amputations develop symptomatic neuromas. Many patients rely on daily opioids, neuropathic pain meds, and/or antidepressant medications that provide suboptimal pain relief with adverse side effects. Many patients cannot return to work as a result of these neuromas. The Regenerative Peripheral Nerve Interface (RPNI) is a surgical technique that involves implantation of a divided peripheral nerve into a free muscle graft. RPNIs mitigate neuroma formation and treat existing neuroma pain in the setting of major limb amputations. The purpose of this study was to determine if RPNIs effectively treat neuroma pain following partial hand and digital amputations.

**Methods:** A retrospective review was performed on seventeen patients who underwent RPNI surgery between November 2014 and July 2019 for the treatment of symptomatic hand and/or digital neuromas following a traumatic injury of the hand. Symptomatic neuromas were diagnosed by history and physical exam. During the operation, the symptomatic neuroma was resected and a free muscle graft for each RPNI was harvested from a donor muscle. The epineurium of the peripheral nerve was secured into the central portion of the muscle graft which was subsequently wrapped around the nerve end entirely. Patient reported postoperative pain, physical exam findings, and complications were reviewed.

**Results:** Thirty-four therapeutic RPNIs were performed on seventeen symptomatic neuroma patients in the outpatient setting under regional or general anesthesia by 6 surgeons. In all patients preoperatively, 100% of neuromas had a positive Tinel sign. Postoperatively, 71% of patients had a negative Tinel sign. A total of 88% of patients were pain-free or reported considerably improved pain at their most recent office visit. Two patients required secondary RPNI operations for new neuromas diagnosed after their initial operation. One patient developed cellulitis that was treated with oral antibiotics and another patient developed a surgical site infection requiring surgical exploration and resection of the RPNI. There were no cases of delayed wound healing. The average patient follow-up was 39 weeks (4-128 weeks).

**Conclusions:** Symptomatic neuromas resulting from hand or digital trauma decrease an individual’s quality of life and extremity function. Our initial retrospective review shows promise that RPNI surgery can provide dramatic improvement in neuroma pain following traumatic hand injury by resecting the painful neuroma and preventing recurrence. This procedure has minimal morbidity to the patient and is easily reproducible by surgeons trained in the technique.

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**Local FK506 Drug Delivery Enhances Nerve Regeneration Through Fresh Nerve Allografts**

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**Purpose:** Peripheral nerve allografts are a strategy of nerve gap reconstruction with advantages including native nerve microstructure, donor Schwann cells that maintain a pro-regenerative milieu, and limitless supply with no donor site morbidity. Despite good outcomes in animal experiments and clinical series, the clinical use of unprocessed fresh nerve allografts is limited due to the requirement for transient systemic immunosuppression with its associated adverse effects. To circumvent the systemic effects of FK506 (an FDA-approved immunosuppressant), our laboratory developed a local FK506 drug delivery system that provides sustained, targeted drug release over 28 days. The objective of this study was to investigate if local FK506 drug delivery enhances nerve regeneration in a rodent model of nerve gap defect reconstruction using unprocessed fresh nerve allografts.

**Methods:** In male Lewis rats, a 10 mm hindlimb common peroneal nerve gap defect was reconstructed with either 20 mm long nerve isografts from donor Lewis rats or 20 mm long fresh nerve allografts from donor ACI rats. Rats with nerve allograft reconstruction received either systemic FK506 (2 mg/kg/day intraperitoneal injections), local FK506 (420 µg FK506 encapsulated in poly(lactic-co-glycolic acid) microspheres suspended in a fibrin hydrogel and applied once directly to the site of nerve injury), or no treatment. The objective of this study was to investigate if local FK506 drug delivery enhances nerve regeneration in a rodent model of nerve gap defect reconstruction using unprocessed fresh nerve allografts.

**Results:** At 4 weeks after nerve allograft reconstruction, there were no cases of delayed wound healing. The average patient follow-up was 39 weeks (4-128 weeks).

**Conclusions:** Symptomatic neuromas resulting from hand or digital trauma decrease an individual’s quality of life and extremity function. Our initial retrospective review shows promise that RPNI surgery can provide dramatic improvement in neuroma pain following traumatic hand injury by resecting the painful neuroma and preventing recurrence. This procedure has minimal morbidity to the patient and is easily reproducible by surgeons trained in the technique.
Purpose: Upper extremity weakness may be debilitating and results from a variety of causes, including peripheral nerve and cervical spinal cord injury, stroke, and disuse atrophy. Therapy is critical for regaining function but patients are unable to engage with traditional methods of therapy until evidence of motor recovery is seen on clinical exam. In this study, we have developed an innovative system of gamified therapy that uses signals detected by surface electromyography (EMG), a well-established, noninvasive technique that measures electrical activity generated by muscle contractions from electrodes placed on the overlying skin.

Methods: We constructed a highly sensitive custom surface EMG device and integrated it with multiple gaming platforms. In our system, adhesive electrodes are placed over a muscle of interest, and muscle activation greater than a set threshold triggers a single action in the virtual gaming environment. Patients with upper extremity weakness from any cause were recruited to use the surface EMG device to play games. Acceptability surveys were administered after each gaming session, and additional metrics to assess feasibility were examined, including task learning speed, length of gameplay session, high scores achieved, and technical problems encountered.

Results: The sensitivity of our custom surface EMG device was assessed through simultaneous needle EMG recordings. Our device is capable of detecting muscle activation even during recruitment of a single motor unit, and signals recorded represent activity from the specific muscle of interest and not of opposing muscle groups nearby. Patients quickly learned how to activate their muscles to interact with the virtual gaming environment. Interestingly, patients lacking antigravity muscle strength, scoring as low as 2/5 on manual muscle testing, were still able to engage in reliable gameplay. Responses from acceptability surveys showed that the majority of patients found the surface EMG-based gaming platform to be motivating, enjoyable, easy to understand, and safe.

Conclusion: Gamified therapy represents a novel approach to rehabilitation that promotes patient engagement, motivation, and compliance. The use of surface EMG signals as input for therapeutic gaming has tremendous potential for severe muscle weakness in the earliest stages of recovery, as nascent signals from underlying affected muscles are detectable on EMG before significant movement is observed on clinical exam. This creates the opportunity for earlier initiation of therapy in many patients with upper extremity weakness. In patients with brachial plexus injuries who have undergone nerve transfer surgeries, surface EMG-based therapy may have the added benefit of facilitating cortical retraining by helping patients learn the association between donor nerve activation and recipient muscle movement. Future studies are needed to assess the clinical efficacy of surface EMG-based gamification therapy in these distinct patient populations.