Prophylactic Regenerative Peripheral Nerve Interfaces for the Mitigation of Neuroma Pain and Phantom Limb Pain

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PURPOSE: Regenerative Peripheral Nerve Interfaces (RPNIs) can be used to treat symptomatic end neuromas that develop after major limb amputation. Symptomatic neuromas occur in approximately 30–40% of individuals after limb loss and phantom limb pain affects 70–95% of these patients. We investigate the potential of prophylactic RPNIs to prevent neuroma formation and to mitigate the experience of phantom limb pain. Furthermore, we examine the potential complications resulting from the addition of prophylactic RPNIs to major limb amputation surgery.

METHODS: RPNIs were performed during the time of amputation by implanting transected peripheral nerves into free muscle grafts harvested from the amputated limb. Patients who underwent major limb amputation with simultaneous prophylactic RPNI implantation were identified. A retrospective chart review was performed to ascertain patient demographics, indication for amputation, level of amputation, characteristics of postamputation pain, perioperative pain management strategies, and postoperative complications. During follow up, all patients were evaluated specifically for symptomatic neuromas, residual limb pain, and phantom limb pain through history and physical examination.

RESULTS: RPNIs were prophylactically implanted in 28 patients who underwent 29 major limb amputations. The mean patient age was 46 years (range 13–79) and mean follow up was 89 days (range 6–273). The most common indication for amputation was infection (n=14, 48%) followed by trauma (n=8, 28%). Below knee amputations comprised the majority of subjects (n=23, 79%). Major postoperative complications were defined as events that resulted in admission or surgery; one patient was admitted for postoperative nausea and vomiting, but this was unrelated to the RPNI surgery. Minor complications included delayed wound healing (28%) and surgical site infection managed on an outpatient basis (14%). The incidence of overall complications after prophylactic RPNIs (32%) was not higher than that of traditional limb amputation procedures (20–70%). Zero of the twenty nine patients (0%) had any clinical evidence of symptomatic neuroma postoperatively. Only 8 patients (28.6%) reported symptoms of phantom limb pain at any point during their postoperative course.

CONCLUSIONS: Prophylactic RPNIs in major limb amputees resulted in a considerably lower incidence of both symptomatic neuromas and phantom limb pain as compared to published rates in the literature. Additionally, prophylactic RPNIs did not contribute to increased morbidity compared to standard amputation techniques. These findings suggest that prevention of peripheral nerve pain following major limb amputation may diminish the central pain mechanisms that lead to phantom limb pain. This pilot study supports prospective comparative investigation of using RPNIs to significantly reduce postamputation pain.

Macrophage Recruitment and Activation to Skeletal Muscle after Acute Nerve Injury

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PURPOSE: The skeletal muscle has a unique immunologic profile that is particularly dynamic following muscle injury. Immune cells such as macrophages, which are normally few in number during physiologic conditions, are recruited to the muscle following injury to assist in inflammatory and reparative processes. In response to their muscle microenvironment, macrophages are able to change their phenotypes and functions during these events. Although macrophage recruitment and activation have been demonstrated in direct muscle injury models, this dynamic process has not been described in muscle after nerve injury. The goal of this study was to determine if acute nerve injury resulted in the recruitment of macrophages to the distal muscle target, and to characterize the phenotype of these activated macrophages.

METHODS: We utilized two strategies to determine if macrophages are recruited to muscle after sciatic nerve