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ORIGINAL ARTICLE

Management of Patella Alta with Semitendinosus Graft in Cerebral Palsy Patients

Mohamed H. Fadel, Ahmed Ramy, Mohammed H. Hashem
Department of Orthopedic Surgery, Faculty of Medicine, Helwan University, Cairo, Egypt.

Correspondence to *Mohamed H. Fadel, Department of Orthopedic Surgery, Faculty of Medicine, Helwan University, Cairo, Egypt.*
E-mail: mohamed.hussein@med.helwan.edu.eg

Introduction Patella alta is a pathological condition where the patellar is superiorly displaced, this can lead to associated anterior knee pain and decreased strength of the extensor mechanism. Pediatric patients with cerebral palsy have a higher incidence rate of patella alta, and this is thought to be a cause of anterior knee pain and weakness of knee extension in those patients In this study, we harvested the semitendinosus tendon and utilized it as a tension band to correct the patella's position. This approach eliminates the need for additional hardware and reduces the flexion strength of the hamstrings, achieving a dual effect.

Subjects and Methods A prospective cohort study was conducted on 20 cases, ages ranging from 10 to 15 years. 16 cases were level III by the gross motor function classification system, while 4 cases were gross motor function classification system level II, and all cases were diplegic cerebral palsy. All of them were managed by semimembranosus muscle fractional lengthening and harvesting the semitendinosus tendon and utilizing it as a tension band to correct the patella's position.

Results There was a statistically significant improvement in the patella position and the gait postoperatively.

Conclusion The semitendinosus tendon used as a tension band for correction of the patella allows correction of both patella positions as well as improving gait pattern. Level of evidence: case series (IV).

Keywords Cerebral palsy, Patella alta, Semimembranosus graft.

INTRODUCTION

The patella is known to be the largest of the sesamoid bones in the human body, it is located within the tendon of the quadriceps femoris. Its only articulation is with the femoral trochlea, this happens all through the range of knee flexion and extension. The main role of the patella is to increase the force of the extensor mechanism of the knee by increasing the lever arm of the quadriceps femoris muscle [1,2].

Patella alta (PA) is a pathological condition where the patellar is superiorly displaced, this can lead to associated anterior knee pain and decreased strength of the extensor mechanism. This superior displacement leads to a reduction of the contact area between the patella and the femoral trochlea, which leads to increased pressure on localized areas of the joint which in turn can accelerate articular cartilage degeneration [3,4].

Pediatric patients with cerebral palsy (CP) have a higher incidence rate of PA, and this is thought to be a cause of anterior knee pain and weakness of knee extension in those patients [4].

In CP pediatric patients suffering from crouch gait, patellar tendon shortening (PTS), or advancement can be offered as a treatment option for PA [5].

The main goal in the management of PA is to reposition the patella. This can be achieved by different techniques, including but not limited to tibial tubercle osteotomy, partial patellar tendon release, distal patellar reconstruction, patellar tendon overlapping, and cerclage wire tension band [6].

The main aim of these techniques is to restore the patellar position leading to an increase in the mechanical advantage of the quadriceps femoris, thereby enhancing the strength of the knee extensor mechanism [6].

In this study, we harvested the semitendinosus tendon and utilized it as a tension band to correct the patella's position. This approach eliminates the need for additional hardware and reduces the flexion strength of the hamstrings, achieving a dual effect.

Aim

This study aims to evaluate the outcome of correction of PA in CP patients using a semitendinosus graft.

SUBJECTS AND METHODS

A prospective cohort study was conducted on 20 cases at Helwan University Hospital. 12 cases were males, and eight cases were females. 16 cases were level III by the gross motor function classification system (GMFCS), while four cases were GMFCS level II, and all cases were diplegic CP. Age ranged from 10 to 15 years, and the mean age was 11.7 years.

Ethical approval has been obtained from the ethical committee of the faculty of medicine at our university. Informed consent has been obtained from the parents of the study participants, addressing risks, benefits, compensations, and withdrawal rights. Administrative approval has been obtained from the university hospital's management.

All cases did not have any previous operation for correction of PA. The average follow-up was 1 year after the operation. Inclusion criteria were patients with age less than 15 years old, both genders and CP patients with PA. While exclusion criteria were patients over 15 years old, nonambulatory patients, bony flexion deformity of the affected knee, hip subluxation or dislocation, pelvic tilt, hip flexion, unbalanced pelvis, weak abdominal muscles, and iliopsoas muscle tightness.

Parents or caregivers will be asked to give consent for study participation. The data of the patients fulfilling the inclusion criteria will be evaluated using clinical evaluation, a carefully detailed history will be taken with a complete lower limb examination for evaluation of gait, popliteal angle, and knee extension.

The radiological assessment included taking plain radiography of the affected knee from both anteroposterior and lateral views to calculate the Koshino Index (KI index). Another radiography was taken for the opposite side for comparative analysis (Figure 1).

Operative procedure

All patients have been operated on a radiolucent standard operation table under general anesthesia in a supine position.

A double incision done for all patients, a posteromedial incision 3cm over the tight hamstring, semimembranosus muscle was identified, and fractional lengthening was done, a tendon stripper was utilized to harvest the semitendinosus tendon from the same incision.

Then a mid-line anterior longitudinal incision from the superior pole of the patella reaching 3cm distal to the tibial tubercle is done, the tendon graft was prepared using Vicryl l–0 sutures, and a 4.5mm drill bit was used to create a transverse hole just proximal to the mid-patella, extending from the medial to the lateral aspect. A second transverse drill hole was created in the tibial diaphysis, located just inferior and posterior to the tibial tuberosity (Figure 2).

With the knee flexed to 30º, the harvested tendon graft was passed through the patellar tunnel in a lateral-to-medial direction. The opposite end of the graft was passed through the tibial tunnel in a medial-to-lateral fashion. The graft ends were then crossed anteriorly to the patella and secured to the patellar tendon bilaterally in a figure-of-eight configuration.

The tendon graft was tensioned until the anterior aspect of the patella was positioned between the tibial plateau and the Blumensaat line, this was confirmed using C arm guidance (Figure 3).

After the last check and wound closure, the knee joint was supported in a high above-knee cast for 6 weeks. After two weeks cast was changed.

Postoperative care

The cast was removed after 6 weeks after surgery. Postoperative radiography were made, and the KI index was calculated. Clinical data was collected at each follow up including popliteal angle, extension lag, and walking gait pattern.

Physiotherapy started 6 weeks postoperative including weight bearing as tolerated. Knee range of motion (0–90º), muscle exercise (strength and stretch) quadriceps, and hamstring.

Postoperative assessment

At 12 weeks postoperatively, patients were assessed for knee range of motion, muscles strength, and gait pattern.

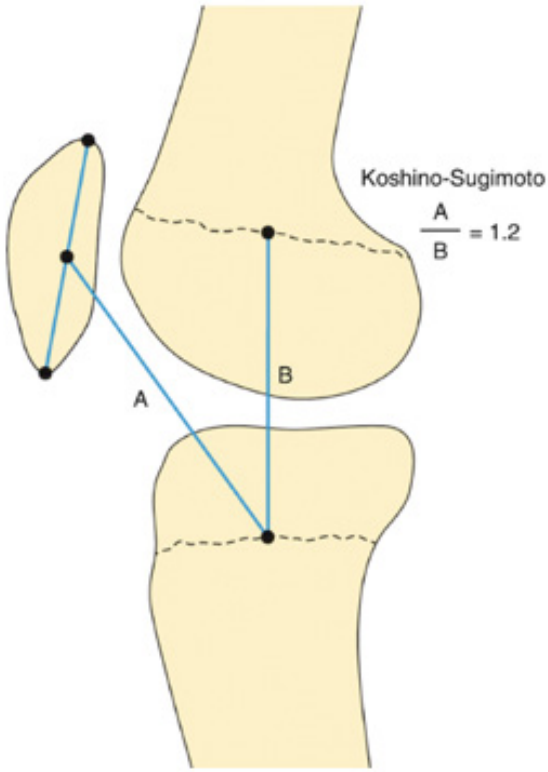
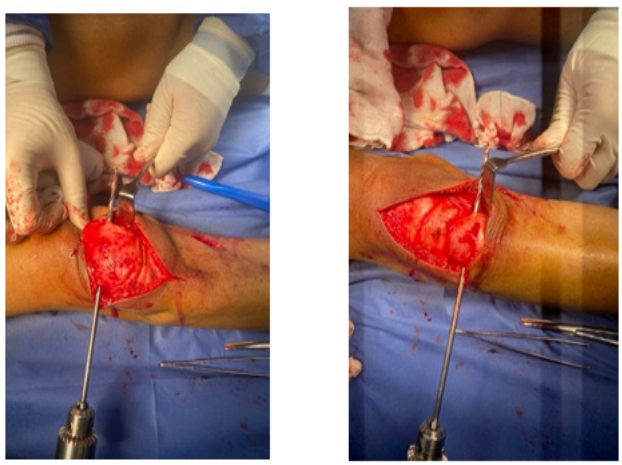
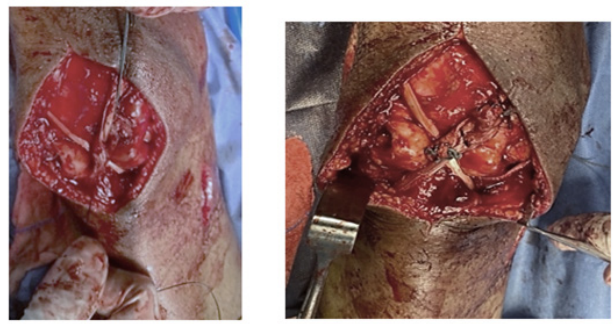


Figure 1: Koshino-Sugimoto (1989) ratio. The measurement of the line A joining the midpoint of the patella to the midpoint of the tibial physes is divided by the inter-physeal distance B calculated by joining the midpoints of the femoral and tibial physes [7].



(A) (B)

Figure 2: Clinical photos showing the technique of drilling the patellar tunnel (a) and tibial tunnel (b).



(A) (B)

Figure 3: Clinical photos showing the technique of suturing the harvested graft before suturing (a) and after suturing in the form of figure-of-8 (b).

RESULTS

A total of 20 patients with diplegic CP were enrolled in the current study. Their age ranged from 10 to 15 years and their GMFCS was III in 16 (80%) cases representing of the study while the remaining four (20%) cases were GMFCS II representing the remaining.

Statistical analysis

After gathering the data, it was reviewed, coded, and inputted into the Statistical Package for Social Science (Armonk, NY: IBM Corp. IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 20).

The study was designed with a 95% confidence interval and a 5% margin of error. The significance of the *p* value was interpreted as follows: a *p* value greater than 0.05 was deemed nonsignificant (NS), less than 0.05 was considered significant (S), and less than 0.001 was highly significant (HS).

Descriptive and analytic data

There were 12 cases were male and eight were female and the ages ranged from 10 to 15 years (mean 11.70 years).

When analyzing the patients' gait patterns preoperatively, all patients were observed to have crouched gait with excessive hip and knee flexion.

The mean preoperative popliteal angle was 71.85º±4.51 and the mean postoperative angle was 31º±2.66, denoting a highly statistically significant improvement, with improvement of gait between preoperative and postoperative gait patterns (Table 1).

The KI preoperatively ranged from 1.6 to 2.3 (mean 1.94) while postoperatively it ranged from 0.8 to 1.2 (mean 1.01) and this was highly statistically significant (Table 2 and Figure 5).

The extension lag preoperatively ranged from 20 to 40º (mean 30.65º) while postoperatively it ranged from 0 to 12º (mean 4.5º) this was highly statistically significant (Table 3 and Figure 4, 6).

Table 1: Distribution of the studied cases according to Popliteal angle

	Number=20	
Popliteal angle (in degrees)	**Mean±SD**	**Range**
Pre	71.85±4.51	65–78
Post	31.00±2.66	25–36

Table 2: Distribution of the studied cases according to KI

Number=20		
KI	**Mean±SD**	**Range**
Pre	1.94±0.22	1.6–2.3
Post	1.01±0.17	0.8–1.2

Table 3: Distribution of the studied cases according to extension lag

	Number=20	
Extension lag	**Mean±SD**	**Range**
Pre	30.65º±6.17	20–40º
Post	4.50º±4.61	0–12º

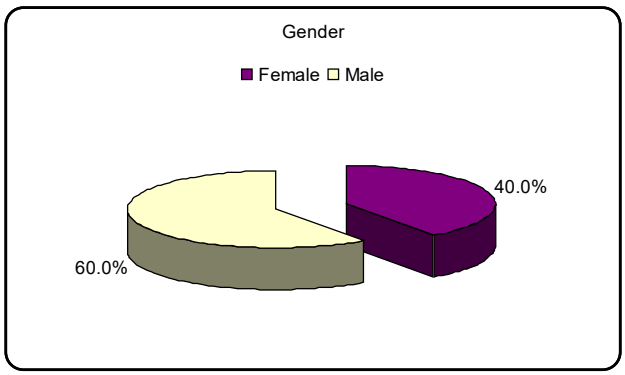


Figure 4: Distribution of the studied cases according to sex.

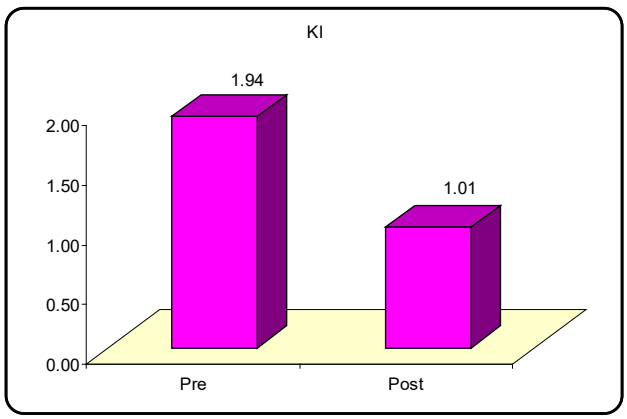


Figure 5: Comparison between preoperative and postoperative KI.

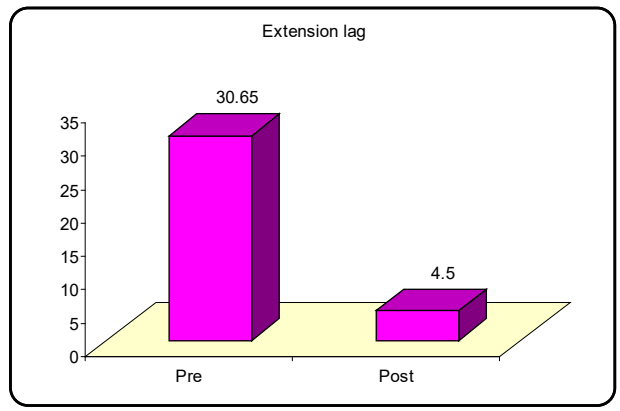


Figure 6: Comparison between Extension lag Pre and postoperative.

DISCUSSION

The knee joint is an important key in improving the function and gait in patients suffering from spastic diplegia thus improving knee extension is important for the patient to have an efficient gait.

Knee extension is a complex movement influenced by hamstring flexibility, quadriceps strength, passive joint mobility, and the coordinated interaction between the knee and ankle joints. A comprehensive assessment of these factors is essential for effective knee rehabilitation [3].

This study investigates a single-stage intervention targeting hamstring length and knee extensor strength to enhance patellar alignment, optimize quadriceps lever arm, and consequently improve knee extensor function.

Roberto S. and colleagues assessed the outcomes of three surgical techniques used to manage patients with spastic diplegia exhibiting a flexed knee gait. The surgical techniques used were PTS, PTS combined with femoral and/or tibial rotational osteotomies, and PTS in conjunction with distal femoral supracondylar extension osteotomy. The results showed an overall improvement in gait patterns. All three surgical groups demonstrated improvements in knee and gait mechanics, physical examination findings, and knee function index. This suggests that a customized approach to correcting flexed knee gait in patients suffering from spastic diplegia is both viable and effective [8].

This study demonstrated PA correction, which can be demonstrated by an improvement in the KI from 1.94 preoperation to 1.0 postoperation (p<0.001). This improvement was accompanied by enhancements in gait patterns.

Klotz and colleagues conducted a randomized controlled trial involving 22 children with CP and flexed knee gait. Patients underwent single-event multilevel

surgery with or without additional PTS. Both groups experienced significant improvements in maximum knee extension postsurgery, but the PTS group demonstrated greater correction. While PTS effectively addressed flexed knee gait and improved knee extension during the stance phase, it was associated with increased stiffness and anterior pelvic tilt [5].

In this study, the mean of the popliteal angle preoperatively was 71.85 and was 31º postoperatively, this was a highly statistically significant improvement. The knee flexion contracture and popliteal angle improved postoperatively, these explain the improvement of the crouch gait pattern observed in all patients after restoring the biomechanics of the knee, enhancing the knee extension, and improving the muscle imbalance.

Limitations of the study

Still, no studies are available for this technique, so more studies are needed, the small patient number in this study also presents a limitation for this study. Nevertheless, the follow-up duration in this study is considered to be short.

CONCLUSION

The semitendinosus tendon used as a tension band for correction of the patella allows correction of both patella positions as well as improving gait pattern by decreasing flexion strength of the hamstrings (dual effect) while avoiding the usage of other hardwa re.

ACKNOWLEDGMENTS

Author contributions: M.H.F.: concepts, design, definition of intellectual content, literature search, and clinical studies; A.R.: data acquisition and data analysis; M.H.H.: statistical analysis, manuscript preparation, manuscript editing, and manuscript review.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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