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Review Article

Stimpod as an Adjunct for Intraoperative Functional Mapping During Brachial Plexus Repair- A Case Series

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Abstract

Intraoperative decision-making during brachial plexus exploration hinges on rapid assessment of nerve identity, continuity, and distal motor unit recruitment. Conventional techniques rely on EMG and visual inspection. We describe the use of the Stimpod device (Xavant technologies) as a non-invasive functional screening adjunct during brachial plexus exploration and repair.

After pre-operative nerve conduction studies and neuroimaging, 21 patients scheduled for brachial plexus repair underwent Stimpod guided intra-operative functional mapping. The responses were correlated with surgical decisions of grafting/transfer and postoperative motor outcomes. Stimpod provided real-time functional information regarding axonal continuity and distal motor unit recruitment, guiding surgical strategy. Postoperative muscle strength in the target muscles, improved in 19 out of 21 patients, with no device-related complications.

Stimpod assisted functional screening is a rapid, low-footprint adjunct that complements surgical judgment and conventional monitoring, particularly valuable in resource-limited settings. Limitations include inability to distinguish sensory from motor fibers and to quantify conduction velocity.

Keywords: brachial plexus; nerve repair; TIVA; entropy

Introduction

Brachial plexus injuries (BPI) present a complex surgical challenge where real-time intraoperative decisions critically influence outcomes. During exploration and repair, surgeons must rapidly answer three practical questions: (i) is the identified structure viable nerve or fibrotic scar, (ii) does conduction persist across the lesion, and (iii) is distal motor unit recruitment sufficient to justify neurolysis rather than nerve grafting or transfer [1].

Traditional assessment tools include intraoperative electromyography (EMG) or nerve conduction studies (NCS), and visual inspection. However, there are limitations - EMG and NCS necessitate trained neurophysiology support and bulky setups, whereas visual inspection is subjective and can be misleading [2]. These constraints are amplified in time-sensitive operations and resource-limited environments of tertiary care centers located in Himalayan region.

The Stimpod device (Xavant technologies) is a portable transcutaneous electrical nerve stimulator designed for clinical neuromodulation and assessment. Its application as a functional mapping tool during brachial plexus surgery can bridge the gap between invasive neuromonitoring and purely anatomical judgment. In our literature review we only came across a retrospective study comparing VARI STIM III nerve stimulator (Medtronic Inc, Jacksonville, Florida) and Stimuplex HNS11 (Braun Medical Inc, Bethlehem, Pennsylvania) [3]. This case series describes its principle of use, technique, and clinical utility.

This device delivers controlled electrical stimulation over targeted anatomical structures like proximal plexus elements, suspected nerve trunks, and distal muscle motor points. A visible or palpable muscle contraction following stimulation suggests preserved axonal continuity and functional motor units distal to the stimulation site. Absence or attenuation of response provides complementary information regarding the severity and level of injury. This physiologic principle allows rapid functional assessment without invasive exposure, serving as an adjunct for definitive intraoperative neuromonitoring [4].

Aim

The aim of our case series was to assess the efficacy of Stimpod with Locoplex needle for intraoperative functional mapping of brachial plexus during surgical repair. Secondary objective was to assess the postoperative outcomes after the use of this technique in the study participants.

Case Presentation

The present case series encompasses the use of this device in 21 patients undergoing brachial plexus exploration and repair for traumatic injuries. Procedures included neurolysis, nerve grafting, and nerve transfers based on intraoperative findings. The patients underwent anesthetic induction and endotracheal intubation under total intravenous anesthesia (TIVA) without the aid of muscle relaxant [5]. Entropy monitoring was used to assess anesthetic depth throughout the anesthetic protocol. Thereafter, surface electrodes of Stimpod were placed over the supraclavicular fossa, infraclavicular region, and motor points of the selected muscles of the upper limb.

After surgical exposure but prior to definitive repair, stimulation was applied using the Locoplex needle (Vygon, France) along the exposed nerve trajectory using a sterile barrier or proximally while observing distal muscle groups for contraction. These responses were interpreted in following manner : (i) robust distal contraction- favored neurolysis and preservation of native nerve; (ii) equivocal or absent response- supported decision for grafting or nerve transfer; (iii) segmental response loss- helped localize the functional level of injury [6]. The technique provided a rapid intraoperative checkpoint, complementing anatomical inspection and surgeon experience.

The series enrolled 21 patients, in which 6 patients underwent Somsak's procedure, 1 patient underwent modified Saha's procedure, 6 patients underwent double Oberlin procedure, 4 patients underwent thoracodorsal to axillary nerve transfer and 4 patients of pan-brachial plexus injury underwent spinal accessory nerve to suprascapular nerve transfer alongwith intercostobrachial nerve to musculocutaneous nerve transfer (Figure 1-5).

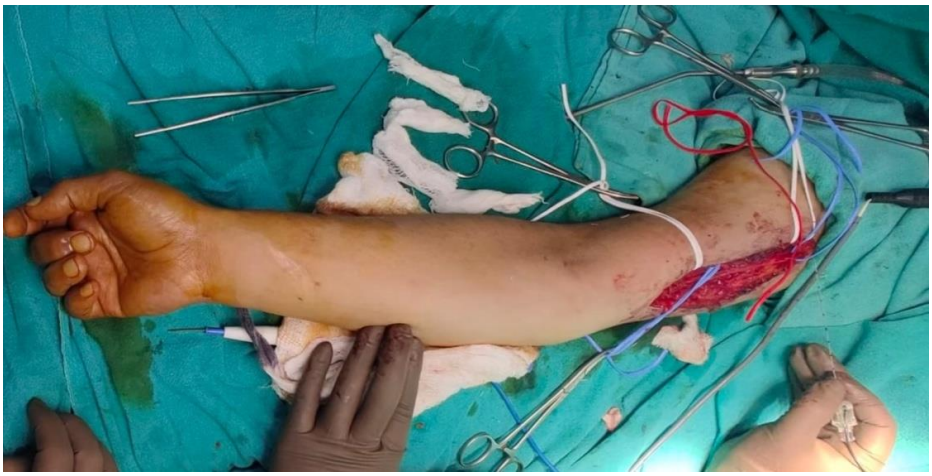

Figure 1: Intraoperative use of a Locoplex needle connected to the Stimpod device for targeted electrical stimulation during brachial plexus exploration. The setup demonstrates real-time functional assessment of neural structures prior to nerve transfer, facilitating identification of viable donor fascicles and recipient targets

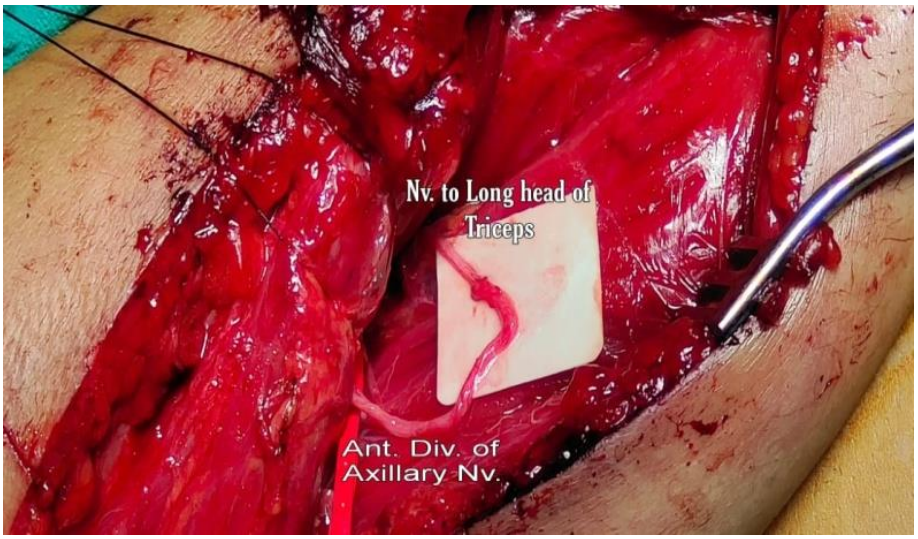

Figure 2: Intraoperative depiction of Somsak's nerve transfer technique, illustrating selective fascicular transfer to restore elbow flexion. The image highlights donor fascicle isolation and coaptation under magnification following functional confirmation

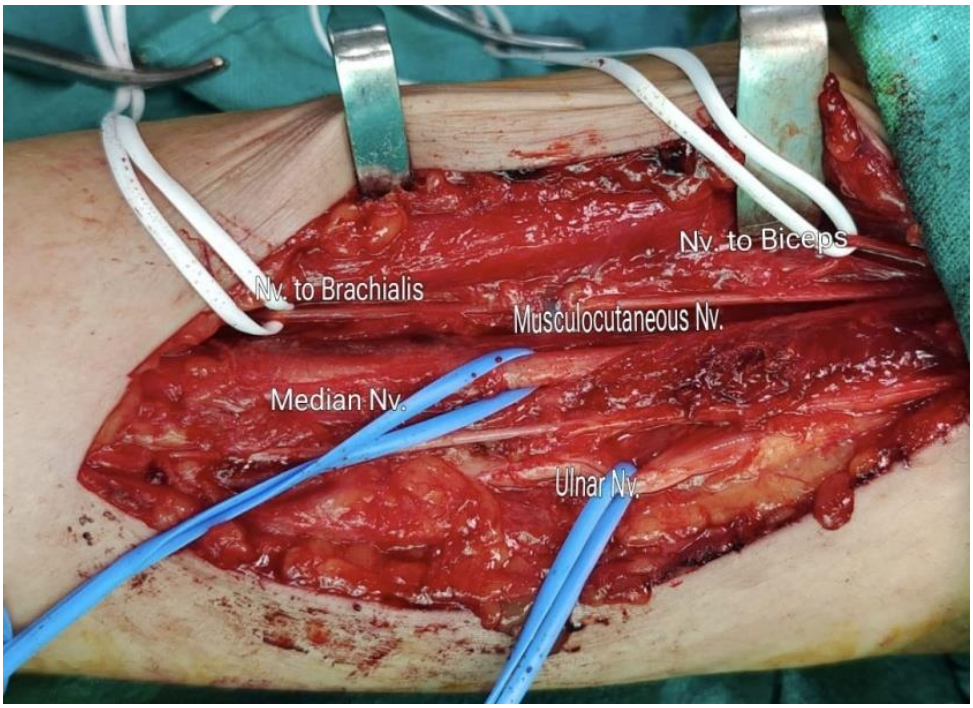

Figure 3: Surgical view demonstrating the double Oberlin nerve transfer technique, wherein fascicles from the ulnar and median nerves are selectively transferred to the motor branches of the biceps and brachialis muscles. Functional intraoperative stimulation was used to confirm donor integrity prior to coaptation.

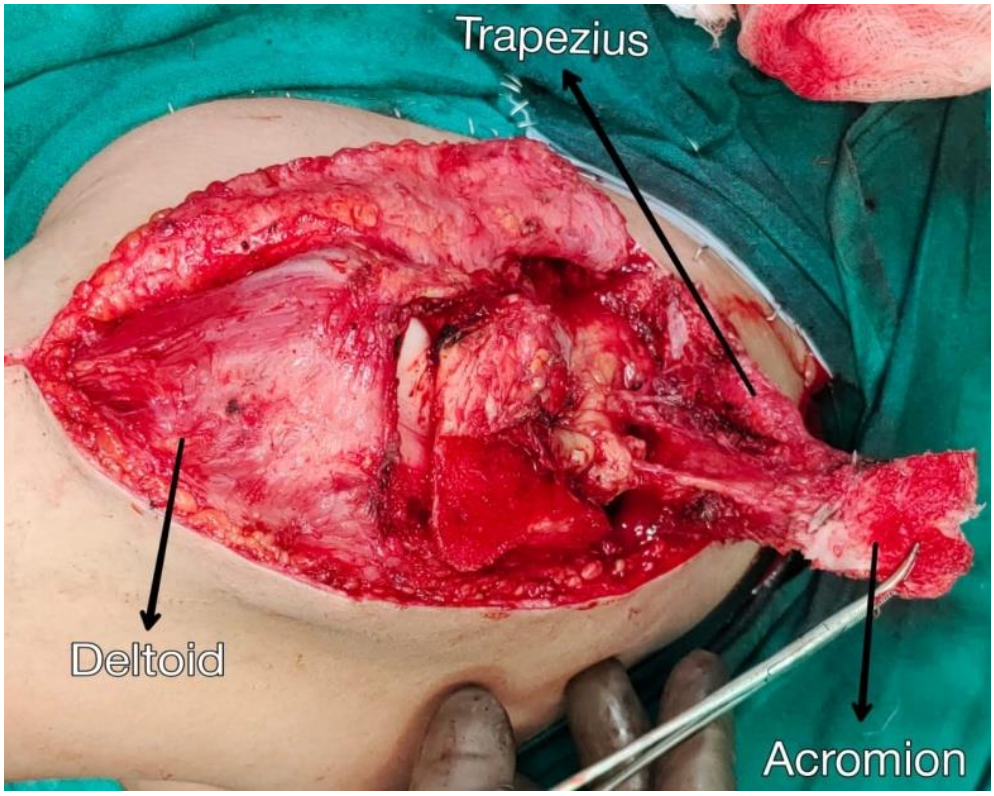

Figure 4: Intraoperative photograph of the modified Saha's procedure showing nerve identification, preparation of recipient branches, and tension-free microsurgical coaptation. Functional stimulation guidance was utilized to optimize donor–recipient matching.

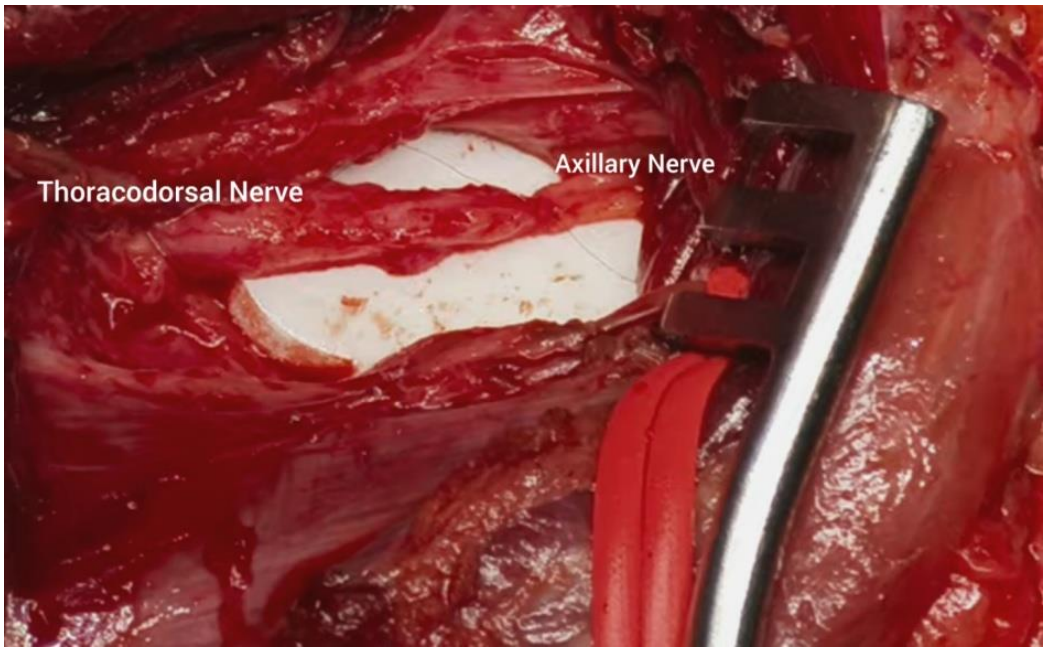

Figure 5: Surgical exposure illustrating thoracodorsal nerve transfer to the axillary nerve for restoration of shoulder abduction. The image demonstrates donor nerve mobilization, preparation of the axillary nerve, and microsurgical coaptation following intraoperative stimulation-based assessment.

The responses elicited by Stimpod through Locoplex needle, influenced the intraoperative decisions in a substantial proportion of cases, where visual assessment alone was inconclusive. Postoperative functional outcomes were assessed using the Medical Research Council (MRC) grading system for muscle strength in target muscle groups corresponding to the repaired or transferred nerves. At follow-up, the majority of patients demonstrated meaningful motor recovery (≥ MRC grade 3) in at least one primary target muscle [7]. Patients in whom intraoperative Stimpod stimulation elicited robust distal motor responses prior to repair showed earlier and more consistent recovery compared with those demonstrating absent or equivocal responses.

A qualitative association was observed between Stimpod responses and surgical strategy. Nerves selected for neurolysis based on preserved distal motor recruitment generally exhibited superior functional outcomes compared with segments requiring grafting or nerve transfer, reflecting underlying axonal continuity. In borderline lesions, Stimpod assisted functional assessment helped avoid unnecessary grafting, without compromising postoperative recovery.

No device-related adverse events were observed. Nerve stimulation did not interfere with anesthetic management. Standard surgical complications related to brachial plexus reconstruction such as donor site morbidity and delayed reinnervation, were comparable to institutional experience and existing literature.

Patients were followed clinically with structured physiotherapy and rehabilitation protocols. Early identification of viable motor units facilitated timely initiation of targeted rehabilitation strategies, potentially contributing to improved functional outcomes. Tables 1 and 2 summarize the key results of the present case series.

Quality of endotracheal intubation	
Attempt	First attempt in all patients
Laryngoscopy duration (in seconds) (mean ± SD)	17.33 ± 4.1096
Desaturation during laryngoscopy	No
Capnography confirmation	Yes
RSI required	No
Adverse Event at Intubation	No
Heart rate during Intubation (beats/min) (mean ± SD)	94.16 ± 9.227
Mean arterial pressure during Intubation (mmHg) (mean ± SD)	87.66 ± 6.446
Surgical procedure	
Somsak's procedure	6
Double Oberlin procedure	6
Modified Saha's procedure	1
Thoracodorsal to axillary nerve transfer	4
Spinal accessory nerve to suprascapular nerve transfer alongwith intercostobrachial nerve to musculocutaneous nerve transfer	4
Intraoperative device metrics	
Stimulus at which contraction observed (Excluding 2 cases) (mean ± SD)	2.94 ± 0.3006 mA
Device malfunction	No
Quality of extubation	
Time to extubation	7.6 ± 0.16 min

Time to respond to verbal commands from cessation of anaesthesia	8.7 ± 2.6 minutes
Any incidence of coughing	No
Heart rate during Extubation (beats/min) (mean ± SD)	86.3 ± 4.8
Mean arterial pressure during Extubation (mmHg) (mean ± SD)	103.6 ± 5.7
MOASS at 15 min in the PACU (mean ± SD)	4.333 ± 0.471
MOASS at 60 min in the PACU (mean ± SD)	4.8333 ± 0.372
CAM-S form score at 15 min in PACU (mean ± SD)	0.8333 ± 0.3726
CAM -S form at 60 min in PACU (mean ± SD)	0.3333 ± 0.471

Table 1: The table summarizes airway management quality (intubation conditions, hemodynamic stability, and adverse events), types of surgical procedures performed, intraoperative stimulation thresholds required to elicit muscle contraction using the device, and extubation/recovery characteristics including hemodynamic variables, sedation scores (MOASS), and delirium assessment (CAM-S) in the post-anesthesia care unit (PACU). Values are presented as mean ± standard deviation where applicable.

Number of patients	Pre- operative MRC score	Post-operative MRC score
10	2/5	4+/5
5	1/5	3 /5
3	0/5	4 /5
2	0/5	0 /5

Table 2: Preoperative and postoperative Medical Research Council (MRC) muscle strength grades are shown according to the number of patients in each functional category, demonstrating improvement in motor power following surgical intervention.

Discussion

Brachial plexus injuries (BPI), particularly traumatic and avulsion-type lesions, pose a formidable reconstructive challenge due to the extensive loss of motor and sensory function and the limited window for reinnervation. Over the past two decades, nerve transfer techniques have emerged as a cornerstone of functional restoration, especially when proximal nerve roots are irreparable or unavailable. The guiding principle of nerve transfer surgery i.e. redirecting expendable donor nerves with preserved function to denervated target muscles, has allowed surgeons to bypass long regeneration distances and achieve more reliable outcomes [8].

Early reports demonstrated the feasibility of targeted nerve transfers for shoulder and elbow function [9-13]. Leechavengvongs et al. described transfer of the nerve to the long head of the triceps to the axillary nerve for deltoid reinnervation, reporting meaningful shoulder abduction recovery in the majority of patients [14]. This work was seminal in establishing intraplexal nerve transfers as a reliable option for restoring shoulder stability and function, particularly in upper trunk injuries.

Restoration of shoulder abduction and external rotation remains a primary objective in BPI reconstruction, as it underpins upper limb positioning and functional reach. Transfer of the spinal accessory nerve to the suprascapular nerve has been widely adopted to restore supraspinatus and infraspinatus function [15]. Bertelli and Ghizoni demonstrated consistent recovery of shoulder abduction and external rotation following this transfer, highlighting its reliability and favorable donor morbidity profile [16].

Alternative donor nerves have been explored to optimize outcomes in complex or delayed presentations. Janes et al. reported the use of thoracodorsal and medial triceps nerves to the anterior division of the axillary nerve, demonstrating satisfactory shoulder reanimation when conventional donor nerves were unavailable [17]. Similarly, Samardzic et al. described thoracodorsal nerve transfer in irreparable C5–C6 lesions, achieving functional shoulder recovery in a subset of patients [18]. These studies emphasize the importance of donor nerve selection based on availability, injury pattern, and residual function.

In chronic and salvage scenarios, reconstructive strategies may extend beyond nerve transfers alone. Bordelon et al. reported a modified Saha procedure for paralytic shoulder following reverse shoulder arthroplasty complicated by BPI, illustrating how tendon transfers and muscle balancing procedures can complement nerve reconstruction when denervation is longstanding [19].

Restoration of elbow flexion is widely regarded as the most critical functional goal in BPI reconstruction. Fascicular transfers to the musculocutaneous nerve have shown consistently favorable outcomes. Texakalidis et al. described double fascicular nerve transfers targeting musculocutaneous branches, achieving meaningful recovery of elbow flexion strength with minimal donor morbidity [20].

In more extensive injuries, including infraclavicular and global plexus lesions, extraplexal donors have been utilized. Soldado et al. demonstrated the utility of thoracodorsal nerve transfer for elbow flexion reconstruction, reporting functional recovery even in challenging infraclavicular injuries [21]. Intercostal-to-musculocutaneous nerve transfer remains another established technique, particularly in complete plexus avulsions. de Mendonça Cardoso et al. reported functional elbow flexion in a majority of patients following intercostal nerve transfers, although outcomes were variable and dependent on rehabilitation intensity and timing of surgery [22].

Precise titration of anesthetic depth is critical during nerve exploration and repair, particularly when intraoperative nerve stimulation, electromyography, or emerging neuromodulation tools are employed. Photoacoustic detection of propofol in breath gas highlights the evolving paradigm of real-time propofol quantification as a surrogate for anesthetic depth, especially relevant in neuroanesthesia contexts where conventional indices may lag behind physiological changes [23]. The ability to finely tune hypnotic depth with propofol-based TIVA supports stable cortical and peripheral neural responsiveness, minimizing both burst suppression and unintended awareness during prolonged microsurgical dissections. This precision is particularly advantageous in brachial plexus surgery, where subtle changes in anesthetic depth can alter nerve excitability and surgeon interpretation of functional responses [24].

Maintenance of stable perfusion pressure is a cornerstone of nerve protection during prolonged reconstructive procedures. Exploratory modeling of intraoperative co-oximetry data by demonstrated that intravenous anesthetic techniques allow predictable coupling between oxygen delivery indices and hemodynamic trends, even in physiologically complex patients [25]. While conducted in a thalassemic neuroanesthesia setting, the implications extend to peripheral nerve surgery, where ischemia–reperfusion injury and microvascular compromise can adversely affect nerve regeneration [26].

TIVA, through reduced sympathetic fluctuation and absence of volatile-induced vasodilation, offers tighter control over mean arterial pressure and tissue oxygenation—factors crucial in brachial plexus repair

performed under magnification and extended operative times. Observational data comparing TIVA with volatile anesthetic maintenance in anterior cervical discectomy and fusion (ACDF) surgeries further strengthen the argument for intravenous techniques in nerve-adjacent surgeries [27]. Sharma et al. demonstrated that TIVA was associated with more stable intraoperative hemodynamics and smoother emergence profiles, attributes that directly translate to improved neurological assessment in the immediate postoperative period [28]. Given the anatomical and functional proximity of ACDF to brachial plexus elements, these findings provide relevant comparative insight.

Additionally, simulation-based and literature-driven analyses of anesthesia–neurological disorder interactions in brain–computer interface (BCI) procedures emphasize that volatile agents can interfere with neural signal integrity, whereas propofol-based regimens preserve signal-to-noise ratios critical for functional mapping [29]. Although BCI procedures differ technically, the underlying principle of neural signal preservation aligns closely with the goals of brachial plexus repair.

The perioperative psychological milieu is increasingly recognized as a modifier of anesthetic requirements and recovery trajectories. A natural experiment during the 2025 India–Pakistan conflict demonstrated heightened perioperative anxiety influencing anesthetic depth and sympathetic tone [30]. In this context, TIVA—especially when combined with agents such as dexmedetomidine—may offer superior anxiolysis, opioid-sparing effects, and smoother perioperative transitions.

Supporting this concept, an integrated dexmedetomidine–sevoflurane algorithm for neurosurgical induction has come into light [31]. This underscores the growing emphasis on alpha-2 agonist–based modulation of stress responses. While the algorithm includes volatile agents, the central role of dexmedetomidine aligns well with TIVA strategies in brachial plexus repair, where attenuation of sympathetic surges and preservation of neural physiology are paramount [32].

Patients with global brachial plexus avulsion represent the most severe end of the injury spectrum. Liu et al. evaluated functional outcomes of nerve transfers in such patients and demonstrated that, while full restoration is rarely achievable, meaningful improvements in elbow flexion and shoulder stability are possible, significantly enhancing independence and quality of life [33]. These findings underscore the role of nerve transfers as part of a staged reconstructive strategy rather than a curative intervention.

Free functional muscle transfer (FFMT) is often employed when nerve transfers are not feasible or have failed. However, these procedures carry substantial complexity and morbidity. Atthakomol et al. reported reoperation rates following FFMT in traumatic BPI, highlighting complications such as inadequate reinnervation, muscle necrosis, and need for revision surgery [34]. These data reinforce the importance of careful patient selection and realistic expectation setting.

Beyond objective motor recovery, patient-reported outcomes and satisfaction are increasingly recognized as critical measures of success. Kretschmer et al. demonstrated that even partial functional recovery after brachial plexus surgery can lead to significant improvements in perceived disability and patient satisfaction, particularly when elbow flexion and shoulder stability are restored [35].

Despite advances in surgical techniques, outcome reporting in BPI literature remains heterogeneous. Dy et al. conducted a systematic review highlighting substantial variability in outcome measures, follow-up duration, and reporting standards, limiting cross-study comparisons [36]. Similarly, Armas-Salazar et al. emphasized inconsistencies in clinical outcome reporting across different surgical strategies, calling for standardized functional scales and patient-reported outcome measures to improve comparability and evidence synthesis [37].

The present case series highlights the utility of stimulation with the Stimpod as a pragmatic adjunct during brachial plexus surgery. The device offers immediate functional feedback without the logistical burden of conventional neuromonitoring. Its value is most evident in differentiating salvageable nerves suitable for neurolysis from those requiring reconstruction.

Nevertheless this device has certain limitations- (i) it cannot distinguish sensory from motor fibers; (ii) quantify conduction velocity; (iii) replace formal EMG/NCS when precise neurophysiologic characterization is required. The responses may also be influenced by edema, scarring, and anesthetic depth. Despite these constraints, its simplicity and portability make it particularly attractive in resource-limited setting.

While outcomes are influenced by injury severity, timing, and rehabilitation, even partial restoration of key functions yields meaningful improvements in patient independence and quality of life. Ongoing challenges include managing chronic injuries, optimizing donor nerve selection, and standardizing outcome reporting to strengthen the evidence base and guide future innovation.

The present case series focuses on real-time functional screening and correlation with muscle strength outcomes that can be juxtaposed with this evidence. Motor strength improvement was consistent with current evidence in literature. Stimpod responses could potentially refine surgical decision pathways supported by published outcomes. There is an opportunity to add quality of life, functional scores, and patient satisfaction to future analyses to match broader trends in the field.

Clinical Implications

From a clinical standpoint, the findings of this case series suggest that handheld functional stimulators such as the Stimpod may serve as a pragmatic intraoperative adjunct in brachial plexus exploration, particularly in environments where formal neuromonitoring infrastructure is unavailable or limited. The device may assist surgeons in real-time differentiation between intact but compressed nerves amenable to neurolysis and non-conducting segments requiring grafting or transfer. In practical terms, its use should be considered as a screening tool rather than a replacement for conventional electrophysiological assessment. Standardized stimulation protocols, careful titration of anesthetic depth to preserve neuromuscular responsiveness, and correlation with intraoperative anatomical findings are recommended to minimize false interpretation. Integration of stimulation responses with preoperative imaging, injury chronicity, and postoperative rehabilitation planning may enhance surgical decision-making. In resource-constrained settings, the Stimpod may offer a cost-effective bridge between clinical examination and advanced neuromonitoring, thereby potentially improving intraoperative confidence and optimizing reconstructive strategies.

Limitations

This case series has several limitations that warrant acknowledgment. First, the small sample size limits generalizability and precludes statistical inference. Second, the absence of a control group using conventional intraoperative neuromonitoring prevents direct comparative evaluation of diagnostic accuracy or prognostic value. Third, quantitative neurophysiologic parameters such as conduction velocity, amplitude mapping, or electromyographic characterization were not systematically recorded, limiting objective correlation between stimulation response and long-term functional recovery. Fourth, responses to stimulation may have been influenced by anesthetic depth, peri-neural scarring, edema, and variability in surgical exposure. Additionally, follow-up duration and standardized functional outcome measures were not uniformly applied, restricting comprehensive outcome comparison with published literature. Finally, the observational nature of the series introduces inherent selection and interpretation bias. Future prospective, controlled studies incorporating standardized functional scales and patient-reported outcomes are necessary to validate the clinical utility and reproducibility of this technique.

Conclusion

Stimpod represents a novel, non-invasive adjunct for functional screening during brachial plexus exploration and repair. By providing rapid insight into nerve continuity and distal motor unit recruitment, it supports informed surgical decision-making, especially where conventional neuromonitoring is unavailable. Further prospective studies are warranted to validate its impact on long-term functional outcomes.

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