

Dual-portal Endoscopic Gastrocnemius Recession for the Treatment of Severe Posttraumatic Equinus Deformity: A Case Series and a Review of Technical Modifications

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Abstract

Objectives: Several authors have recently reported the benefits of endoscopic gastrocnemius recession (EGR) for the treatment of nontraumatic equinus contracture. However, little is known about its potential for correcting severe posttraumatic equinus contracture. This study aimed to evaluate the effectiveness of dual-portal EGR in patients with severe, intractable equinus following severe trauma to the leg and foot. The recent technique of EGR with supplemental modified procedures was reviewed to improve its capability for correcting deformities and to provide information to avoid complications.

Methods: The subjects were 4 patients with intractable, progressive, severe posttraumatic soft-tissue equinus contractures after at least 3 months of unsuccessful conservative treatment. The exclusion criteria were spastic contracture, including osseous equinus. One patient with gastrocnemius equinus underwent EGR alone as a straightforward correction. Three patients with gastrocnemius-soleus equinus underwent EGR to correct the gastrocnemius component followed by a modified percutaneous tendo-Achilles lengthening (TAL) procedure to correct any residual deformities. All data of the preoperative period and each successive postoperative period (1, 3, and 6–12 months) were prospectively collected and included the degree of ankle dorsiflexion, American Orthopaedic Foot and Ankle Society (AOFAS) clinical rating scale score, the Visual Analogue Scale-Foot and Ankle (VAS-FA) score, and any related complications. Intraoperatively, the degree of ankle-dorsiflexion was recorded immediately following each procedure.

Results: The mean increase in intraoperative dorsiflexion was $35^\circ \pm 9.1^\circ$ (range: 25° – 45°) in all 4 patients and $21.7^\circ \pm 10.4^\circ$ (range, 10° – 30°) in the 3 patients undergoing EGR and modified TAL, respectively. There were significant differences in the improvements ($p < 0.05$) in the preoperative period and each successive postoperative period in the increased values of ankle dorsiflexion, AOFAS scores, and VAS-FA scores. There were no significant iatrogenic complications.

Conclusion: Intractable, severe posttraumatic equinus is not commonly encountered by orthopaedic surgeons. Despite the rarity of this condition, which is responsible for the limited number of patients in this series, our results indicates that dual-portal EGR, with or without modified TAL, is a promising treatment, with satisfactory effectiveness and lower risks of complications, for correcting this problematic deformity.

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Key words: gastrocnemius, Achilles, endoscopic, equinus, lengthening

Introduction

With the recent trend toward minimally invasive procedures for the treatment of foot and ankle disorders, numerous authors have reported the benefits of the recently described procedure of endoscopic gastrocnemius recession (EGR)¹⁻³. This procedure has been reported to be associated with a lower rate of complications¹⁴ and a lower risk of disfigurement^{1,2,5}. Several surgeons have used this procedure to correct nontraumatic equinus contracture^{1,2}. However, little is known about the potential of EGR for correcting severe posttraumatic equinus contracture.

The aim of the present study was to evaluate the effectiveness of dual-portal EGR for treating severe, intractable equinus following severe trauma to the leg and foot. The recently described technique of EGR with supplemental, modified procedures was reviewed to improve its capability for correcting deformities and to provide information to avoid complications.

Materials and Methods

Patients

The subjects were 4 patients who had recovered from their initial traumatic injuries but continued to have severe, refractory, progressive soft-tissue equinus contractures. The criterion for severe equinus was ankle dorsiflexion $\leq -20^\circ$ with the knee extended. The patients had had at least a 3-month course of standard, conservative treatment. The exclusion criteria were concomitant spasticity, including osseous equinus. Dual-portal EGR, with or without supplementary modified procedures, was performed in these patients by the same surgeon. Informed consent was obtained from all patients for this study.

Data Collection

All data of the preoperative period and each postoperative period (1, 3, and 6-12 months) were prospectively collected and included the degree of ankle dorsiflexion, the American Orthopaedic Foot and Ankle Society (AOFAS) clinical rating scale score⁶, the Visual Analogue Scale-Foot and Ankle



Fig. 1 Surface markings of the safe endoscopic zone on the medial side of left leg in case 2 with severe equinus⁸. The contracture of split thickness skin graft is shown from the popliteal area to the distal calf (**white asterisk**).

(VAS-FA) score⁷, and any related complications. Intraoperatively, the gained degree of ankle-dorsiflexion from each procedure was recorded. Statistical analysis was performed with the software program SPSS version 13.0 (SPSS, Inc., Chicago, IL, USA). The statistical significance was identified at $p < 0.05$.

Surgical procedure

The surgical procedures were performed with the patients in the supine position, a padded tourniquet applied to the ipsilateral thigh, and proper anesthetic techniques. The heel was placed on a sterile rolled sheath. These preparations allowed comfortable access to the operative site with surgical instrumentation. A 5- to 10-mm-long longitudinal incision was made on the medial aspect of the leg; distal to the medial head of the gastrocnemius muscle, typically, 16 to 17 cm proximal to the medial malleolus⁸ (**Fig. 1**). Blunt dissection of the gastrocnemius aponeurosis was performed. The subcutaneous tissue was separated from the aponeurosis by means of a fascial elevator; after the elevator was removed, an obturator/cannula was inserted into the identified plane. The obturator was removed, and a 4-mm endoscope was put in its place. After the aponeurosis was visualized through the cannular slit, the endoscope could access the entire length of the aponeurosis (**Fig. 2**). Care was taken to ensure that a branch of the sural nerve had not entered the endoscopic field. A lateral portal was then made, with transillumination of the lateral

surface of the skin via a medial approach. A 5-mm incision was made laterally over the tenting cannula, and irrigation was performed via a small suction tip through this portal (**Fig. 3**). Next, a hook blade was inserted laterally into the cannula, and the aponeurosis was transected entirely from the medial aspect to the lateral aspect under direct endoscopic visualization while a dorsiflexion force was applied to the foot on the table and knee extension was maintained by a surgical assistant (**Fig. 4A, 4B**). Before the procedure was completed, the longitudinal bands of the intramuscular septum were rechecked for the possibility that the initial release

had been incomplete because visibility had been impaired by residual fibers of the gastrocnemius aponeurosis. Both the longitudinal bands of the intramuscular septum and the residual fibers of the gastrocnemius aponeurosis must be transected for complete release while avoiding injury to the belly of the soleus. Following complete recession of the aponeurosis, the soleus muscle should be visible (**Fig. 4C**). If the increase in dorsiflexion was considered inadequate, percutaneous tendo-Achilles lengthening (TAL) was performed in accordance with our modified techniques, which was an adjustment of the original percutaneous triple hemisection described by Hoke⁹; a one-third resection of the entire width of a tendon with each percutaneous cut was planned and performed. This modified TAL procedure was designed to decrease the risk of

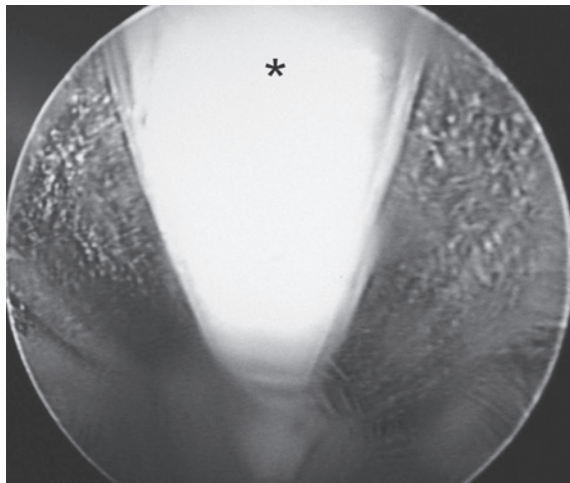


Fig. 2 Entire length of the gastrocnemius aponeurosis is visualized through the cannular slit (**black asterisk**).



Fig. 3 Lateral portal was created over the tenting cannula after transillumination from medial portal.

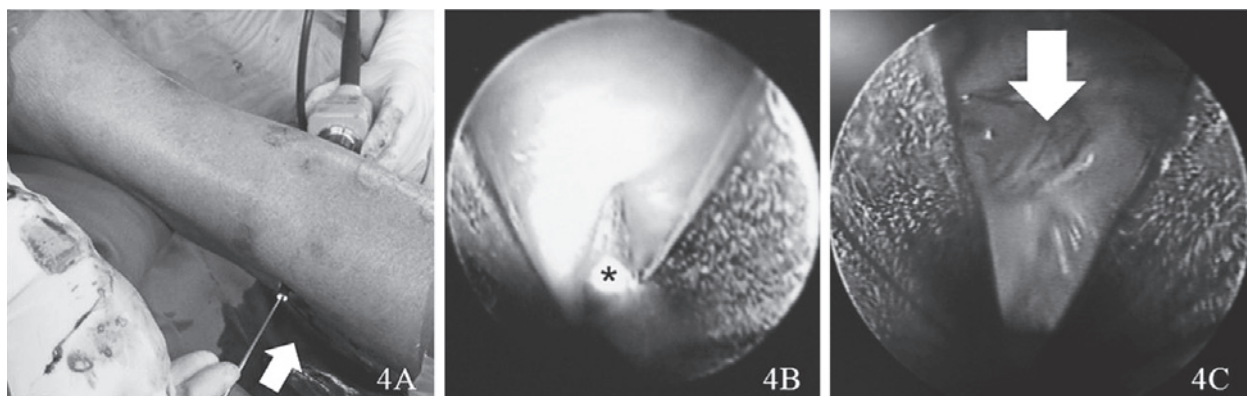


Fig. 4 **A:** Demonstration of a hook blade inserting with the right hand through a lateral portal (**arrow**).
B: The endoscopic view shows a hook blade (**black asterisk**) presenting into the scope's field, preparing to perform the section through the gastrocnemius aponeurosis.
C: The soleus muscle is demonstrated clearly after complete recession of the gastrocnemius aponeurosis (**arrow**).

Table 1 Baseline characteristics of patients undergoing EGR

Patient	Age (yr)	Sex	Side	Injury cause	Initial injuries	Previous operations
1	22	M	L	Motorcycle accident	Severe soft-tissue injury at heel and posterior ankle with subsequent infection	Serial debridement, negative-pressure wound therapy, STSG
2	62	F	L	Car accident	Popliteal arterial injury with compartment syndrome	Arterial revascularization with fasciotomy, STSG
3	26	F	L	Car accident	Severe crush injury at calf with mild displaced distal fibular fracture ^a	Fasciotomy, serial debridement, negative-pressure wound therapy, circumferential STSG, short leg posterior splint
4	47	M	L	Motorcycle accident	Closed knee injury with blunt soft-tissue injury at calf	None ^b

Abbreviations: M, male; F, female; L, left; STSG, split-thickness skin graft

^aPatient 3 had a minimally displaced distal fibular fracture with stable ankle mortise which was treated conservatively.

^bPatient 4 received conservative treatments for his initial injuries: supportive treatments for a soft tissue injury at the calf and splinting with a brace and concurrent physical therapy for a knee injury.

iatrogenic complications due to extensive cutting and to limit unnecessary TAL release following EGR.

Postoperative Care

For 2 weeks the patient wore a posterior splint so that the foot was positioned at 90° angle to the leg. During the next 2 weeks, the patient was fitted with a removable splint and started gentle physical therapy with actively assisted exercises of dorsiflexion. The patient was then instructed to continue vigorous therapy and was weaned from splint use during the next 4–12 weeks.

Results

Baseline patient data are shown in **Table 1**. The mean intraoperative increase in dorsiflexion was 35° ± 9.1° (range, 25°–45°) in the 4 patients undergoing EGR and was 21.7° ± 10.4° (range, 10°–30°) in the 3 patients undergoing modified TAL (**Table 2**).

There were significant differences in the improvements in the preoperative period and each successive postoperative period in the increasing values of ankle dorsiflexion, AOFAS scores, and VAS-FA scores (**Table 2**). There were also significant improvements in VAS-FA scores between the 1-month period and the final postoperative period ($p=0.04$). No significant differences in these variables were found among other periods of comparisons. There were no

significant iatrogenic complications.

Discussion

Several procedures have been developed to correct equinus deformity in patients who have sustained severe injuries. These procedures include open gastrocnemius recession and EGR. Some of these open methods, possibly accompanied by poor cosmesis and wound complications², may not be appropriate for severe posttraumatic equinus deformities. The soft-tissue conditions of these deformities are frequently poorer than those equinus deformities due to other benign conditions. Certain procedures, such as percutaneous TAL, may be an option for treating these deformities⁹. However, the surgeon must be aware of possible complications of the percutaneous TAL procedure, such as inconsistent lengthening, postoperative weakness of plantar flexion, lengthening tendon rupture, delayed healing of the lengthened tendon, and iatrogenic neurovascular injuries^{29,10}. Patients at greater risk of these complications are those who have had various adverse consequences, particularly alterations in local soft-tissue conditions after the initial trauma. These include compartment syndrome¹¹ and changes to the Achilles tendon due to previous complex limb-saving procedures. For these reasons, to treat severe equinus deformities we have carefully modified a base procedure, minimally invasive EGR, which has been shown to be an effective

Table 2 Specific data of patients undergoing EGR

	Case 1	Case 2	Case 3	Case 4	Mean (SD)	<i>p</i> -value ^d
Equinus cause	Gastrocnemius-Soleus	Gastrocnemius-Soleus	Gastrocnemius-Soleus	Gastrocnemius		
Corrective procedures	EGR, modified TAL	EGR, modified TAL	EGR, modified TAL	EGR		
EGR: intraoperative dorsiflexion gained	45°	40°	30°	25°	35° (9.1°)	
modified TAL: intraoperative dorsiflexion gained	10°	30°	25°	–	21.7° (10.4°)	
Preoperative ankle dorsiflexion ^a	–50°	–70°	–50°	–20°	–47.5° (20.6°)	
Postoperative ankle dorsiflexion ^a						
At 1 month	5°	5°	5°	5°	5° (0°)	0.015
At 3 months	5°	3°	10°	0°	4.5° (4.2°)	0.019
At final follow-up ^b	0°	0°	15°	0°	3.75° (7.5°)	0.020
Preoperative AOFAS	40	15	54	43	38.0 (16.5)	
Postoperative AOFAS						
At 1 month	96	70	95	71	83.0 (14.4)	0.007
At 3 months	96	77	98	73	86.0 (12.8)	0.007
At final follow-up ^b	91	68	92	74	81.3 (12.1)	0.004
Preoperative VAS-FA	19.5	13.3	35.8	32.5	25.3 (10.6)	
Postoperative VAS-FA						
At 1 month	69	55	60.8	60.8	61.4 (5.8)	0.008
At 3 months	77.5	73.1	91.5	65.8	77.0 (10.8)	0.004
At final follow-up ^b	79.5	75.9	88	66.8	77.6 (8.8)	0.004
Complications ^c	None	None	None	None		

Abbreviations: EGR, endoscopic gastrocnemius recession; TAL, tendo-Achilles lengthening; AOFAS, American Orthopaedic Foot and Ankle Society score⁶; VAS-FA, Visual Analogue Scale-Foot and Ankle score⁷; SD, standard deviation

^aMeasurement during knee extension

^bThe final postoperative follow-up was at 12 months for patients 1, 3, and 4 and at 6 months for patient 2.

^cFrom the follow-up in all postoperative periods

^dThe *p*-value from comparisons of each variable between the preoperative period and each postoperative period

lengthening procedure. Regarding the effectiveness of EGR, this procedure helped reducing the overuse of TAL. Using this procedure, we were able to transect just one-third of the width of the tendon and could thereby possibly avoid postoperative complications, such as tendon rupture and weakness of plantar flexion. The concept of based EGR combined with our modified TAL has not, to our knowledge, been reported previously for the treatment of severe posttraumatic equinus.

Motor vehicle injuries are a major public health problem in developing countries, such as Thailand¹². All the patients in our study had sustained severe injuries in motor vehicle accidents. The initial injuries and their treatments resulted in such conditions as distortions of normal local anatomy,

poor flexibility of the healed skin grafts, and the possibility of insufficient healing of the skin and underlying structures, including the Achilles tendon. Such conditions can complicate the usually straightforward procedure of lengthening the tendons involved in the formation of equinus deformities. Nevertheless, after the equinus deformities in the 4 patients of the present series had been corrected by means of EGR (combined with the modified TAL procedure in 3 patients), significant improvements in plantigrade posture were achieved. Despite the markedly low mean value of dorsiflexion before surgery in these patients ($-47.5^\circ \pm 20.6^\circ$), our method of EGR produced a higher mean value of improvement in dorsiflexion ($35^\circ \pm 9.1^\circ$) than achieved in previous studies¹². A

possible explanation for this greater improvement was that our surgeon was meticulous in checking and releasing residual fibers of the gastrocnemius aponeurosis and the longitudinal bands of the intramuscular septum for every patient. The modified TAL procedure, which was performed as necessary following an effective EGR procedure, also produced a satisfactory increases in dorsiflexion. These stepwise procedures may be effective in providing a significant increase in the total amount of dorsiflexion when compared with preoperative findings. Postoperative weakness in plantar flexion was absent in all our patients. Also absent were many types of iatrogenic postoperative complication, such as rupture of the lengthened tendon and neurovascular injuries. Our results differed from those of a previous study that found that 38% of patients had weakness of calf muscle strength after undergoing the percutaneous TAL procedure¹⁰. Such postoperative weakness can be prevented by limiting the incisions with our modified TAL procedure, which decreased the possibility of the excessive, invasive incisions used in other TAL procedures (>50% transection)⁹. Our limited TAL procedure also decreases the chances of iatrogenic injury to adjacent structures, such as major nerves and tendons, which were close to the area of hemisection^{9,13,14}.

In conclusion, despite the rarity of severe posttraumatic equinus deformities, which was responsible for the small number of patients in the present series, our results show that dual-portal EGR, with or without our modified TAL procedure, is a promising method, with satisfactory effectiveness and lower risks of complications, for correcting these problematic deformities.

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