

Comparative Study between Nerve Transfer and End to Side Neurotomy on the Muscle Function of the Donor and Recipient Nerves: An Experimental Study

Thesis

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LIST OF CONTENTS

➤ Introduction.....	1
➤ Review of literature:	
▪ Peripheral nerve anatomy and physiology.....	5
▪ Peripheral nerve injuries and healing.....	18
▪ Techniques of nerve repair	28
▪ End to side nerve repair.....	46
▪ Nerve transfer.....	61
➤ Aim of work.....	82
➤ Materials and methods.....	83
➤ Results.....	101
➤ Discussion.....	134
➤ Summary and conclusion.....	143
➤ Recommendations.....	145
➤ References.....	146
➤ Arabic summary	

LIST OF FIGURES

Figure Number	Content	Page Number
1	The neuron, including dendrites, soma, and myelinated axon	6
2	Show the concept though by Sunderland 1987 and later by Williams and Jabaley 1986 for the arrangement of fibers along the course of the nerve.	8
3	The internal topography of the median nerve from proximal to distal	9
4	The peripheral nerve fascicular pattern.	10
5	Connective tissue elements include the epineurium, perineurium, and endoneurium.	11
6	The vascular system of the peripheral nerve.	13
7	Schematic diagram of the neural response to axotomy.	19
8	Representation of Sunderland's five degrees of injury.	26
9	Epineurial repair	29
10	Group fascicular repair	30
11	Synthetic nerve conduit between the proximal and distal nerve stumps	41
12	Guided nerve regeneration with nerve conduit	42
13	The technique of end to side neurorrhaphy used by Ballance et al, 1903	47
14	Different types of nerve anastomosis by Sherren 1906	48
15	Showing the interposition jump ETS graft technique for facial nerve repair	51
16	ETS model represents the work of Balance et al 1903 and work done by Viterbo et al 1992.	52
17	Showing the ETSN between the distal end of the sural nerve and the superficial fibular (peroneal) nerve	58
18	Transfer of part of the functioning ulnar nerve into the motor nerve of the biceps.	63
19	Modification of Oberlin's procedure	70
20	The distal to the pronator quadratus is transferred to the deep motor branch of the ulnar nerve.	73
21	Microsurgical anastomosis between motor nerve to masseter and the lower trunk of facial nerve	78
22	The trifurcation of the Sciatic nerve	84

23	Denervated control (Group II).	86
24	ETS Neurorraphy between distal peroneal nerve and the side of tibial nerve (Group III)	86
25	ETE repair of the Peroneal nerve (Group IV).	87
26	ETE repair of the proximal stump of the peroneal nerve and the motor branch supplying the LGCM (Group V).	88
27	ETS repair of the proximal stump of the peroneal nerve and the side of the motor branch supplying the LGCM (Group VI).	89
28	Diagram showing the six groups, and the different procedures done on each	90
29	The rat feet and forepaws prints in <i>CatWalk XT 9</i>	92
30	Mid leg circumference.	93
31	Electromyography	94
32	Forced muscle contraction	95
33	Muscle weighting and width measurement	96
34	Muscle specimen stained by H&E showing the histomorphometric values.	98
35	Section of nerve fibers stained by Toluidine blue showing the histomorphometric values.	99
36	Transverse section (Haematoxylin and Eosin 200X) of the CTM of the six groups	118
37	Transverse section (Haematoxylin and Eosin) of the LGCM of groups I, III, V and VI (200X)	122
38	Transverse section (Toluidine blue) of the peroneal nerve in the six groups (400X).	126

LIST OF TABLES

Table Number	Content	Page Number
1	Sensory grading system created by Medical Research Council	44
2	Muscle strength grading system created by Medical Research Council	45
3	Grading of the motor and sensory outcome	45
4	Showing the averages and the standard deviations (SD) among the rats' weight gain in different groups	101
5	Showing the average PFIs and the standard deviations (SD) of the six groups preoperatively, after 60 days and at time of sacrifice.	103
6	Showing the statistical difference of the PFI within the same group in different time zone.	104
7	Showing the statistical difference of the PFI among the groups.	104
8	Showing the averages and standard deviations (SD) postoperative amplitude of the CTM of the six groups	106
9	Showing the statistical difference between the groups as regards the amplitude of CTM in electrophysiological study.	107
10	Showing the averages and standard deviations amplitude of the LGCM of groups I, III, V and VI.	107
11	Showing the statistical difference between the groups I, III, V and VI as regards the amplitude of LGCM in EMG	108
12	Showing the averages and standard deviations (SD) of CTM forced contraction in all the groups	109
13	Showing the statistical difference between the groups as regards the CTM forced contraction.	110
14	Showing the averages and standard deviations (SD) of LGCM forced contraction in groups I, III, V and VI	110
15	Showing the statistical difference between the groups I, III, V, and VI as regards the LGCM forced muscle contraction.	111
16	Showing the average and standard deviation (SD) of CTM weight (in grams) in the six groups	112
17	Showing statistical difference of CTM weight	113
18	Showing the averages and Standard deviations of the LGCM weight (grams) in groups I, III, V, and VI.	113

19	Showing the statistical difference in LGCM weight in groups I, III, V, VI.	114
20	Showing the averages and standard deviations (SD) of the CTM width in cm in all groups.	115
21	Showing statistical difference of CTM width among the six groups.	115
22	Showing the averages and Standard deviations (SD) of the LGCM width (cm) in groups I, III, V, and VI.	116
23	Showing the statistical difference in LGCM width in groups I, III, V, VI.	116
24	Showing the average and standard deviation (SD) of the CTM fiber surface area (μm^2), fiber perimeter (μm), and minimal fiber diameter (μm)	119
25	Showing the statistical difference between the six groups regarding the CTM fiber surface area, perimeter, minimal fiber diameter.	121
26	Showing the average and standard deviation (SD) of the LGCM fiber surface area (μm^2), fiber perimeter (μm), and minimal fiber diameter (μm)	123
27	Showing the statistical difference in LGCM fiber surface area, perimeter and minimal diameter in groups I, III, V, VI.	125
28	Showing the averages and standard deviations (SD) of axonal count, axonal in the six groups.	127
29	Showing the statistical difference in the axonal counts within the six groups.	128
30	Showing the averages and standard deviations (SD) of the axonal surface area and myelin surface area in the six groups.	130
31	Showing the statistical difference in the axonal surface area and myelin surface area in the six groups	131
32	Showing the averages and standard deviations (SD) of minimal axonal diameter and myelin thickness in the six groups.	132
33	Showing the statistical difference in the axonal minimal diameter and myelin thickness within the six groups.	133

LIST OF GRAPHS

Graph Number	Content	Page Number
1	Showing the mean PFI of the six groups preoperatively, after 60 days and at time of sacrifice and the pattern of change with time.	103
2	Showing the gain in the mid leg circumference in the normal and experimental side of all the groups.	105
3	Showing the average amplitudes of the CTM	106
4	Showing the averages amplitude of the LGCM in groups I, III, V and VI.	108
5	Showing the averages forced muscle contraction of the CTM in all the groups.	109
6	Showing the average forced muscle contraction of the LGCM in groups I, III, V and VI	110
7	Showing the average CTM weight in the six groups	112
8	Showing the average LGCM weight in groups I, III, V and VI.	113
9	Showing the average CTM width (cm) in the six groups.	115
10	Showing the average LGC muscle width in groups I, III, V and VI.	116
11	Showing the average CTM fiber surface area (μm^2) in the six groups	119
12	Showing the average CTM fiber perimeter (μm) in the six groups	120
13	Showing the average CTM fiber minimal diameter (μm) in the six groups.	120
14	Showing the average LGCM fiber surface area (μm^2) in groups I, III, V and VI.	123
15	Showing the average LGCM fiber perimeter (μm) in groups I, III, V and VI.	124
16	Showing the average LGCM minimal fiber diameter (μm) in groups I, III, V and VI.	124
17	Showing the averages axonal count in the six groups	128
18	Showing the averages axonal surface area and myelin surface area in the six groups	130
19	Showing the averages axonal minimal diameter and myelin thickness in the six groups.	132

LIST OF ABBREVIATIONS

CTM	Cranial Tibial Muscle
DFV	Décio Fernandes de Vasconcellos
EMG	Electromyography
ETE	End to End
ETEN	End to End Neurorrhphy
ETS	End to Side
ETSN	End to Side Neurorrhphy
FFMT	Functioning free muscle transfer
H&E	Heamatoxylin and Eosin
LGCM	Lateral Head of Gastrocnemius Muscle
NGF	Nerve growth factor
P	Peroneal Nerve
PFI	Peroneal function index
RNA	Ribonucleic acid
Sc	Sciatic Nerve
SCa	Slow component- a
SCb	Slow component- b
SD	Standard Deviation
Su	Sural Nerve
T	Tibial Nerve
TPI	Tibial function index
UNESP	University of state of Sao Paulo
VNG	Vascularized nerve graft

Introduction

Upper extremity nerve injuries may have devastating consequences. The optimal correction is a direct tension free repair whenever possible. Large nerve gaps, proximal injuries, and avulsion type injuries complicate the surgical management (**Weber and Mackinnon, 2004**).

Time factor owing to muscle atrophy after denervation negatively influence the recovery. Motor end plates become refractory to reinnervation after 15-18 months from the time of injury. Major nerve injuries more than 15 cm from the denervated end organ have uncertain outcomes. Common clinical situations include proximal injuries to the radial, ulnar and median nerves and the brachial plexus (**Nath and Mackinnon, 2000**).

Traditionally nerve grafts or tendon transfer have provided options for restoration of function. Advances in nerve repair and understanding of the internal topography of the nerve have contributed to the development of other options for reconstruction (**Weber and Mackinnon, 2004**).

Nerve transfer is recruiting donor nerve or its fascicles to innervate, missing, motor, or sensory nerves close to their target end organs. In **1948, Lurje** described the concept of nerve transfer to reconstruct the axillary, suprascapular, and musculocutaneous nerves. After Lurje a list of commonly used nerve transfers is rapidly expanding. In **1993, Brandt and MacKinnon** described the result of transferring the

medial pectoral nerves to the musculocutaneous nerve; this transfer moved the level of the repair more distal than previous reconstruction. In **1994, Oberlin et al.** moved the repair further distal by coapting a fascicle of the ulnar nerve directly into the biceps branch of the musculocutaneous nerve.

Many studies followed concerning nerve transfer to restore forearm pronation, finger flexion and thumb opposition in case of median nerve palsy. Patients with ulnar nerve palsy may have significant pinch and grip weakness and clawing of the two ulnar digits, this can be managed by transferring the distal branch of the anterior interosseous innervating the pronator quadratus to the deep motor branch of the ulnar nerve (**Weber and Mackinnon, 2004**).

The concept of a nerve transfer is to convert a high level nerve injury into a low level nerve injury. Donor nerves are selected based on their proximity to the motor end plate of interest, and ideally the neurorrhaphy is carried out in a tension free manner (**Dvali and Mackinnon, 2003**).

Unlike a tendon transfer, a nerve transfer does not rely on amplitude and excursion of the tendon muscle unit, and also it is not limited to one tendon (one function) or to the straight line pull principles. Nerve transfer provides sensibility in addition to motor function, and it restores innervation of multiple muscle groups without disturbance of its insertions. When more than one nerve is available for transfer, a nerve that innervates a synergistic muscle group is preferable, because less retraining in the postoperative period is needed (**Weber and Mackinnon, 2004**).

Surgical indications for nerve transfers are evolving. As new transfers are developed, the indication for their use continues to broaden. In general, the indications for nerve transfer are proximal nerve injuries, areas with previous scarring to avoid injury of critical structures and major limb trauma with segmental loss of nerve tissue (**Dvali and Mackinnon, 2003**).

End to side neurorrhaphy, is the technique of creating a neurorrhaphy between the distal end of an injured nerve and the side of an uninjured donor nerve. The earliest report of end to side neurorrhaphy dates back to late 1800s. With the introduction of microsurgical techniques for end to end repair, the procedure was disfavored until it was reintroduced in the early 1990s. Since that, numerous reports of successful end to side neurorrhaphies have been published, and lateral sprouting was proved either with epineurial window or without (**Viterbo et al., 1992; Zhang et al., 1998 and Kalliainen et al., 1999**).

An important question concerns the effect on the donor nerve after End to side neurorrhaphy. Experimentally, the function of the donor nerve recovers completely and has not been shown to be of any clinical significance (**Zhang et al., 1999**).

Francoise et al. (1998) reported the treatment of three patients with rupture of the c_{5,6&7} roots using End to side neurorrhaphy. The musculocutaneous nerve was cut and connected laterally to the ulnar nerve. They reported the return of the biceps muscle contraction after 4-6 months.