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Medial Gastrocnemius Flap for Reconstruction of the Extensor Mechanism of the Knee Following High-Energy Trauma. A minimum 5 year follow-up

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ABSTRACT

Introduction: The purpose of this study was to assess the medium-term results of reconstruction of the extensor mechanism using the medial gastrocnemius while also providing soft tissue coverage.
Materials and methods: This retrospective review consisted of a consecutive series of four patients (age 28–40 years) with complex high energy traumatic injuries to lower extremity including both soft tissue loss and disruption of the knee extensor mechanism. The medial gastrocnemius rotational flap was used to reconstruct the patellar tendon and restore soft tissue coverage simultaneously. Range of motion and extensor lag; functional recovery was judged by return to work and sports activity. Validated measures included the Oxford Knee Score, Knee Injury and Osteoarthritis Outcome Score, and the modified Cincinnati Score.
Results: At the final follow up was 61.5 (57–66) months after reconstruction, the mean SF 12 physical component score ranged from 21.7 to 56.8 with a median of 55.3; the mental component from 42.8 to 60.7 with a median of 58.6. The KSS knee score ranged from 50 to 78 with a median of 68; the function score from 65 to 90 with a median of 85. The Oxford knee score ranged from 22 to 45 with a median of 33.5. The KOOS ranged from 28 to 82.7 with a median of 73.7 and the modified Cincinnati score from 38 to 82 with a median of 76.5. Knee range of motion ranged from 0 to 120°. Of the four patients three returned to working fulltime in their profession and returned to sports, including mountain biking and fitness training.
Conclusions: For severe traumatic knee injuries with the combination of soft tissue defects and disruption of the extensor mechanism, the medial gastrocnemius flap provides an excellent reconstructive option to address both problems simultaneously. The results of this small case series support the use of this limb salvage technique.

Introduction

Extensive traumatic injuries at the knee with involvement of the extensor apparatus are a challenging problem [16,17]. The soft tissues overlying the knee are relatively thin and high-energy trauma in this region often leads to open fractures or dislocations, with a significant risk of developing infection [7,17]. When the extent of soft tissue loss is severe enough to destroy the extensor mechanism, the potential problems involved in limb salvage and reconstruction are compounded [17,23]. These injuries are often associated with contamination of the wound, and internal fixation and definitive surgery is routinely delayed [7]. The combination of a soft tissue deficit and an absent patellar tendon can result in arthrodesis or amputation if these efforts are unsuccessful [30].

Management of open injuries with aggressive débridement and early coverage is a basic principle of modern treatment, often involving muscle flaps to restore the soft tissue envelope [8]. Reconstruction of the extensor mechanism using the medial gastrocnemius muscle has been previously described for combined tissue loss during revision knee arthroplasty or tumour surgery [5,15,20,26,27], but few prior reports describe its use as a post-traumatic reconstructive option [3,7,16,23].

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The management objectives are therefore complex, but generally include preliminary stabilization with external fixation, aggressive débridement, and restoration of the soft tissue envelope as early as possible [10]. Soft tissue coverage with viable muscle delivers nutrients and antibiotics to augment control of bacterial contamination, limiting the risk of further infection [8]. With this constellation of injuries it is important to restore the extensor mechanism while minimizing immobilisation, to reduce potential stiffness and maximise the power of knee extension [25].

The purpose of this retrospective review was to assess the medium-term results of reconstruction of the extensor mechanism using the medial gastrocnemius while also providing soft tissue coverage.

Material and methods

This case series reviewed four male patients aged 28–40 years who sustained high-energy trauma and were treated with a medial gastrocnemius rotational myoplasty for simultaneous soft tissue coverage and reconstruction of the patellar tendon (Table 1). Prior approval to conduct this study was obtained from our Institutional Review Board. Two patients were admitted directly to our unit, and two transferred from another hospital after initial débridement and spanning external fixation. Disruption of the extensor mechanism occurred at the time of injury in three patients.

Three patients with open injuries sustained direct trauma to the patellar tendon or the tibial tubercle. In one of these patients direct repair of the patellar tendon was attempted at another institution, but was complicated by deep infection leading to subsequent débridement of the patellar tendon and overlying soft tissues. The degree of soft tissue loss in the others precluded primary repair. In all four patients, débridement was repeated until healthy tissue margins were attained; an average of 3.5 procedures (2–5) was required before wound final coverage was performed. Definitive reconstruction and soft tissue coverage with the medial gastrocnemius flap was achieved an average of 32 days after the initial injury (13–44 days). The final follow up was 61.5 (57–66) months after reconstruction.

Surgical technique

The surgical technique followed the principle described by Babu et al. [3]. Through a posterior midline or posteromedial incision the gastrocnemius muscle was isolated and then raised with its deep fascia from the underlying soleus. The medial muscle belly was released distally to the musculotendinous junction, the medial portion of which was harvested together with the muscle. The medial gastrocnemius was denervated after identifying the neurovascular bundle proximally, taking care to preserve the sural arterial pedicle. Most of the deep fascia was scored or removed to increase muscle compliance and maximise the potential area covered by the flap. However the distal fascia was maintained and used for the reconstruction of the patellar tendon.

The muscle was rotated on its pedicle, passed through a subcutaneous tunnel beneath the medial skin bridge proximally, to cover the anterior soft tissue defect. When aligned over the site of the disrupted patellar tendon, the muscle fibres lay approximately 20° to the horizontal. The inferior border of the muscle was sutured to the deep fascia of the anterior compartment and the periosteum of the subcutaneous tibia, and the superior border was sutured to the remnant of the patella tendon. The position of the flap was initially set with the knee in extension, and any slack was taken out of the tendon. Flexing the knee to 90°, the patellar tendon tension and length was set with the inferior pole of the patella at the level of the apex of the inter-condylar notch.

Table 1
Clinical summaries.

Mechanism	Patient 1 Motorcycle	Patient 2 Motorcycle	Patient 3 Motorcycle	Patient 4 Boating accident, Propeller injury
Injury	Schatzker VI tibial plateau #	3B open proximal tib/fib #, ipsilateral femoral condyle #	Segmental 3b tib/fib #, Schatzker VI component, 8 cm bone loss including tibial tubercle	Open knee dislocation
Initial Treatment	Admitted direct	Admitted direct	Referred day 4	Referred day 25
Other injuries	N/A	Ipsilateral ankle open # dislocation, displaced NOF, contralateral distal tib'fib #	Ipsilateral Pilon #	Pelvic #, peroneal nerve palsy
Skeletal Management	ORIF, Ilizarov	ORIF femur Ilizarov tibia	ORIF, Ilizarov	Patella tendon primary repair
Cause of patella tendon loss	Infection post ORIF	Primary loss	Primary loss	Infection following direct repair of severely injured tendon
Sequence of operations	ORIF Reconstruction	Extensor reconstruction, ORIF	Extensor reconstruction, ORIF	Tendon repair, ORIF
Débridement before reconstruction	4	2	3	5
Injury-reconstruction interval (in days)	44	25	13	44
Organism	Enterobacter cloacae Staph warneii	MRSA Enterobacter cloacae	MRSA Pseudomonas aeruginosa	Mycobacterium fortuitum
Complications	Late malalignment, prominent metal	Infection bone graft donor site, non-union, stiffness prominent metal, prominent scar	Infection, malalignment, nerve entrapment, knee OA	Knee stiffness
Further operations	Late re-alignment, removal of metal	MUA knee ORIF LFC, Débridement (x1)	Frame adjustment (x3), débridement (x6), re-alignment frame	Judet Quadricepsplasty
Return to work	Yes: IT	Yes: Lecturer	No	Yes
Return to sport	YES: Cycling	Yes: Bushwalking, hiking	No	Yes: Gym, fitness