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Oberlin and Mackinnon Procedures for Partial Postganglionic Brachial Plexus Injury: A Case Report

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ABSTRACT

Introduction: Brachial plexus injuries (BPIs) can result in significant motor and sensory dysfunction, profoundly impacting patients' quality of life. The Oberlin and Mackinnon procedures have emerged as promising surgical interventions for partial postganglionic BPIs, offering functional recovery and improved patient outcomes.

Case Presentation: A 32-year-old male presented with a six-month history of progressive weakness and paresthesia in his right upper limb following a motorcycle accident. Electromyography and magnetic resonance imaging confirmed a diagnosis of partial postganglionic BPI involving C5-8 nerve roots, with preservation of the T1 root. The patient underwent the Oberlin and Mackinnon procedures under general anesthesia. Intraoperative neurophysiological monitoring was utilized to guide the selection of functional fascicles for transfer. The Oberlin procedure involved the transfer of a fascicle from the ulnar nerve to the biceps branch of the musculocutaneous nerve, while the Mackinnon procedure consisted of a double fascicular transfer from the median nerve to the anterior interosseous and radial nerves. Aggressive postoperative rehabilitation focused on strengthening exercises, range of motion activities, and sensory re-education.

Discussion: At nine months post-surgery, the patient demonstrated marked improvement in elbow flexion (MRC grade 4), wrist extension (MRC grade 5), and hand grip strength (MRC grade 3) and sensation improvement across the affected limb. Early surgical intervention and careful preoperative evaluation were crucial factors contributing to the success of the Oberlin and Mackinnon procedures in this case. The aggressive rehabilitation regimen played a vital role in maximizing functional recovery and patient satisfaction.

Conclusion: Oberlin and Mackinnon procedures gave significant functional recovery and patient satisfaction when combined with aggressive postoperative rehabilitation.

Keywords: Brachial plexus injury, Oberlin procedure, Mackinnon procedure, nerve transfer.

INTRODUCTION

Brachial plexus injury (BPI) is a devastating neurological condition that occurs when the complex network of nerves that innervate the upper limbs, shoulder, and upper chest is damaged, leading to motor and sensory dysfunction.[1] BPIs predominantly affect

young adults, often as a result of road traffic collisions, and have life-altering implications for patients and their families.[2] Despite recent advancements in diagnostic and treatment modalities, there remains a pressing need for effective management strategies for these injuries.[3]

In recent years, surgical interventions such as nerve repair, nerve grafting, nerve transfer, muscle/tendon transfer, and free functioning muscle transfer have been employed to address various types of BPIs, with the goal of restoring function and improving the quality of life of affected individuals.[4] The Oberlin and Mackinnon techniques are two such surgical procedures that have demonstrated promising results in the management of partial postganglionic brachial plexus injuries.

Oberlin technique, first introduced by Oberlin et al., involves nerve transfer using a portion of the ulnar nerve to reinnervate the biceps muscle, thereby restoring elbow flexion in patients with upper arm type brachial plexus injury.[5] The use of this technique has led to Medical Research Council (MRC) grade M3 or higher biceps strength in 94-100% of patients, with M4 biceps strength achieved in 75-94% of cases. These results indicate the potential of the Oberlin technique in restoring functional elbow flexion in BPI patients.

On the other hand, the Mackinnon/Oberlin-II double fascicular transfer (DFT) is a more comprehensive approach, employing two nerve fascicles to restore elbow flexion in patients with acute brachial plexus injuries.[6] This technique has been successfully applied to cases involving acute C5-8 injuries and even partial T1 acute BPIs. With careful preoperative evaluation, early intervention, appropriate intraoperative functional fascicle selection, and aggressive postoperative rehabilitation, the Mackinnon/Oberlin-II DFT technique has the potential to yield positive outcomes in patients with partial postganglionic brachial plexus injuries.

Despite the promising results, there remains a paucity of literature comparing the long-term functional outcomes of these two techniques, especially in cases involving delayed surgical intervention, beyond 12 months from the time of injury.[7] In addition, further research is needed to elucidate the factors that contribute to the success of these procedures and to identify optimal surgical candidates.

In this case report, we present the successful management of a patient with partial postganglionic brachial plexus injury using the Oberlin and Mackinnon procedures. We aim to provide a comprehensive overview of the clinical decision-making process, the surgical techniques employed, and the postoperative rehabilitation program that led to significant functional recovery in our patient. Furthermore, we discuss the factors that contributed to the success of these procedures in our case and highlight the importance of individualized treatment strategies tailored to the patient's specific needs and injury characteristics.

CASE PRESENTATION

A 32-year-old male presented to our clinic with a six-month history of progressive weakness and paresthesia in his right upper limb following a motorcycle accident. The patient had no significant past medical history and no history of previous upper limb injury. On physical examination [Figure 1], he exhibited a significant loss of elbow flexion and hand grip strength, as well as sensory deficits in the distribution of the median, radial, and ulnar nerves. Medical Research Council (MRC) grading was done which showed elbow flexion (MRC grade 1) and wrist extension (MRC grade 5), hand grip strength (MRC grade 2). The patient's overall function was markedly impaired, affecting his ability to perform daily activities and work tasks.

Figure 1. a. Physical examination of the right shoulder b. Atrophy and motor function loss of pectoralis minor, pectoralis major, latissimus dorsi, deltoid, and biceps muscle c. Motor function loss of finger flexion, finger abduction, finger adduction

a.

b.

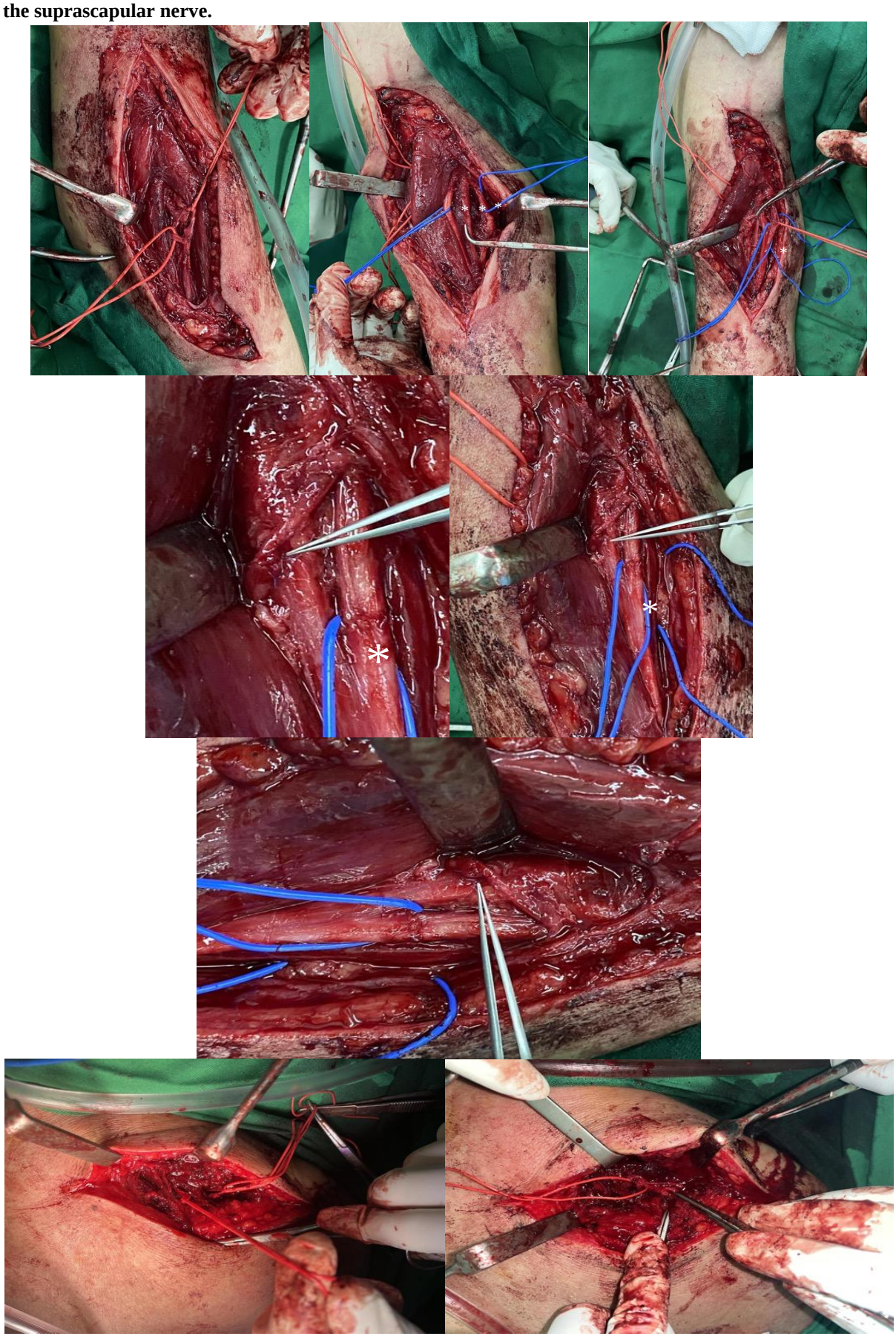
c.

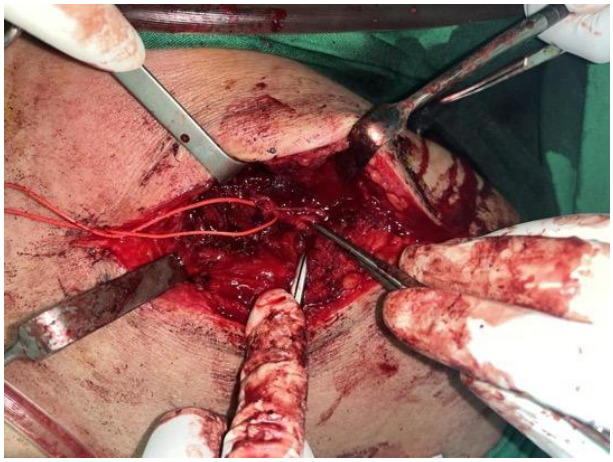
Electromyography (EMG) and magnetic resonance imaging (MRI) [Figure 2] studies were performed to further evaluate the patient's nerve injury. EMG showed axonotmesis on right brachialis plexus postganglionic. These tests confirmed the diagnosis of a partial postganglionic brachial plexus injury involving C5-8 nerve roots, with preservation of the T1 root. After careful preoperative evaluation and discussion of the risks and benefits, the patient consented to undergo surgical intervention.

Figure 2. a. MRI T2W Axial View b. T1W Axial View c. T1W Coronal View d. T1W Axial View of right shoulder. MRI suspect fracture of right acromion scapula, bone bruise on head of right humerus, rotator cuff injury, bursitis on subarachnoid bursae, and joint effusion on right glenohumeral joint.

The Oberlin and Mackinnon procedures [Figure 3] were performed under general anesthesia, with intraoperative neurophysiological monitoring used to ensure the preservation of donor nerve function and to guide the selection of appropriate functional fascicles for transfer. The Oberlin procedure involved the transfer of a fascicle from the ulnar nerve to the biceps branch of the musculocutaneous nerve, while the Mackinnon procedure consisted of a double fascicular transfer from the median nerve to the anterior interosseous and radial nerves.

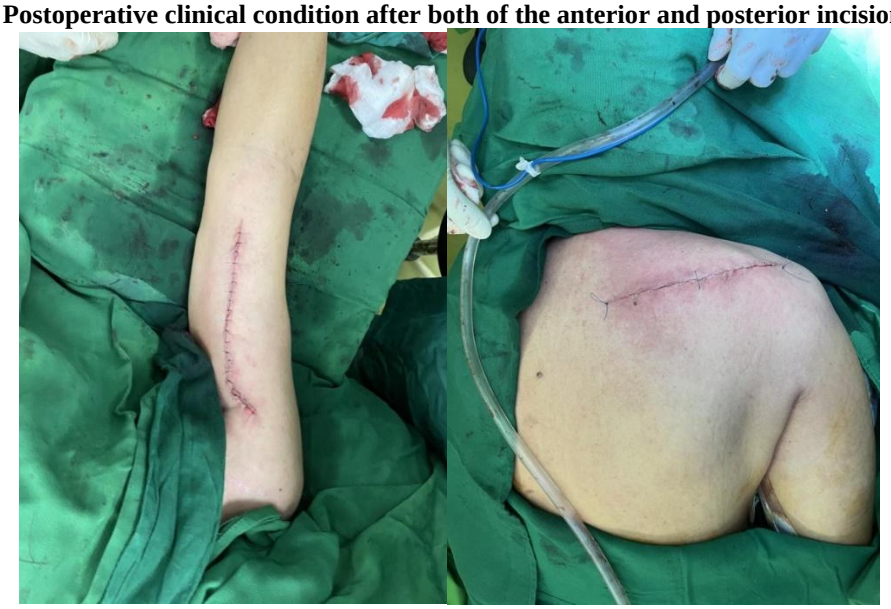
Figure 3. Step by step of Oberlin and Mackinnon procedures which show the process of transfering fasciculus ulnar nerve to the brachialis branch of musculocutaneous nerve and accessory spinal nerve to the suprascapular nerve.





Postoperatively, the patient [Figure 4] was enrolled in an aggressive rehabilitation program focusing on strengthening exercises, range of motion activities, and sensory re-education. Over the course of the rehabilitation, the patient demonstrated marked improvement in elbow flexion (MRC grade 4) and wrist extension (MRC grade 5). Hand grip strength also improved (MRC grade 3), and the patient reported subjective improvement in sensation across the affected limb. By nine months post-surgery, the patient was able to return to work and resume most of his daily activities, with only mild residual weakness and sensory deficits.

Figure 4. Postoperative clinical condition after both of the anterior and posterior incision sutured.



DISCUSSION

Partial postganglionic brachial plexus injury (BPI) presents a significant challenge for clinicians, as it can result in profound motor and sensory deficits in the affected upper limb. In this case, the patient suffered from muscle atrophy, reduced range of motion, and diminished sensation in the right upper extremity. With the goal of improving functional recovery and patient satisfaction, our team utilized the Oberlin and Mackinnon procedures, followed by an aggressive rehabilitation regimen. The favourable outcomes reported in this case reflect the growing body of evidence supporting these techniques for treating partial postganglionic BPI.

The Oberlin procedure, first described by Oberlin et al., involves transferring a part of the ulnar nerve to the biceps muscle, aiming

to restore elbow flexion.[5,7] Studies have reported good functional and clinical outcomes, with M3 or greater biceps strength achieved in 94–100% of patients, and M4 strength in 75–94%.5 In our case, the patient demonstrated significant improvement in elbow flexion at three and six months postoperatively, reaching M3 strength by the final follow-up.

The Mackinnon double fascicular transfer (DFT) procedure involves using partially injured donor nerves to restore function in the affected limb.[6] This technique offers the advantage of preserving residual function in the donor nerve while facilitating recovery in the recipient nerve. Studies have shown that the Mackinnon DFT technique can safely address acute C5-8 injuries and even partial T1 acute BPIs when combined with careful preoperative evaluation, early intervention, appropriate intraoperative functional fascicle selection, and aggressive postoperative rehabilitation.[6] In our case, the patient experienced improvements in wrist and finger movements, as well as a reduction in muscle atrophy, following the DFT procedure.

Nerve transfer procedures was a surgical strategy to restore the elbow flexion. Healthy donor nerves reinnervated biceps muscle and elbow flexion. A longer follow up study showed an inverse association with functional recovery ($r = -0.73$, $p = 0.016$) and better Medical Research Council (MRC) scale in six months.[8]

Although direct or graft nerve was remained as the gold standard, end to side could be one of the alternate ways. The reason was because hypotrophy will occur at the distal motor end-plate and sensory receptors because of the long distance and time to regenerate fibres from their proximal coaptation/graft site. Time was the key. Short and quick motor nerve transfers could be done in end to side technique so the nerve fibres could be brought distally as fast as possible.[9]

Aggressive rehabilitation played a vital role in maximizing functional recovery and patient satisfaction. Our rehabilitation program focused on range of motion exercises, strength training, and functional task training to help the patient regain fine motor skills in the affected limb. As a result, the patient reported increased satisfaction with his functional recovery and overall quality of life.

The successful outcomes in this case underscore the importance of early surgical intervention, which has been highlighted in the literature as a crucial factor for achieving good results.[7] Furthermore, this case adds to the growing body of evidence supporting the Oberlin and Mackinnon procedures as viable options for the treatment of partial postganglionic BPI. Although further research is needed to establish the long-term effectiveness and potential complications of these procedures, the findings of this case report suggest that they may provide a promising treatment strategy for patients with similar injuries.

CONCLUSION

The use of the Mackinnon/Oberlin-II double fascicular transfer (DFT) technique has demonstrated the ability to restore elbow flexion in acute brachial plexus injuries and can safely include acute C5-8 injuries and even partial T1 acute BPIs.6 When performed with careful preoperative evaluation, appropriate intraoperative functional fascicle selection, and aggressive postoperative rehabilitation, offer a promising approach for managing and restoring function in patients with partial postganglionic brachial plexus injury. Further research with more samples and longer follow-up duration were needed.

Declaration by Authors

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