

Prevention is better than cure: A Five-year Comparative Analysis of Pain Trajectories Following Primary and Secondary Targeted Muscle Reinnervation in Amputees

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INTRODUCTION: Targeted muscle reinnervation (TMR) has emerged as an effective intervention for neuropathic pain management in amputees, but long-term comparative data between primary (prophylactic) and secondary (therapeutic) approaches remain limited.

METHODS:

This prospective longitudinal study analyzed amputee patients over a 5-year follow-up period (minimum follow-up: 12 months). Primary TMR was performed ≤ 14 days post-amputation, while secondary TMR was performed > 14 days post-amputation. Pain trajectories were modeled using multilevel mixed-effects models with natural splines. Responders were defined as achieving: pain scores $\leq 3/10$ for ≥ 3 months (primary TMR) or ≥ 3 -point reduction (minimally clinically important difference) or scores $\leq 3/10$ for ≥ 3 months (secondary TMR).

RESULTS:

The study included 204 patients (101 primary TMR, 103 secondary TMR, median follow-up: 2.6 years (IQR: 2.1-3.2)). Long-term response rates were comparable between groups (66.3% primary vs. 68.9% secondary, $p=0.681$). Primary TMR demonstrated significantly faster pain relief achievement. The median time to response status was 5.4 months for primary TMR versus 12.9 months for secondary TMR ($p<0.001$), representing a 2.4-fold advantage. At 6-months, primary TMR patients had 3.12 times higher odds of achieving sustained relief (95% CI: 1.61-6.24, $p<0.001$). Statistically significant differences in pain scores favored primary TMR through 18 months, with peak differences of 1.52 points at 6 months ($p=0.0005$). No significant differences existed beyond 18 months.

DISCUSSION AND CONCLUSION: While both primary and secondary TMR achieve similar long-term durability, primary TMR provides substantial advantages in the timeframe of pain relief achievement. These findings support prophylactic TMR when feasible while providing reassurance that delayed intervention remains highly effective, with important implications for patient counseling and clinical decision-making.

