




Modified Roux-Goldthwait procedure for habitual patellar dislocation in pediatric population

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ABSTRACT

Objectives: Patellar instability is one of the most common pathologies in children and adolescents. The objective of this study is to present the functional and diagnostic results after performing modified Roux-Goldthwait procedure for habitual patellar dislocation in pediatric population.

Materials & methods: A retrospective analysis was performed on 17 patients, under the age of 18 years, from September 2007 to March 2023. For diagnostic results were evaluated congruence angle, sulcus angle and Caton-Deschamps index. Functional results were evaluated by modified Lysholm score and Cox grading system.

Results: Excellent and good results were reported for 82%, fair and poor results for 18%. No statistical significance was reported on the topic of congruence angle and sulcus angle.

Conclusions: Modified Roux-Goldthwait procedure for habitual patellar dislocation in pediatric population is safe and effective as it is entirely soft tissue operation that leaves the growth plate intact.

Keywords: soft tissue, patella, dislocation, habitual

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INTRODUCTION

Patellar instability is one of the most prevalent knee problems during growth. It is a common and challenging problem that comprises different conditions, such as acute, chronic, recurrent and habitual. Habitual dislocation is a condition, where the kneecap dislocates whenever the knee is flexed and spontaneously relocates with the extension of the knee. The incidence rate is around 50 in 100,000 children and adolescents per year [4].

Studies have reported that patients with open physes are at over twice the risk for habitual patellar dislocation compared with skeletally matured knees [5]. The biomechanics of the patellofemoral joint are complex with combination factors. They can be categorized in anatomic and demographic.

Anatomic factors include fibrosis of quadriceps femoris and vastus lateralis, patella alta, systemic ligament laxity, dysplasia of the femoral condyle, increased

TT-TG distance. Demographic factors include young age, sex, and anamnesis for contralateral dislocation. A history of opposite knee patellar dislocation has been shown to increase the risk by three times compared to those without previous incident [6, 7].

More than 100 operations have been described, but no single procedure is fully effective in the surgical treatment and a combination of techniques is required [8-11]. Conservative treatment is considered unapplicable for habitual dislocation and is advised only in a single episode of patellar instability. In the skeletally immature patient, operative techniques that include bone transfer must be avoided, if possible, to prevent premature physeal closure. This leaves soft tissue procedures to address the above problems in this patient population. In this present study, we report upon an operative technique performed by a single surgeon in children and adolescents for treatment of habitual dislocation of the patella.

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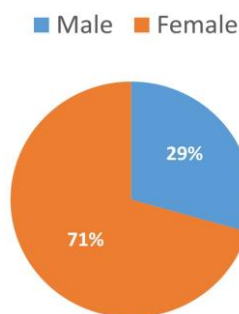


Figure 1. Statistics of male & female percentage included in study (Source: Niya Gecheva 2023, Modified Roux Goldthwait procedure for habitual patellar dislocation in pediatric population. Medical University of Sofia, University hospital of Othopedics "Prof. B. Boichev", Sofia, Bulgaria)

Excellent	Asymptomatic Unrestricted activities Full range of motion No crepitus No tenderness
Good	No muscle atrophy Slight symptoms with activity Full range of motion Occasional crepitus Occasional tenderness
Fair	No effusion Improvement in symptoms, but pain with activity Limited range of motion Occasional painful crepitus Occasional joint effusion
Poor	Chronic pain Marked limitation of activity Recurrence of subluxation

Figure 2. Cox grading system (Source: Niya Gecheva 2023, Modified Roux Goldthwait procedure for habitual patellar dislocation in pediatric population. Medical University of Sofia, University hospital of Othopedics "Prof. B. Boichev", Sofia, Bulgaria modified for this study from [3])

MATERIALS & METHODS

A retrospective study was conducted in the clinics of pediatric orthopedics in a University Hospital of Orthopedics for the time period between February 2007 and January 2023 with a mean follow up of 75 months. Total of 17 (71% women and 29% men) patients with habitual patellar dislocation were treated by the modified Roux-Goldthwait technique with a mean age during the operation 9.29 ± 3.99 years (Figure 1).

A single surgeon performed the operations. The inclusion criteria were habitual patellar dislocation, age under 18 years, unclosed pyses. Exclusion criteria were age over 18 years, previous operations, anamnesis for underlying conditions, fractures of the lower limb, lack of postoperative radiographs. The main symptoms were complete dislocation of the patella with each flexion and relocation with each extension, usually presenting when the child starts walking and well tolerated by the youngsters [12, 13].

Clinically the condition is assessed by the "flexion-extension test" and apprehension test. Modified Lysholm

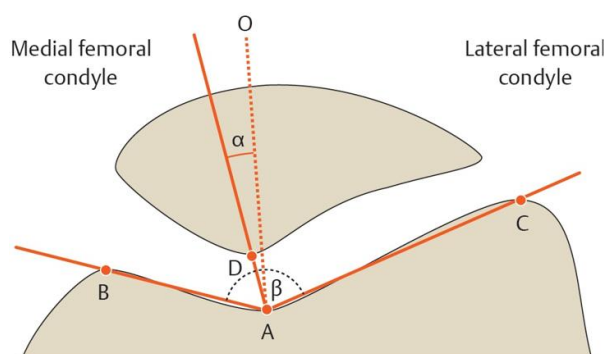


Figure 3. Measurement of congruence & sulcus angle (Source: Niya Gecheva 2023, Modified Roux Goldthwait procedure for habitual patellar dislocation in pediatric population. Medical University of Sofia, University hospital of Othopedics "Prof. B. Boichev", Sofia, Bulgaria modified for this study from [1])

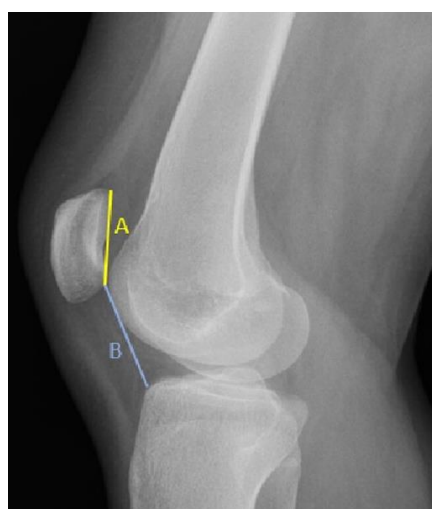


Figure 4. Measurement of CD index (Source: Niya Gecheva 2023, Modified Roux Goldthwait procedure for habitual patellar dislocation in pediatric population. Medical University of Sofia, University hospital of Othopedics "Prof. B. Boichev", Sofia, Bulgaria)

score, where 91 to 100 points is considered excellent, 84 to 90 points is considered good, 65 to 83 points is considered fair, and 64 or less points is considered unsatisfactory, and Cox grading system (Figure 2), are used for pre-and postoperative functional outcome.

The sulcus angle (brattstorm angle), congruence angle (merchant angle) and Caton-Deschamps (CD) index were evaluated by knee AP view radiographs with 30-degree flexion and axial view (merchant) radiographs–45-degree skyline view (Figure 3). The mean sulcus angle is 138 ± 6 degrees. Mean congruence angle is defined as < -16 degrees.

CD index, which is confirmed reliable of using for evaluating patellar height in pediatric population, is calculated on lateral knee radiographs, where distance from the inferior pole of patella (A) to the superior pole of the tibia is divided by the length of the patellar articular surface (B)–B/A [14–16]. Cutoff criteria is usually from 1–1.2 (Figure 4).

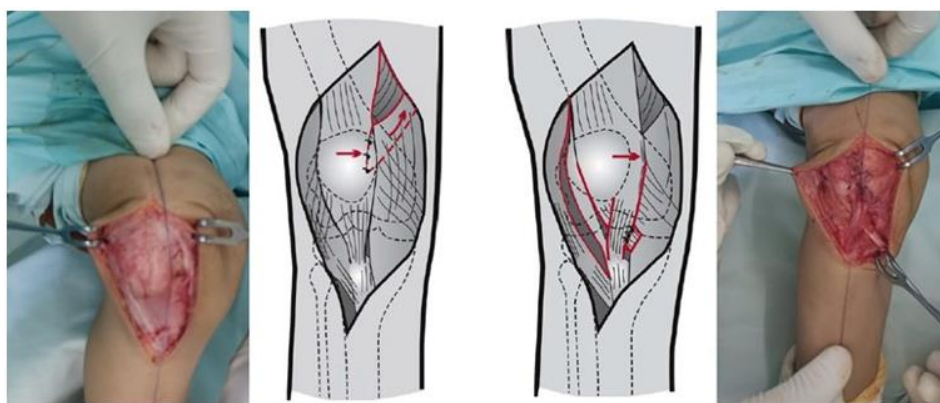


Figure 5. Operative technique (Source: Niya Gecheva 2023, Modified Roux Goldthwait procedure for habitual patellar dislocation in pediatric population. Medical University of Sofia, University hospital of Othopedics "Prof. B. Boichev", Sofia, Bulgaria)

Operative Technique

The procedure is carried out under general or spinal anesthesia. The patient is supine on the operating table. Tourniquet is applied to the thigh. A midline parapatellar skin incision is made to expose the quadriceps mechanism and the patellar tendon. The incision is deepened through the subcutaneous fat to the fascia, allowing visualization to the lateral and medial retinaculum and the insertion of the vastus medialis obliquus.

Release of the lateral retinaculum and lateral femur patellar ligament is performed leaving the synovium intact and not opening the joint capsule. On the medial side medial release is preformed and the proximal vertical muscle fibers of vastus medialis are dressed distally and from vertical become horizontal. This muscle is with great significance as the main stabilizing structure of the soft tissue procedure (Figure 5).

The lateral part of the patellar tendon is detached from its tibial insertion, split from the remaining tendon, leaving it attached to the patella proximally. Under dosed tension of 50-60 degrees the tendon is transferred medially under the remaining half and reattached to the periosteum providing distal and medial advancement. Hemostasis was achieved before the wound was closed in layers. A splint in extension of the knee was applied for 28 days. The post operative regimen includes full extension of the knee for four weeks, using crutches for 30% weightbearing. From 5th-7th week the flexion in the knee joint develops from 30 degrees up to 90 degrees. At six weeks after surgery a program of strengthening the musculature and restoration of the range of motion is commenced. Late rehabilitation includes self-walking without additional assistance, balance-board and exercises.

RESULTS

Data were available on 17 knees with a minimum follow-up period of three months and mean follow up period 75 months. The mean patient age during the surgery is 9.29 ± 3.99 years. The congruence angle was calculated before and after surgery as the normal value is between -5 and 16

Table 1. Patients evaluated by modified Lysholm score

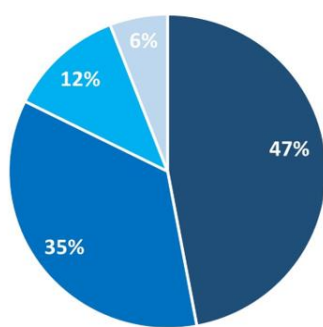
Excellent (91-100)	8
Good (84-90)	6
Fair (65-83)	2
Poor (below 65)	1

Table 2. Patients evaluated Cox grading scale

Excellent	Asymptomatic	5 patients
	Unrestricted activities	
	Full range of motion	
	No crepitus	
	No tenderness	
Good	No muscle atrophy	8 patients
	Slight symptoms with activity	
	Full range of motion	
	Occasional crepitus	
	Occasional tenderness	
Fair	No effusion	3 patients
	Improvement in symptoms but pain with activity	
	Limited range of motion	
	Occasional painful crepitus	
	Occasional joint effusion	
Poor	Chronic pain	1 patient
	Limitation of activity	

degrees. The mean preoperative angle is 10.35 degrees, and the mean postoperative angle is 10.09 degrees and by using t-student test the difference is statistically insignificant. The mean sulcus angle was also pre-operatively (141.11) and post-operatively (140.16) evaluated. Eleven of the patients, included in the study, were measured with CD index above one, thus belonging to B and C group by Dejour classification. At the final follow up no impactful divergence following the criteria was distinguished. The children were able to return to regular physical activities within one year of the operative treatment. The mean Lysholm score at the most recent follow up was 88.1 and five patients were reported to have excellent results according to Cox grading scale (Table 1 and Table 2).

Lysholm score results



■ Excellent (91-100) ■ Good (84-90) ■ Fair (65-83) ■ Poor (below 65)

Figure 6. Modified Lysholm score table results (Source: Niya Gecheva 2023, Modified Roux Goldthwait procedure for habitual patellar dislocation in pediatric population. Medical University of Sofia University hospital of Othopedics "Prof. B. Boichev", Sofia, Bulgaria)

Table 3. Summary of results

	Pre-O	Post-O	SD	SS
Lysholm score	69.90	88.10	8.95/9.75	p<0.05
Sulcus angle	141.11	140.16	3.51/3.35	p>0.05
Congruence angle	10.35	10.09	5.14/4.95	p>0.05
CD index	1.21	1.14	0.63/0.56	p>0.05

Note. O: Operative & SS: Statistical significance

The diagram displays graphically that 47% of the patients had excellent results, 35% had good results, 12% fair and only 6% had poor results (Figure 6).

In Table 3, a summary of functional outcomes is presented. Complications after surgery were not reported.

DISCUSSION

Over 100 surgical techniques have been described for treatment of patellar instability. Although they all have advantages and impairments, none is considered ideal. Patient groups are variable and indications for surgery-debatable. Patellar maltracking can cause cartilaginous lesions and chronic hyperpression with the risk of later development of osteoarthritis. It has been proposed a system for classification of the patellofemoral disorders thus allowing identification of underlying condition that can reflect on the diagnostics [17].

Physicians should look into patient and family history of ligament laxity or collagen disorders that predispose to patellar instability. Clinical evaluation includes number of tests focused on patellar tracking during active and passive range of motion and patellofemoral examination of the involved extremity compared with the contralateral one. The combination of history, physical exam, and the previously described radiographic measurements are crucial to determine the risk for dislocation and establishing an appropriate treatment plan. Most authors have reported habitual dislocation in association with shortening of the

quadriceps and the lengthening of the tendon-crucial for the patella to remain reduced after the realignment. Important factor is contracture of soft tissues lateral to patella. In 1963, it was described an abnormal attachment of the iliotibial tract to the patella, producing habitual dislocation in flexion [18]. Later, in 1964, it was put forward the idea that quadriceps contracture may sometimes give rise to dislocation of the patella [19]. Although of different etiology, the surgical treatment of congenital patellar dislocation consists of soft tissue release coupled with patellar tendon transfer [20]. It was shown that 88% satisfactory results with extensive lateral release of the retinaculum and incision of the joint capsule, medial plication of the capsule, a transfer of lateral half of the patella tendon and release of the rectus femoris [21]. As much as it is needed lateral release is found to be insufficient as a single surgical approach in the fight with the habitual patellar dislocation. It was noted a deterioration in the results according to the system of Crosby and Insall—from 50% graded excellent at four years after lateral release to 37% at eight years [22]. It was examined lateral release alone, lateral release with medial reefing, and the Roux-Goldthwait procedures in an effort to address specific indication for specific procedures [23]. It consisted of 57 operations—for patellar tilt, for subluxation of the patella and combination of tilt and subluxation. They found that lateral release is a sufficient operative technique when only patellar tilt is present. In the cases of tilt and subluxation the authors advised medial reefing. Subluxation alone was best treated with a Roux-Goldthwait procedure. Roux-Goldthwait was first described in 1888 by Roux and reported in 1895 by Goldthwait. The operation was modified by Marsh, who performed not only lateral release, but also longitudinal split of the patellar ligament and the lateral part is detached from the tibial tuberosity, transferred deep to the medial half and sutured on to the periosteum. It was reported a 71% good to excellent results (with 90% of athletes returning to normal competition) while using a proximal and distal soft tissue procedure [24]. There are other procedures for treatment of patellar instability, such as Fulkerson, but it should only be considered in adolescent patients with closed growth plate due to the endangerment of the physes. Tibial tubercle osteotomy is contraindicated in skeletally immature patients as it can lead to genu recurvatum deformity [25].

In our survey a great attention is paid to the patellofemoral joint and its stability. It is determined by both bone structure and soft tissue. The static structure consists of the articular cartilage and supportive soft tissue, while the dynamic stability includes the quadriceps muscle. The vastus medialis advancement 5-10 mm distally and laterally is of crucial significance for stabilizing the patellar position. The three-component operative technique, presented, is with 82% of the patients having excellent and good results and only 18%—with fair and poor results. No physeal damage and recurrent dislocations were reported, thus making the

modified Roux-Goldthwait procedure suitable for skeletally immature patients. Another promptly advantage is redundancy of metallic osteosynthesis as operation is utterly involving soft tissue advancement. The procedure is applicable in every operational unit as long as the surgical team is acquainted with its particularities.

CONCLUSIONS

However, studies have not consistently shown superior outcomes with one technique over another, we believe that our modification of the prominent Roux-Goldthwait procedure is a considerable approach when skeletally immature individuals are involved, thus making it attainable but with a high rate of learning over repeated experience.

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Ethics declaration: The authors stated that the study is retrospective & approved by Dean of Medical Faculty at Medical University Sofia & thus, no ethical approval is mandatory.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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