Abstract:
Tendon turnovers were described by Cerovac et al as a novel cost and time effective method to treat small, non load bearing tendons defects of the hand. This paper depicts a modification of the procedure to allow it to be applied to a larger weight bearing tendon that was not amenable to a primary tenorrhaphy. Reconstruction of a discontinuous tendon defect under tension is a difficult task. Attempts to solve this challenging issue surgically have met with success but rely on the skill of the surgeon and the technology and equipment available. There are a variety of options ranging from lengthening to grafting and tendon transfers. We have come up with the utilisation of a novel technique for the reconstruction of a severed Tibialis Anterior (TA) tendon that was performed on a case with good post-operative results. The patient was able to resume normal activity in 12 weeks. The advantage with this technique is that one avoids additional morbidity and complications associated with grafting, transfers and two stage reconstruction while simplifying the care for such patients while still providing future opportunities for more conventional intervention.

Keyword: tendon gap, tendon defect, lengthening, Tendon reconstruction, tibialis anterior.

Introduction:
The routinely available methods of reconstruction of a discontinuous tendon defect include lengthening of the tendon stumps through traction lengthening, grafting, staged tenoplasty and tendon transfers. Each technique has it's specific shortcomings. In addition, they require a high degree of surgical skill and availability of resources which may not be universally available.

Proposed Technique:
By avoiding grafting and using a novel tendon “turnover lengthening” procedure as described by Cerovac et al has been adopted for use on the TA
tendon. This is ideal for tendon defects not exceeding 5 to 6 centimetres and provides reconstruction at one single stage without any secondary donor sites. This can be used to treat people who are not amenable to primary tenorrhaphy. In addition, should the procedure fail; more conventional methods of treatment by tendon transfer or two-stage reconstruction are still available for use.

**Aim**

To describe the tendon elongation and reconstruction of a severed Tibialis Anterior tendon that was not amenable to primary tenorrhaphy.

**Case**

A 34 year old male day wage labourer was hit by a car in a road traffic accident 3 months prior. He was treated at another hospital for a laceration of the anterior aspect of the lower 1/3 of the right leg. The sutures and wound became infected and the patient was treated at the same institute with dressings. The patient presented with complaints of difficulty walking. Upon examination he was seen to have foot drop and was incapable of dorsiflexion and extension of toes. There was no sensory loss or vascular deficit.

On reviewing his records, there was no exploration of the wound and the tendon injury was missed and not repaired during the initial treatment. Intra-operatively after adequate cleaning, tendon debridement and mobilisation, a 5 cm gap remained between proximal and distal stumps of the Tibialis Anterior. In addition, the Extensor Hallucis Longus and Extensor Digitorum Longus muscles were badly scarred and non-functional. The decision was made to salvage the EHL which was sutured after debridement while the EDL could not be saved. It was established that a primary tenorrhaphy would result in undue tension, the decision was made to utilise this procedure to attempt to save the function of the limb.

**Technique**

After establishment that a primary tenorrhaphy is unviable, the tendon gap was measured and found to be 5 cm and the tendon elongating pedicles and anastamosis would glide freely. Due to the increased thickness of TA tendons we believe a defect of 4 to 6 cm would be ideal to avoid potential morbidity of tendon weakening and suture failure. The proximal and distal end of the tendon stumps are exposed and incised in a L-Shaped fashion. This is done in such a way that around 50% of the circumference of the tendon is split. The tendon split is stopped at 1 to 1.3 cm from the lacerated end so that sufficient tendon substance remains for reinforcement at the point of tendon turnover with 2-0 prolene sutures. The next stage involves tubularisation of the exposed tendon core from both the donor site and the turnover with continuous epitendinous sutures. 2-0 prolene core sutures and 5-0 prolene epitendinous sutures were used. Current biomechanical research indicates that a 50% or lower loss of thickness should still enable the tendon to function. The sutures reinforce the turnover site, strengthen the tendon, maintain tendon continuity and reduce adhesions. The choice of suture material was 5-0 prolene. The two pedicles created by this can then be anastomosed and reinforced. The wound is then closed and the patient's foot was immobilised using a posterior plaster of paris slab.
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**Outcome:**
After suture removal, the patient was started on a physiotherapy regimen to maintain mobility of the joint and increase muscle strength. After the 8th week follow-up, the patient was strong enough to begin active mobilisation and began to walk with partial weight bearing. At the 12th week, the patient had regained the capacity to dorsiflex the ankle with a power of 4/5. At this point, the patient was capable of resuming his normal work. There were no complications or side effects during this particular procedure.

**Discussion:**
The management of a tendon defect can be divided into surgical and non-surgical management. Non-surgical methods seem to be poorly tolerated in younger and more active patients. These should be reserved for elderly patients with limited functional demands or patients who have medical co-morbidities that prevent them from undergoing surgery. Other authors have reported equally good results in similar procedures involving the elderly, while Dooley et al recommends a non-surgical approach for patients with a delay of more than three months after diagnosis.

While clinical diagnosis remains at the heart of the recognition of tendon defects, MRI imaging can be used to confirm diagnosis and plan for the surgical reconstruction. It is of particular use in the identification of a Peroneus Tertius or Plantaris muscle for a donor graft. However MRI imaging is of limited use for determining the continuity of tendon and whether a graft is necessary. Since the ideal gap is under 5 to 6 cm and unopposed tension of the muscle has caused elastic recoil, the technique for reconstruction has to be decided intra-operatively after the debrided tendon has been mobilised from adhesions and approximated in order to calculate the gap that needs to be bridged.
Tendon lacerations under 60% of the cross-sectional area do not require repair unless any entrapment of the tendon is observed. On this basis we can say that reducing the tendon cross-section by up to 50% is biomechanically safe and in keeping with the literature and so should be strong enough to allow the patient a near full range of power and mobility of the joint. The major complication of treatment is down to delays in diagnosis. If the tendon cannot be directly approximated, a reconstructed tendon graft or a extensor hallucis longus tendon transfer are both possible as a treatment plan. Split lengthening of the distal stump of an extracted extensor hallucis longus tendon is another possibility. The usage of an acellular dermal scaffold can be done, however the process of tubularisation makes it unnecessary and avoids the added costs and morbidity associated with it's use.

The technique described was first used by Cerovac et al. Was to use the turnover technique to lengthen smaller tendons in non-load bearing muscles of the hand. And while their technique in the reconstruction of Flexor Pollicis Longus and Extensor Indicis Proprius used a single turnover in the proximal stump, our modification to the procedure has a turnover at both proximal and distal stump. We believe this provides a stronger tendon reconstruction necessary for a load bearing limb.

It is evident that the patient's dorsiflexion and capacity to work was restored by the procedure, and that this type of repair has an added advantage in a developing nation in that the repair is cheaper, easily reproducible and quicker. While it requires patient compliance to a routine of physiotherapy, the rapid improvement alongside with the benefit of having no donor site morbidity makes it ideal for a patient with a discontinuous tendon defect in the developing world.

**Conclusion**

In this particular case, the ideal outcome was achieved. A patient whose livelihood was threatened by a discontinuous tendon that was not amenable to surgical treatment and the inability to walk was restored to near normal function despite not having received any treatment for three months. In addition there was a rapid recuperation, with the patient walking in 8 weeks and returning to work 12 weeks after the procedure. We would like to perform more double turnover procedures and compare the outcomes to other conventional methods of tendon reconstruction.