just before the foot hits the ground, the foot is perpendicular to the leg (plantigrade) or slightly plantarflexed (about 5°), and the muscles that lift the foot and the toes are active. After the heel hits the ground, the foot performs plantarflexion movements until it touches the floor. This movement is called the first leg swing. The placement of the sole of the foot on the floor is controlled by the leg lifters. The lower leg then moves forward over the foot, which is now on the floor, producing a dorsiflexion movement at the ankle, which is cushioned by an eccentric contraction of the triceps (»pendulum secondi«). The full range of this movement is between 15° and 20°. At the end of this dorsiflexion movement, the eccentric contraction of the triceps progresses to a concentric contraction through the isotonic phase. As a result, the heel is lifted and the foot pushes the leg away from the ground ("pendulum third"). After pushing off, the foot returns to its previous position by activating the leg lifters. The knee is slightly bent after the foot touches the ground and the quadriceps prevent the leg from bending by eccentric action. The deceleration of the forward movement of the lower leg over the foot, which is now on the ground, results in passive extension of the knee as the lower leg continues to move forward. The ground reaction force, which can be represented as a vector between the foot and the ground, shifts from the rear knee position to the front knee position. While the rear knee force can be divided into a dynamic component in the direction of the ground and a knee flexion component (which requires muscular compensation), the ground reaction force occurs at the front knee, exerting an extensor force on the knee. In other words, the knee is extended indirectly and passively mainly during the second part of the phase. After push-off, the leg swings forward, after a short period of muscular acceleration, like a passive pendulum. The length of this passive pendulum and the weight of the leg determine the comfortable walking speed and stride length, which vary slightly from person to person. During walking and after being extended to a flexed position of about 5°-10° at the end of the swing phase, the knee is initially slightly flexed to about 15°-20°, then further extended to about 5° or even 0°. During the swing phase, the knee flexes approximately 75°-85° and reaches its maximum point of flexion when the knee passes the supporting leg. Likewise, the knee also moves only in the vertical plane [37,38]. The hip joints perform flexion and extension movements in the vertical plane: During leisurely walking, the adolescent hip flexes approximately 30° when the foot touches the floor. During full stance, the joint is gradually extended to 5°-10°. The hip then flexes again. Young children, in particular, are accustomed to walking at a speed faster than their height and thus have a relatively large stride length. This increased stride length is reflected in greater hip flexion when the foot touches the ground. In addition to flexion and extension, the hip also needs to rotate to keep the body's center of gravity moving forward. The hip rotates externally when flexion occurs before the foot touches the ground. The pelvis then swings forward over the pivot leg, creating an internal rotation. In standing, the hip joint not only flexes but also flexes outward.

Clinical gait analysis

Clinical gait analysis can detect serious pathologies in the kinetic chain. The prerequisite for analysis is that the patient is naked except for underwear and can walk a sufficient distance (at least 3 meters). Ideally, the assessor should sit on a low stool so that his eyes are at the level of the patient's pelvis. Gait is assessed primarily from the front and rear. Although it would be more effective to perform the test from the side, this view is rarely possible due to space constraints. The assessor will record the position of the feet when the patient stands, the position of the knees during swing and stance phases, and the movements of the pelvis. Claudication is a deviation from the normal kinetic chain and is often due to compensatory reasons, i.e. external forces generated through shifting the body's center of gravity are used to replace muscle activity. A familiar type of claudication is excessive pelvis drop toward the swing, known as Trendelenburg lameness, and compensatory upper body movement toward the supporting leg, known as Duchenne lameness. Both indicate a functional defect in the hip adductor muscles on the supporting leg because they do not provide adequate stability to the pelvis. Anterior tilt of the upper body reduces the load on the knee extensors. Active and full knee extension after the foot hits the ground is a sign of plantar flexor weakness. Other types of lameness, such as toe-off lameness with a shorter stance phase on the affected leg or a shorter gait with a highly asymmetrical pelvic movement, are also easily identified. At the level of the foot, the examiner will note the position of the foot on landing (pedal deformity or even equinus deformity) and the position of the heel relative to the lower leg (valgus or valgus deformity). Foot alignment relative to the direction of gait is another important factor. All of these points can be determined from the anterior or posterior perspective.

Instrumental gait analysis Instrumental gait analysis is used to identify gait pathologies, especially during the faster phases of movement, and to document their functional impact. always lead to functional impairment. However, this therapeutic differentiation can only be made with instrumental gait analysis, which remains an extremely important investigative method to this day. The equipment is expensive and technically complex, measuring many different parameters, including force, motion, and electromyography (EMG), and can take about a working day to record and evaluate the data for a single patient. For these reasons, instrumental gait analysis is reserved for complex problems.

Hněvkovský (1961) and Miki (1962) were the first authors to describe fiber changes after intramuscular injection of antibiotics in children [15,17]. Since that time, most of the published cases of muscle contractures have been associated with injections in children, such as: quadriceps fibrosis [1,5,8,10,12,14,16,19,20,22,23,28-30], triceps fibrosis [2,36], deltoid fibrosis [3,4,6,7,18,24,25,34,36], knee stiffness with patellar dislocation due to quadriceps fibrosis [16,24,26], gluteus maximus fibrosis [13,28], and rectus femoris fibrosis [9,16,19,31]. Lénárt [19], McCloskey [21] and Ogata [28] have shown that the injection site also correlates with the progression of the disease: for example, injection into the lateral thigh leads to quadriceps fibrosis, into the anterior thigh leads to rectus femoris fibrosis. Our study found a history of multiple antibiotic injections into the rectus femoris muscle in all patients, causing atrophy of the thigh muscle. The injection site is directly correlated with the diseased area. Therefore, the proportion of affected muscles depends on the usual injection site in each country. In our patients, the antibiotics injected included penicillin in 106 cases (69.7%), penicillin and gentamycin in 39 cases (25.7%), and others (lincomycin, streptomycin, cloxacillin) in 7 surgeries (4.6%). The palpable skin dimpling and contracture of the rectus femoris muscle resolved completely in 149 knees (92.5%). Frasch W 1976 [8] and McCloskey JR 1977 [21] suggested that if long-term antibiotic therapy is planned for children, intramuscular antibiotics should be avoided and intravenous administration should be used if possible, and we agree with their opinion.

According to Gray [11], the quadriceps femoris, the large extensor muscle of the leg, covers most of the anterior and lateral aspects of the femur. It can be divided into four parts, each of which is named separately. One, the rectus femoris, originates from the ilium and runs straight down the middle of the thigh, its shape and course determining its name. The other three originate from the femoral shaft and encircle it (except the linea aspera) from the trochanters to the condyles: the vastus lateralis lies on the outside of the femur, the vastus medialis lies on the middle of the femur, and the vastus medialis lies in front of the femur. The rectus femoris crosses both the hip and knee joints, while the three vastus medialis only cross the knee joint. The rectus femoris muscle leads to limited hip and knee motion and knee stiffness during swing phase, with a tendency to kyphosis, anterior pelvic tilt (occurring in 161 knees [100% (152 patients)].

The vastus lateralis fascia [11] with its proximal insertions may extend to the superficial fascia of the gluteus medius. It runs medially and is attached to the two layers of the iliotibial tract of the vastus lateralis and usually ends about one-third of the way down the thigh, although it may extend to the lateral femoral condyle. The vastus lateralis fascia, acting via the iliotibial tract, extends the knee by externally rotating the leg; it may also assist in abduction and internal rotation of the thigh, although its role as an abductor muscle remains controversial. The muscle helps maintain an upright posture while minimizing the energy expenditure of muscle activity: when the subject stands, it acts from below to stabilize the pelvis on the top of the femur and via the iliotibial tract, to stabilize the femoral condyles on the tibial condyles while the knee extensors are relaxed.

Some authors believe that the iliotibial tract is more important in stabilizing the pelvis than the latissimus dorsi. This muscle assists the gluteus medius in abduction at the hip. Its primary function is to control posture. During the last 20° of extension, the iliotibial tract moves anterior to the axis of knee flexion, and the latissimus dorsi is therefore a weak extensor. Flexion beyond 20° causes the iliotibial tract to pass posterior to the axis of flexion, making the muscle a weak flexor. Thus, contracture of the latissimus dorsi causes the hip to abduct in stance and the leg to rotate laterally when the knee is extended. Contracture of the hip flexors results from shortening of the hip flexors or the joint capsule. A tight iliotibial band is a variant of this disorder that increases the anterior tilt of the pelvis. Release of the iliotibial tract reduces the anterior tilt of the pelvis and increases knee flexion. These “double-jointed” muscles-the rectus femoris anteriorly, the gracilis, semitendinosus, and semimembranosus posteriorly (medial hamstrings), and the biceps femoris (lateral hamstrings)-all directly influence knee position as well as hip position. In our series, the normal range of motion of the knee while sitting on a stool demonstrated normal function of all hamstring muscles.

In gait analysis, at the end of final stance and before swing, the knee flexes rapidly, continuing throughout the initial swing until the knee is maximally flexed (60°); during swing, the motion at the hip changes from flexion to extension, with the knee extending passively due to this change in hip direction, and excessive hip flexion can affect many activities of daily living. All three hamstring muscles (long head of the biceps femoris, semimembranosus, semitendinosus) are active during the swing from mid-to-late to slow knee extension. The relationship between hip flexion and knee flexion is commonly referred to as “slouching posture”. The imbalance in strength between the rectus femoris and hamstrings causes “slouching posture”. In this study, normal hamstrings and release of rectus femoris spasm eliminated “slouching posture” and improved gait. Before surgery, 136 knees (84.5%) had a hip flexion angle ≥ 30° at 60° knee flexion. After surgery, 149 knees (92.5%) had a hip flexion angle < 15° at 60° knee flexion, and the tendency to kyphosis and anterior pelvic tilt was significantly improved.

Under general anesthesia, the Ely and Ober tests were negative in all cases before the completion of surgery. However, we obtained poor results in 17 knees (16.7%) with variant A and in only 1 knee (0.9%) with variant B.

We agree with Sung’s opinion that the surgical procedure for treating post-injection rectus femoris contracture is medial rectus femoris release [32]. Mukherjee PK [24], Nguyen NH [25], the authors observed quadriceps fibrosis after intramuscular antibiotic injection and found iliotibial tract contracture. Their surgical procedure was to lengthen the quadriceps and create a V-Y division or iliotibial tract to allow full knee flexion. The vastus lateralis muscle, which acts through the iliotibial tract and at the last 20° of knee extension, is a weak extensor muscle, so we performed iliotibial tract release at the proximal border of the lateral femoral condyle. The main weakness of variant A is the untreated adhesion between the rectus femoris and vastus lateralis in the middle third of the thigh.

Conclusion

1. Rectus femoris fibrosis may result from intramuscular antibiotic injection. The main signs of the disease are: knee stiffness during the swing phase; positive Ely and Ober tests; The patient tends to hunch over, tilt the pelvis forward; Skin dimpling in the mid-anterior thigh and a palpable contracture of the rectus femoris. Muscle biopsy shows marked fibrous tissue of the muscle (also seen on ultrasound) and vastus lateralis fascia.
2. The preferred surgical treatment for such knee stiffness during the swing phase is option B (medial release of the rectus femoris and transverse division of the vastus lateralis fascia). This simple and safe surgical procedure significantly improves knee and hip function, improves stooped gait and anterior pelvic tilt.

Limitations of the Study

This study has the following limitations:

1. There were no injuries to the rectus femoris muscle after antibiotic injection to compare with clinically, radiographically, and pathologically similar injuries.
2. There were no results to compare after surgery with the superior rectus femoris muscle or muscle separation.

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