Introduction:
Mutilating injuries to the upper limb pose a significant problem as an increasing number of young adults participate in high-risk activities (Moran 2005, Venkatramani 2008, Sabapathy 2016). There remains a shortage of literature showing management with delayed secondary neurotisation following severe extremity trauma. This case shows what may be achieved if extreme trauma is managed within an effective protocol and timely access to expertise.

Case Report:
A 22-year-old male sustained a subtotal amputation of his left arm requiring vein graft revascularisation. Other injuries included a divided axillary artery, fractured clavicle and ruptured musculocutaneous nerve with intact posterior cord of the brachial plexus, median nerve and ulnar nerve. Total ischaemia time was less than 4 hours. The patient made a good recovery and was discharged two weeks later.

Three months post-injury the patient had full hand function and sensation and elbow extension, although he scored M1 for elbow flexion, M3 for trapezius function and M0 for shoulder abduction (O’Brien 2000). He underwent a nerve transfer of a median nerve motor fascicle to the brachialis muscle and received physiotherapy and electrical neuromuscular stimulation post-operatively.

At clinic 12 months following injury the patient scored M4+ elbow flexion and extension but M0 for deltoid. We carried out a nerve transfer of the posterior motor branch of triceps to axillary nerve. He has regained excellent shoulder abduction and returned to his usual pre-morbid employment.

Discussion:
The high volume of severe trauma at our centre has enabled us to develop an effective trauma system which successfully manages candidates for limb salvage (Sabapathy 2007, Sabapathy 2013, Sabapathy 2016). However, when this patient presented to us there had been little published utilising delayed nerve transfer following mutilating upper limb injuries. As a result, we had to establish our own practice.

We consider three months a reasonable time for secondary procedures as the skin should be supple and swelling-free. For proximal upper limb injuries, the restoration of elbow function should take precedence, followed by shoulder stability and active abduction and external rotation (Venkatramani 2008). However, when we operated on this patient, the tissue scarring had made the nerve branch to biceps unavailable. Therefore, we chose to coapt a fascicle of the median nerve to the brachialis muscle branch within unscarred tissue. In this patient, the outcome resulting from brachialis reinnervation alone was excellent.

On returning for review 12 months the patient still needed improvement in shoulder function. As we could not use the spinal accessory nerve transfer to suprascapular nerve, (Bertelli 2007) we utilised the nerve branch to triceps to reconstruct the axillary nerve (Lechavengvongs 2016). Physiotherapy and electrostimulation was given post-operatively and after 10 years the patient has regained shoulder function allowing him to return to full-time employment.

Conclusions:
This case is the first documented case showing an improved functional outcome in a revascularised limb following nerve transfer after 12 months. We stress the importance of senior expertise and a clearly defined trauma protocol which minimises ischaemia time. Mutilating upper limb injuries present a challenge, but modern neurotisation techniques, even if delayed, can result in success.

References