Early functional outcome of a modified Brostrom-Gould surgery using bioabsorbable suture anchor for chronic lateral ankle instability

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ABSTRACT

Introduction: The purpose of this study was to evaluate the early functional outcome following the use of a bioabsorbable suture anchor to simplify the repair of injured lateral ankle structures as a variation of an established technique known as the Brostrom-Gould procedure.

Methods: This was a prospective study of 30 ankles with chronic lateral instability that underwent a modified Brostrom-Gould surgery using a bioabsorbable suture anchor, performed by a single surgeon. A total of 29 patients, aged 15 to 52 (mean is 33) years, were enrolled in the study. The follow-up period ranged from three to six (mean is four) months. The function of the patients' ankles was scored using the Kaikkonen Functional Scale, both preoperatively and postoperatively.

Results: Preoperatively, all ankles had poor scores (less than 50). Postoperatively, 28 ankles showed excellent scores and two ankles showed good scores, while none obtained a fair or poor score. The difference in the overall means between the postoperative and preoperative scores was statistically significant (p-value is 0.001). Post surgery, 24 ankles had no symptoms, while six had only mild ankle tightness with extreme inversion movement at the last review. All patients were able to walk normally, and 29 ankles regained their normal running capability. There was marked improvement in the ability to descend stairs, to rise on heels and toes, to perform a single-limb stance, and in range of motions of the ankle dorsiflexion as well as in ankle laxity.

Conclusion: The modified Brostrom-Gould procedure using a bioabsorbable suture anchor allowed for early ankle rehabilitation and offered a reproducible and excellent early functional outcome with minimal complications.

Keywords: bioabsorbable, Brostrom-Gould, functional outcome, joint instability, suture anchor

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INTRODUCTION

Lateral ligamentous complex, specifically, the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL), are most commonly injured during ankle sprains.[1,2] While 80%–85% of acute ankle sprains can be successfully managed with rehabilitation and bracing, the remaining 15%–20% continue to suffer from chronic ankle instability and reinjury, requiring surgical intervention.[3]

The goals of surgery in chronic lateral ankle instability are to re-establish ankle stability and function, without compromising ankle motion. Generally, an anatomical repair using a modified Brostrom-Gould surgery is considered to be the gold standard procedure for treating chronic lateral ankle instability.[1,3,4] Non-anatomical lateral ankle tenodesing reconstructive procedures with tendon augmentation, such as the Watson-Jones procedure, Evans procedure and Chrisman-Snook procedure, are frequently reserved for patients with generalised ligamentous laxity, or as salvage revision procedures, as they involve sacrificing normal tendons and have been shown to cause restrictions in motion, particularly of the tibiotalar and subtalar movement, and carry an increased risk of adjacent cutaneous nerve injury as well as medial degenerative joint disease of the ankle.[2,3,5-8]

There have been a few articles describing a further modification to the Brostrom procedure using titanium alloy implantable anchoring systems, namely, the barbed anchor of Mitek GII (Mitek Inc, Norwood, MA, USA)

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and a screw-in type Statak (Zimmer Inc, Warsaw, IN, USA) 3.5-mm threaded anchor with number 2 Ethibond suture.[2,4,5,9] The usage of these metallic suture anchors was believed to simplify the procedure while providing more accurate anatomical and durable repair to treat the chronic lateral ankle instability.[4,5] However, many complications have been associated with the use of metallic suture anchors such as loosening, migration, incarceration of the metal implant within the joint, difficulty with revision surgery and chondral damage.[10,11] Moreover, the potential necessity for future removal of the metallic suture anchor and the imminent problem of interference with advanced imaging procedures have led many surgeons to use bioabsorbable suture anchors instead. Concerns have been raised on the effect of the biological degradation on the suture anchor mechanical strength and consequently, on the outcome of surgery; however, studies have shown that the integrity of the newer design of bioabsorbable suture anchors would be maintained long enough to enable complete healing of soft tissue-to-bone repair, which normally requires approximately 12 weeks.[10,12] Nonetheless, to date, there has been no published literature that evaluates the outcome of the modified Brostrom-Gould surgery following the use of these bioabsorbable suture anchors. This paper thus presents our experience with this surgery utilising a tap-in type bioabsorbable anchor system with FibreWire suture (3.0-mm Bio-SutureTak, Arthrex Inc, Naples, FL, USA) to simplify the plication of the injured capsular and ligamentous structures of ankles suffering from chronic lateral instability.

METHODS

This was a prospective study of a single surgeon series, conducted over a two-year period from January 2006 to December 2007. All skeletally matured patients who had traumatic injury to their lateral ankle ligament with chronic symptoms that was refractory to at least a three-month period of non-operative treatment were included in the study. A total of 29 patients were enrolled, all of whom belonged to the Malay race. The age of the patients ranged from 15 to 52 years, with a mean age of 33 years. There were 22 male and seven female patients. The event causing the lateral ankle instability was football injury in 20 patients, a motor vehicle accident in six patients and a fall at the workplace in three patients. All patients had a symptomatic ankle persisting from 6–36 months, with a mean duration of 12 months. A total of 30 ankles were operated on, as one of the patients also had bilateral ankle involvement. Among the 30 ankles, 16 were on the right side, while 14 were on the left side. 22 ankles had only the ATFL reconstruction, while eight ankles had a combined ATFL and CFL reconstruction.

The indications for surgery were based on the patient's symptoms and physical examination findings, which included a local tenderness over the lateral aspect of the symptomatic ankle, a positive anterior drawer test, or a positive varus tilt test when compared to the normal contralateral ankle. Additionally, patients were examined to exclude the generalised multiligamentous laxity problem. Preoperative radiographs consisting of anteroposterior, lateral and varus stress views were performed in all patients. The varus stress view was considered to be significant when the tibiotalar angle was $\geq 9°$.[5] Magnetic resonance (MR) imaging was performed in 15 patients who also complained of medial joint pain. Patients who had associated extraarticular or intraarticular injuries, such as peroneal tendon rupture and ankle fracture, or required additional surgery such as arthroscopic ankle debridement, were excluded from the study. The range of the follow-up period was 3–6 months, with a mean of four months postoperatively. The function of the patients' ankles was assessed using the Kaikkonen Functional Scale preoperatively and postoperatively, and scores of 85–100 were rated as excellent, 70–84 as good, 50–69 as fair, and < 50 as poor.[6] Statistical analyses were performed using the Statistical Package for the Social Sciences version 12.0.1 (SPSS Inc, Chicago, IL, USA). The difference in the overall means between the postoperative and preoperative score was tested at 5% level of significance, by using a paired *t*-test.

All patients underwent the surgery in a semi-lateral position, under spinal anaesthesia and tourniquet control. An incision was made just anterior to the lateral malleolus, curving posteriorly distal to the tip of the malleolus, while preserving any branches of the superficial peroneal nerve (Fig. 1). The full thickness flap was elevated to identify the inferior extensor retinaculum, which was retracted anteriorly to reveal the joint capsule and the torn ends of the ATFL. A subperiosteal sleeve was elevated proximally off the distal lateral malleolus surface for about 1 cm long. With the ankle at a slightly everted and dorsiflexed position (about 5°), repair of the ATFL was performed by pulling the distal portion of the ATFL as well as the joint capsule to the lateral malleolus and fixing it to the malleolus using two Bio-SutureTak suture anchors, which were placed perpendicular to the sagittal margin of the malleolus on the anterolateral aspect, as close to the anatomical origin of the ATFL as possible (Fig. 1).

When repair of the CFL was also required, a

Fig. 1 Intraoperative photograph shows the incision made over a right ankle and the application of bioabsorbable suture anchor to the lateral malleolus.

longer incision was made distally and posteriorly while preserving the sural nerve and lesser saphenous vein in order to open the peroneal sheath. The peroneus brevis and longus tendons were identified and retracted to expose the CFL. Repair of the CFL was done with the ankle at a neutral position, by pulling the distal remnant of the ligament to the lateral malleolus and fixing it to the tip of the malleolus as close to the anatomical origin of the CFL as possible, using another suture anchor placed perpendicular to the sagittal plane of the malleolus. If only an elongated and laxed ATFL or CFL was found after exposure, the affected ligament was divided at its midsubstance about 1–2 mm from the origin at the lateral malleolus, and then repaired using the technique described above. The periosteal flap created on the lateral malleolus was plicated in a 'vest over pant' fashion over the newly anchored ATFL, CFL and capsule using a Vicryl 2-0 (Johnson & Johnson Intl, Lenneke Marelaan, St-Stevens-Woluwe, Belgium) suture. The remaining anterolateral joint capsule was also repaired and fortified using a Vicryl 2-0 suture by imbricating the capsule in a double-breasted manner. As recommended by Gould et al,[13] the proximal part of the inferior extensor retinaculum was pulled to the lateral malleolus and fixed to the periosteum surface using a Vicryl 2-0 suture. Closure of the wound was done using a 3-0 Vicryl subdermally, and a 3-0 Monocryl (Johnson & Johnson Intl, Lenneke Marelaan, St-Stevens-Woluwe, Belgium) subcuticularly.

All patients underwent the same postoperative rehabilitation regime. The operated ankles were immediately immobilised postoperatively in a removable aircast walker, with the ankle in neutral alignment for three weeks. Isometric exercise was started in all patients on Day 1 postoperatively. Cryocuff was applied intermittently over a three-day period, and patients were instructed to mobilise non-weight-bearing with the aid of crutches. All patients were discharged after three days in the ward following a satisfactory wound inspection. After three weeks, the aircast walkers were discontinued, and patients were advised to perform both active and passive ankle dorsiflexion as well as plantarflexion movement. Proprioception training was started by asking the patient to touch the ankle intermittently using cotton wool and a pin. Peroneal strengthening was also initiated by asking the patient to do a writing manoeuvre using the ipsilateral big toe on the floor and to do an intermittent heel raise exercise while sitting on a chair. Gradual partial weight-bearing was allowed three weeks following the surgery. Six weeks postoperatively, all patients were allowed to fully weight-bear and were continued on the range-of-motion exercise, ankle muscles strengthening exercise, as well as proprioception training using a balanced board, until satisfactory recovery was achieved.

RESULTS

The overall parameters of the Kaikkonen Score measured preoperatively and postoperatively are shown in Table I. Preoperatively, all the ankles had a poor Kaikkonen score of less than 50. 28 ankles were symptomatic with pain, 25 ankles presented with swelling, 16 ankles had positive tenderness, 22 ankles had the symptom of "giving-way", and one ankle presented with stiffness. Using the Kaikkonen criteria,[6] four ankles presented with mild symptoms consisting of merely pain, 22 ankles presented with moderate symptoms consisting of pain, swelling and "giving-way", and four ankles presented with severe symptoms. Of the four ankles with severe symptoms, three ankles presented with tenderness, while the remaining ankle had stiffness in addition to the pain, swelling and "giving-way" (Table I). Preoperative anterior drawer tests were positive in all ankles, with 22 ankles showing Grade 2 laxity, and the remaining eight ankles showing Grade 3 laxity. All the ankles with Grade 3 laxity also demonstrated a positive varus tilt test, supported by the varus stress radiograph view, indicating involvement of the CFL injury. None of the patients showed evidence of generalised multiligamentous laxity.

Preoperative radiographs and MR imaging confirmed no associated bony avulsion or osteochondral fracture and medial ankle injury in all patients.

Postoperatively, 28 ankles showed an excellent Kaikkonen score, two ankles showed a good score, and none of the ankles obtained a fair or poor score. The difference in the overall means between the postoperative and preoperative score was 6.3, and this was statistically significant (95% confidence interval 3.5 to 9.3; *t*-test statistic 5.1, 8° of freedom; p-value = 0.001). Using the Kaikkonen criteria,[6] 24 ankles had no symptoms when last reviewed. On the other hand, six ankles with mild symptoms after the surgery were only disturbed by mild discomfort, felt as tightness over the scar, with extreme inversion movement. All the patients were able to walk normally during their last follow-up review. Out of the 30 ankles that were not able to run normally preoperatively, 29 ankles managed to regain their running capability after the surgery. One ankle failed to run normally postoperatively because the mild discomfort became aggravated during this activity. The ability to descend stairs, rise on heels and toes, perform a single-limb stance, as well as a range of motions of the ankle dorsiflexion were all improved postoperatively. Ankle laxity was greatly improved in all patients and none of the ankles had symptomatic laxity even in the one patient who had Grade 2 anterior translation. There were no complications of wound dehiscence and infection occurring in any of the patients operated. None of the patients experienced paraesthesia or numbness in their foot. Additionally, there was no marked limitation in the eversion and inversion in all the ankles operated on.

DISCUSSION

In this study, much emphasis was placed on the patient's functional disability and symptoms. This was because a previous study showed that 11% of asymmetric joint laxity might actually be asymptomatic.[14] Furthermore, it was frequently observed that the function of the ankle did not return to the satisfactory level even when restoration of the mechanical stability of the joint had already been achieved.[15,16] Thus, in this study, the outcome was measured using an established scoring system to provide a meaningful analysis of the ankle performance before and after the surgery. The Kaikkonen Functional Score was used as it had been validated and proven to offer the best approach for a combined clinician and patient assessment of ankle functional ability.[17] The final score obtained from this outcome measure would correlate significantly with the isokinetic strength of the ankle, the subjective feeling of recovery and subjective functional assessment.[6]

Table I. Overview of the pre- and postoperative Kaikkonen ankle scores of the patients.

Kaikkonen parameter; score	No. of ankles (%)	
	Preoperative	Postoperative
Symptom*		
None; 15	0 (0.0)	24 (80.0)
Mild; 10	4 (13.3)	6 (20.0)
Moderate; 5	22 (73.3)	0 (0.0)
Severe; 0	4 (13.3)	0 (0.0)
Mean score	5	14
Walk normally		
Yes; 15	25 (83.3)	30 (100.0)
No; 0	5 (16.7)	0 (0.0)
Mean score	12.5	15
Run normally		
Yes; 15	0 (0.0)	29 (96.7)
No; 0	30 (100.0)	1 (3.3)
Mean score	0	14.5
Walking down 44 stairs (sec)		
< 18; 10	3 (10.0)	23 (76.7)
18–20; 5	18 (60.0)	7 (23.3)
> 20; 0	9 (30.0)	0 (0.0)
Mean score	4	8.8
Rising on heel (no./min)		
> 40; 10	0 (0.0)	21 (70.0)
30–39; 5	12 (40.0)	9 (30.0)
< 30; 0	18 (60.0)	0 (0.0)
Mean score	2	8.5
Rising on toes (no./min)		
> 40; 10	0 (0.0)	23 (76.7)
30–39; 5	15 (50.0)	7 (23.3)
< 30; 0	15 (50.0)	0 (0.0)
Mean score	2.5	8.8
Single-limb stance (sec)		
> 55; 10	1 (3.3)	28 (93.3)
50–55; 5	20 (66.7)	2 (6.7)
< 50; 0	9 (3.00)	0 (0.0)
Mean score	3.7	9.7
Laxity of the ankle joint, anterior drawer (mm)		
≤ 5; 10	0 (0.0)	29 (96.7)
6–10; 5	22 (73.3)	1 (3.3)
> 10; 0	8 (26.7)	0 (0.0)
Mean score	3.7	9.8
Dorsiflexion		
≥ 10°; 10	12 (40.0)	22 (73.3)
5°–9°; 5	18 (60.0)	8 (26.7)
< 5°; 0	0 (0.0)	0 (0.0)
Mean score	7	8.7
Overall mean score	4.5	10.9

* Pain, swelling, stiffness, tenderness or giving way during activity (mild: only one symptom present; moderate: 2 to 3; and severe: ≥ 4)[6]

In this study, the modified Brostrom-Gould technique was performed as the treatment of choice as it has been shown to have an excellent success rate of 85%–95%, superb long-term stability while maintaining subtalar and tibiotalar motion, fewer associated nerve injuries, and a faster functional recovery without the need to sacrifice the other normal tendon.[3,18] It has also been shown to provide a greater mechanical restraint in anterior talar displacement and talar tilt than the Watson-Jones or Chrisman-Snook procedures.[2] Its success in the revision surgery for recurrent lateral ankle instability has been proven,[19] and the long-term functional outcome achieved with a 26-year follow-up has been shown to be excellent.[18]

In this study, the cause of the chronic lateral ankle instability was trauma. Previous studies have suggested that since there is a higher prevalence of generalised joint hyperlaxity in Asian populations as compared to Caucasian populations, a combination of the Brostrom repair and modified Evan's tenodesis procedure would be more effective in treating chronic lateral ankle instability in an Asian population.[6] However, no generalised ligamentous laxity was detected from the preoperative evaluation in this study. The 'good-to-excellent' functional results achieved in this study were, therefore, in accordance with previous observations, which noted better functional results in patients following a Brostrom repair compared to a tenodesis procedure when there was no co-existing generalised ligamentous laxity (86% vs. 68%).[6]

In this case series, suture anchors were used to repair the ATFL with or without the CFL. The distal portion of the ligament was secured by the suture anchor to the lateral malleolus biomechanically, as such a fixation has been shown to be significantly stronger than if fixation is performed to the talus.[20] The rationale for using a suture anchor was that quite often in chronic ankle instability, the torn ligament ends are tenuous and flimsy, making direct suturing of the ligament difficult.[6] This problem of a lack of healthy ligament margin suitable for suturing could, on the other hand, be solved by using suture anchors. In addition to the ATFL restoration, repair and fortification of the remaining anterolateral joint capsule was also done as it has been shown to contribute to about 30% of the overall preoperative lateral laxity of the ankle.[21] Intervention was also necessary when the ATFL or CFL ligament was redundant and laxed, as previous studies have shown that a 20% increase in length, which could be as small as 4 mm in ATFL, could result in a positive anterior drawer test and functional ankle instability.[20] Though controversial, the restoration of the ligament tension and tissue stretching after repair might enhance the ankle proprioceptive afferent input, and thus improve the functional stability of the ankle.[22]

As demonstrated in the results of this study, a modified Brostrom-Gould using a bioabsorbable suture anchor could provide adequate functional correction to the unstable ankle. As with the metallic suture anchors, its utilisation also made the surgery relatively rapid, reproducible and simple.[4,5] However, the use of a radiolucent bioabsorbable suture anchor rather than a metallic anchor would, in addition, avoid the potential need for implant removal and future interference with advanced imaging procedures, and would eventually allow for the restoration of bone density at the lateral malleolus, which might be essential, should a revision surgery be required later. While the effectiveness of bioabsorbable suture anchors in creating a secure soft tissue-to-bone repair and the pulling-out strength of the anchors has been comparable to metallic suture anchors, its reported complication rate has been lower.[10] With absorption over time, a bioabsorbable suture anchor would theoretically minimise or avoid the future problems of migration and secondary chondral damage.[10] The invention of a newer design of bioabsorbable suture anchor using PLDLA poly (L-lactide-co-D, L-lactide), like the one used in this study, has been purportedly shown to be more biocompatible with soft tissues and bone.[10,12,23] Studies have shown that PLDLA degradation might take about 12 to 16 months,[23] and the Bio-SutureTak anchor, in particular, would be able to sustain its strength and failure load for at least 16 weeks, despite its degradable property, to allow the soft tissue to stay strongly fixed to the lateral malleolus bone during the critical 12-week period of healing.[10,12] While an assumption of the 12-week duration required for healing to occur might fairly justify the follow-up period of 3–6 (mean of 4) months employed in this study, it nonetheless potentially ignored any cases that might experience late healing, which might affect the final functional outcome. On the other hand, the superb functional outcome observed in this study, despite the short period of follow-up, would strongly indicate that the repair healing had indeed been completed, as the majority of the ankles were asymptomatic and were able to perform normal walking and running manoeuvres.

The Bio-SutureTak anchor used in this study possessed ridges along its entire length that would provide a higher pullout strength than the hook-type anchor, when applied to a less dense bony area such as the lateral malleolus.[10] It had a moulded-in suture eyelet with suture-on-suture eyelet interface that would reduce or eliminate abrasion to the attached suture during knot tying when compared to a metallic eyelet-suture construct, thereby reducing the risk of suture failure.[12] The flexible polyaxial eyelet possessed by the Bio-SutureTak anchor would not be influenced by the suture pull angle and the anchor rotation angle, thus eliminating the need to orientate the anchor eyelet during insertion, which would be essential in the application of metallic anchors as it could lead to suture abrasion and early failure.[12,24,25] Although a recent study found no statistical difference in the ultimate failure load after cyclic loading among different bioabsorbable anchors,[26] the use of a polyethylene-based FibreWire suture in this study had nonetheless been proven to be stronger than standard polyester such as an Ethibond suture, in terms of the ultimate load properties, stiffness and viscoelastic stress relaxation.[24,25,27,28] The high static strength means that the suture would be less likely to break and would deform less under initial loading, which could happen during knot tying and tightening of the repair.[27] Furthermore, the greater viscoelastic strength would make the suture less likely to fatigue or break in the postoperative period of rehabilitation while healing is taking place.[27]

In this study, the presence of immediate rigid fixation and high strength characteristics conferred by the suture anchor system used was especially important during the postoperative period, as it allowed for a more accelerated rehabilitation programme and early protected ankle motion, thereby minimising the risk of postoperative stiffness. The early rehabilitation regime would also lead to an early accomplishment of sensory and motor control, as well as proprioception of the ankle, which is beneficial in promoting healing and maximising its ultimate function.[22]

In this study, the potential disadvantages of suture anchors, such as misplacement, breakage and pullout,[11,12,24] were not observed, which concurred with the findings noted in a previous study.[5] The small incision made and quicker surgery, helped by the use of the suture anchor, could account for the absence of wound dehiscence and infection noted in this study.

In conclusion, a modified Brostrom-Gould anatomical reconstruction using the Bio-SutureTak suture anchor system, as described above, allowed for an early emphasis on functional rehabilitation, and offered a reproducible and excellent early functional outcome with minimal complications, thereby providing an effective alternative to simplify the repair technique in ankles with chronic lateral instability. A similar study with a longer term of follow-up might be required in order to eliminate any potential case of late healing that would affect the final functional outcome of this modified technique.

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