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REVIEW

Goldthwait technique for patellar instability: surgery of the past or here to stay procedure? A systematic review of the literature

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Abstract

Patellar instability is the pathologic condition where the patella is prone to recurrent lateral dislocation. The clinical results on large series of patients and long-term outcome of Goldthwait techniques have not been described in the literature. The aim of this systematic review is: (1) to analyze and summarize the available literature focused on Goldthwait procedure in the treatment of recurrent patellar dislocation and (2) to evaluate the clinical and functional outcomes of patients treated with this surgical procedure. A systematic review of the literature was performed to investigate the results of Goldthwait procedure according to the PRISMA 2009 guidelines. A total of 7 articles published were systematically reviewed. A total of 197 knees (182 patients: 86 males and 96 females) have been treated with Goldthwait procedure. The mean reported follow-up was 6.8 years. The mean age at surgery was 18 years old. The Goldthwait procedure was associated with open lateral retinacular release in 127 (64.5%) knees to arthroscopic lateral retinacular release in 20 (10.1%) knees, and with retinacular plasty and a vastus medialis advancement in 33 (16.7%) knees. Only in 17 (8.6%) knees the Goldthwait procedure was performed as an isolated procedure. Poor standardization of methodological assessment has been observed. Despite the limitations of the available literature, the Goldthwait technique provides satisfying results for the treatment of patellar instability even in pediatric population. More high-quality studies are necessary to evaluate the long-term complications and the real incidence of long-term PF osteoarthritis.

Keywords Patellar instability · Goldthwait · Roux · Patellofemoral pain syndrome · Patellar luxation

Introduction

Patellar instability is the pathologic condition due to morphologic abnormalities in the patellofemoral joint where the patella is prone to recurrent lateral dislocation.

Treatment of the first episode is still controversial, and the management in youngest patients represents a particular challenge [1]. Recurrent patellar dislocation is often associated with anatomic predisposing factors: trochlear dysplasia, patella alta, lateral patellar tilt, increased tibial extra-torsion, increased femoral anteversion, vastus medialis hypoplasia, subtalar joint pronation or valgus alignment of the lower limb [2]. When the conservative measures are failed, the second-line approach is the surgical treatment. Many different operative techniques have been developed over the years, providing good-to-excellent clinical results and low recurrence rate [3]. Nevertheless, the choice of the best surgical technique to address this pathologic condition represents a challenge.

The most commonly applied procedures are proximal and/or distal realignments with the aim to reconstruct the patellar retinacular anatomy and/or restore the physiological *Q* angle [4].

The Roux–Goldthwait procedure was initially described by Roux [5] in 1888 and then modified by Goldthwait in 1895 [6] as hemi-patellar transfer for the treatment of recurrent patellar dislocation.

The clinical results on large series of patients and long-term outcome of Goldthwait techniques have not been already described in the literature.

The aim of this systematic review is: (1) to analyze and summarize the available literature focused on Goldthwait procedure in the treatment of recurrent patellar dislocation

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and (2) to evaluate the clinical and functional outcomes of patients treated with this surgical procedure.

Materials and methods

Literature analysis

A systematic review of the literature was performed to investigate the results of Goldthwait procedure according to the PRISMA guidelines (preferred Reporting Items for Systematic Reviews and Meta-Analyses) with a PRISMA checklist and algorithm. The search algorithm according to the PRISMA guidelines is reported in Fig. 1.

A primary search on MEDLINE through PubMed distribution used the following keywords: "patellar instability" OR "patellar dislocation" OR "Roux Goldthwait" OR "Goldthwait" OR "patellar realignment" OR "patellar pain" OR "recurrent dislocation" OR "patellar pain".

The inclusion criteria were studies providing clinical results of Roux Goldthwait or Goldthwait procedures, English language papers without any restrictions on publication date, prospective or retrospective studies including cohort studies, randomized controlled trials, non-randomized trials, case–control study, case series studies with a minimum of 24-month follow-up. Studies that present Roux Goldthwait or Goldthwait techniques combined with other procedures were also included.

The exclusion criteria were: non-English language papers, studies that did not provide clear clinical results, a study population less than 15 patients and studies in which Goldthwait was used as a revision surgery of other failed procedures.

Reviews of the literature, case reports, biomechanical reports, ex vivo, animals or in vitro studies, technical notes, letters to the editors, editorial commentary and instructional course were excluded as well.

Three independent reviewers (MAM, AGC and SL) independently conducted the research.

All journals were included, and all relevant studies were considered for this study.

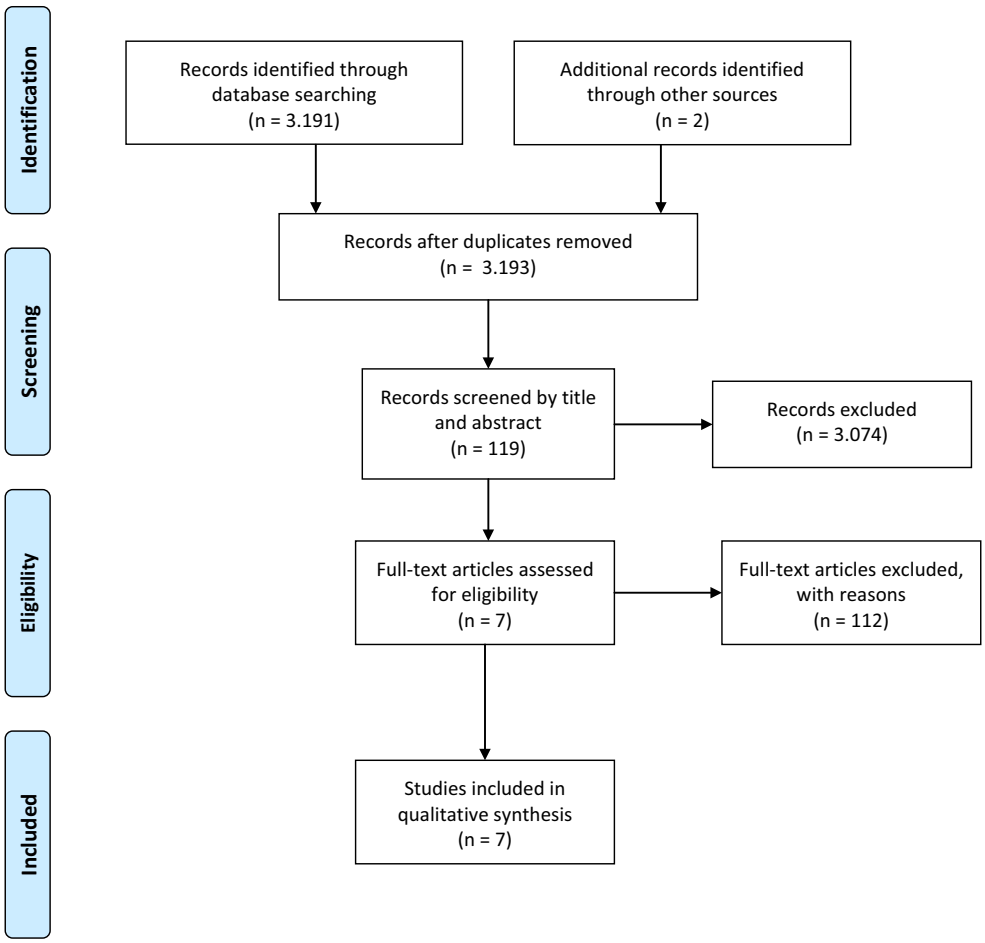

Fig. 1 PRISMA 2009 flow diagram

Papers were initially identified based on the title and abstract. The investigators separately reviewed the abstract of each publication and then performed an accurate reading of all extended papers to minimize bias.

The researcher checked all the references from the identified articles in order to not miss any relevant study.

Results

Following the research protocol, a total of 3191 articles were identified. The PRISMA flow 2009 diagram illustrates the number of studies that have been identified, included and excluded as well as the reason for exclusion (Fig. 1).

A total of 7 articles published between 1979 and 2016 met the selection criteria and were systematically reviewed. A summary of these studies is reported in Table 1. All relevant included studies were level IV series, and poor standardization of methodological assessment has been observed.

Preoperative Assessment

All patients were clinically evaluated before surgery. In 157 (79.7%) cases the imaging technique of choice was the X-ray; in 37 (18.8%) cases the assessment was completed by computer tomography (CT); only in one study on 40 (20.3%) patients, the preoperative imaging was not specified.

In all cases, surgical indication was given for recurrent patellar dislocation or subluxation (at least 2 episodes) and patellofemoral (PF) pain. In 28 (14.2%) cases, the first episode was traumatic.

Patients and treatment

A total of 197 knees (182 patients: 86 males and 96 females) have been treated with Goldthwait procedure in the included studies. The mean reported follow-up was 6.8 years. The mean age at surgery was 18 years old.

The Goldthwait procedure was associated with open lateral retinacular release in 127 (64.5%) knees [7–10], with arthroscopic lateral retinacular release in 20 (10.1%) knees [11], and with retinacular plasty and a vastus medialis advancement in 33 (16.7%) knees [12]. Only in 17 (8.6%) knees [13] the Goldthwait procedure was performed as an isolated procedure.

Postoperative management

The reported postoperative management was extremely heterogeneous in the analyzed studies.

One hundred and fifty-two (79.7%) cases were treated with 2–6 weeks of cast or brace immobilization with the knee positioned in full extension or in 10° of flexion [2, 9–12].

Only 28 (14.2%) knees were immediately mobilized with flexion restricted to 90°, and partial weight bearing with crutches was allowed for 4 weeks [8].

In all the analyzed cases, the full weight bearing without any limitation was allowed after 6 weeks.

In 17 (11.6%) knees the postoperative management was not described [13].

Postoperative Assessment

All patients were clinically assessed after surgery.

Only in 61 (30.9%) cases the apprehension test has been assessed, and it was reported as positive in 23 (37.7%) cases.

In 157 (79.7%) cases was performed a postoperative X-ray, in 17 (8.6%) cases the assessment was completed by CT; in 29 (14.7%) cases in addition was performed the magnetic resonance imaging (MRI) to detect the presence of cartilage defects of PF joint.

Outcomes

Limitation of this study was the heterogeneity of the functional evaluation and scores used by the authors. Poor standardization of methodological assessment has been observed.

Kujala score has been reported in only 2 articles [7, 12], and the mean value was 85.5 ± 15.0 (range 58–100) points for a total of 61 patients. In one article [7], the mean Tegner Activity Score of 5 (range 2–7) for 29 knees was reported. Malecki et al. [12] and Aarima et al. [8] reported also the Lysholm score, and the mean value was 86.6 ± 15.6 (range 39–100) points for 61 knees. Other evaluation systems were: Bray score, Cox grading system [11], Bentley score [13], Grana and O'Donoghue rating system [10]. However, regardless of different scoring systems, Aarima et al. [8] reported a rate of outcomes classified as "satisfactory" of 86%, Chrisman et al. [10] of 96%, Biglieni et al. [11] of 80%.

In one study (33 knees) [13], it was not possible to define the number of procedures classified as successful at the final follow-up evaluation.

On a total of 164 patients, 134 (81.7%) were classified as "satisfied" according to the different evaluation criteria (mean follow-up of 6.8 ± 1.7 of years).

Fifteen (7.6%) cases had recurrence of symptoms with 13 (6.6%) re-dislocations and 2 (1.0%) subluxations. In 2 cases the re-dislocation occurred for a new traumatic event; 3 patients were revised but the technique used for the revision surgery has not been specified. For the other 8 cases, the management of the re-dislocation was not specified.

Postoperative restriction of the range of motion was reported in 6 (3.0%) cases. Four (2.0%) patients reported joint stiffness with severe capsular contracture [10–12]. Two

Table 1 Reported cases of patients treated with Goldthwait for patellar instability

Author	Year	Cases	Years of FU mean (range)	Mean age (range)	Surgical technique	Postoperative management	Clinical results	Re-dislocations	Residual symptoms	Height of patella	*Q* angle	PF OA
Malecki K. et al.	2016	33 knees	5.6 (3–15)	19.6 (9–29)	Goldthwait + retinacular plasty + vastus medialis advancement	Plaster cast (6 weeks)	*Kujala* 85.0 (48–100) SD: 15 *Lysholm* 84.2 (39–100) SD: 15.6	4	Positive apprehension test: 6 Articular contracture: 5%	Caton index > 1.2: 17	N.D	N.D.
Biglieni L. et al.	2011	20 knees	6.8 (3–10)	13.4 (11.2–15.1)	Goldthwait + arthroscopic lateral release	3 weeks: brace with 10° flexion 2 weeks: rehabilitation with brace After 5 weeks of de-ambulation with crutches, after 2 months of free de-ambulation	*Bray score* 80% satisfactory (10 excellent; 6 good) and 20% unsatisfactory (3 fair 1 poor) *Cox Grading System* 11 excellent (55%); 6 good (30%); 2 fair (10%); 1 poor (5%).	2 (traumatic cause)	2: crepitation, limitation in flexion (10°–15°), swelling 1: maximum flexion 80°, limping muscle hypotrophy	No changes	Improved in 16 cases (between 14° and 16°)	N.D.
Sillanpaa P.	2008	29 knees	7.0 (5–11)	20 (19–24)	Goldthwait + open lateral retinaculum	Immobilization (posterior splint or patellar orthosis) for 2–4 weeks with no limitation of weight bearing	*Kujala* 86 (58–100) *Tegner* 5 (2–7)	3 (treated with revision) + 2 subluxation	Occasionally severe pain (6%)	Mean post-op Insall–Salvati: 1.26 (0.96–1.47)	N.D.	5
Aarima V. et al.	2007	28 knees	4.3 (2–7)	23 (17–48)	Roux Goldthwait + lateral release	Partial weight bearing for 4 weeks with crutches and flexion restricted to 90°	*Satisfaction* 86% *Lysholm* 89	1	Positive apprehension test: 61%, patellofemoral pain 10%, anterior knee pain 43%	Change in Insall–Salvati index (post-op phase) mean: −0.08 (mean reduction in patellar tendon length was 7%)	N.D	No statistically significant increment

Table 1 (continued)

Author	Year	Cases	Years of FU mean (range)	Mean age (range)	Surgical technique	Postoperative management	Clinical results	Re-dislocations	Residual symptoms	Height of patella	*Q* angle	PF OA
Marsh J.S.	2006	30 knees (20 patients)	6.2 (2–13)	14.2 (3–18)	Modified Roux Goldthwait + lateral release	4 weeks in a knee immobilizer, then 2 weeks with protected mobilization	*Kin Com dynamometer* evaluation of 10 patients: strength greater than 90% in 8 patients and greater than 80% in 2 patients	N.D.	N.D.	N.D.	Insall criteria 26 excellent (14°), 3 good (14°–16°), 1 fair (18°) results	N.D.
Scheneider T.	1995	17	10 (3–14)	16.0 (4–53)	Roux Goldthwait	N.D.	*Bentley score* 8 excellent, 4 good, 3 fair, 2 poor	1	N.D.	Insall–Salvati mean value: 0.77. No statistically significant difference with pre-op values	N.D	4 grade 0; 3: grade I; 6 grade II; 3 grade III, 1: grade IV
Chrisman O.D.	1979	40 knees	7.7 (4–12)	N.D. (9–43)	Roux Goldthwait + lateral capsular release and overlap medial capsule	Moduled cylinder cast from groin to ankle in extension for 6 weeks	*Grana and O'Donoghue rating system* 28 excellent, 9 good (37 satisfactory 93%), 0 fair 3, poor (3 unsatisfactory 7%)	2	1 stiffness requiring manipulation	1 patella baja	N.D.	N.D.

FU follow-up, *OA* osteoarthritis, *PF* patellofemoral

(1.0%) patients [11] reported crepitation, swelling and mild limitation of knee flexion (10°–15°).

Aarima et al. [8] reported that 61% of patients were positive to apprehension test, and Malecki et al. [12] reported a 18.2% of positive apprehension test.

Residual PF pain was reported in 17 (8.6%) cases [7, 8].

Data of the postoperative patellar height were not uniform. Seventy-four (37.6%) patients were assessed with the Insall–Salvati index, 33 (16.7%) with the Caton–Deschamps index and 20 (10.1%) with the Blackburne–Peel index.

In 40 (20.3%) cases the evaluation method was not specified, and in 17 (8.6%) cases the patellar height was not assessed.

Malecki et al. [12] reported postoperative data of 17 knees with a Caton–Deschamps index > 1.2; Sillanpaa et al. [7] (29 knees) reported a mean postoperative Insall–Salvati index of 1.26. Aarima et al. [8] (28 knees) reported a significant change of the mean Insall–Salvati index, from preoperative value of 1.15 to postoperative value of 1.07, with the mean reduction in patellar tendon length of 7%. Schneiders et al. [13] and Biglieni et al. [11] did not show significant changes of the patellar height correlated with this technique.

Postoperative patella baja was described only in 1 (0.5%) case [10].

Only 2 studies [9, 11] reported the data of postoperative *Q* angle. On a total number of 50 knees, in 45 (90%) cases the *Q* angle was between 14 and 16 degrees, defined as "good" according to the Insall's criteria.

The presence of PF osteoarthritis was preoperatively assessed only in 74 (37.6%) cases.

This surgical technique was not related to the presence of PF degenerative changes on imaging assessment in 56 (75.7%) cases.

Postoperative PF osteoarthritis was detected in 18 (24.3%) cases.

Sillanpaa et al. [7] reported 5 cases (6.7%) of PF osteoarthritis visible in plain radiographs without further details about the grading system. Schneider et al. [13] reported 1 case (1.3%) of grade IV PF osteoarthritis at the end of the follow-up, 3 cases (4.0%) of grade III, 6 (8.1%) cases of grade II and 3 (4.0%) cases of grade I.

Discussion

The most important finding of this systematic review is that Goldthwait technique, performed alone or combined with other soft tissue procedures, provides good clinical outcome both in short–medium- and long-term follow-up. Moreover, the reported complications and the re-dislocations or subluxations are very rare event.

Patellar instability is a complex pathology with multifactorial etiology [14]. Over the years, many surgical techniques have been described with the purpose of reducing anterior knee pain to avoid new dislocation and re-establish the physiological biomechanics of the PF joint.

The satisfaction rate after surgery, in all the analyzed studies, is above 80%. Also, the complications of the Goldthwait technique are comparable to other surgical techniques.

The reported long-term PF osteoarthritis changes related to this technique raise concerns [15], but more biomechanical studies to understand the etiopathologic developing mechanism are required.

It is interesting to note that, in most cases, the Goldthwait was performed combined to lateral retinacular procedures. Only one study [13] was performed without any other soft tissue procedures. In fact, the rate of PF osteoarthritis of this series was higher if compared to other studies. This aspect could justify the protective role of the lateral retinacular release to decrease cartilage contact pressure on the lateral patellar facet [16, 17]. The medialization of the maximum patellofemoral pressure point in flexion after lateral retinacular release has the unloading effect on the lateral patellar facet during the knee flexion and could theoretically prevent the postoperative PF osteoarthritis changes if combined with distal realignment procedures [18–20].

The re-dislocation rate and functional outcome were not statistically superior to medial patellofemoral ligament reconstruction [12, 15, 21] or Elmslie–Trillat [8]. Moreover, the Goldthwait technique, differently from other distal realignments, does not involve bony structures, and this aspect extends its indication in younger patients with open physis when other distal bony realignment procedures or trochleoplasty is not indicated [14].

In patients with open physes undergoing distal bony realignment, severe complications are reported, such as genu recurvatum, damage to the patellar ligament vascularization and alterations of the tibial tuberosity perfusion [3, 22].

It has been shown that an alteration of the *Q* angle (physiological values 14°–16°) is described as risk factor for patellar instability [23]. One of the advantages of Goldthwait technique is the correction of the *Q* angle due to the medialization of the patellar tendon. For this reason, the *Q* angle results improved after surgery. Unfortunately, only two articles [9, 11] reported postoperative data concerning the postoperative *Q* angle values, and the results were defined as "good" in 90% of cases.

Main limitations of this review are the heterogeneity and poor standardization of the data and of the evaluation methods and the low level of evidence of the included studies.

Further high-quality studies with long-term follow-up are necessary to assess the results and complications of this procedure.

Conclusions

The Goldthwait technique is still effective for the treatment of patellar instability and provides high satisfaction rate with low re-dislocation episodes and satisfying long-term clinical results even in pediatric population.

More high-quality studies are necessary to evaluate the long-term complications and the real incidence of PF osteoarthritis.

Compliance with ethical standards

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

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