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

Thesis

Submitted for partial fulfillment of M.D. Degree
In Plastic and Reconstructive Surgery

By

Ahmed Mohamed Gad Ali
M.B., B.Ch., M.Sc.
Ain Shams University

UNDER SUPERVISION OF

Prof. Mahmoud Magdy Sherif

Professor of Plastic and Reconstructive Surgery
Faculty of Medicine - Ain Shams University

Dr/ Basim Mohamed Zaki Salem
Assistant Professor of Plastic and Reconstructive Surgery
Faculty of Medicine - Ain Shams University

Dr/ Eman Mohammed Yahya Sadek
Assistant Professor of Plastic and Reconstructive Surgery
Faculty of Medicine - Ain Shams University

Dr/ Hany Kamal Kamel
Assistant Professor of Histology
Faculty of Medicine – Ain Shams University

Faculty of Medicine
Ain shams university

2014

Acknowledgments

First and last, I thank "Almighty Allah" as I owe Allah mercy, support and guidance throughout my life.

I would like to express my deepest appreciation to ***Prof. Dr. Mahmoud Madgi Sherif,*** *Professor of Plastic and Reconstructive Surgery, Ain Shams University, for giving me the honor of working under his supervision and providing me a lot of encouragement throughout this work.*

My deepest appreciation and grateful thanks are due to ***Dr. Basim Mohamed Zaki****, Assistant Professor of Plastic and Reconstructive Surgery, Faculty of Medicine, Ain Shams University, who saved no time or effort helping me with this work.*

I wish to express my everlasting debt for the effort and help provided by ***Dr. Eman Yehya Sadek****, Assistant Professor of Plastic and Reconstructive Surgery, Faculty of Medicine, Ain Shams University.*

I am also grateful to ***Dr. Hany Kamal Kamel,*** *Assistant Professor of Histology, Faculty of Medicine, Ain Shams University, for his active supervision, valuable advice and kind help.*

I am also offering my warmest thanks to ***Prof. Fausto Viterbo,*** *Professor of Plastic Surgery, UNESP, Sao Paulo State, Brazil for his kindness in accepting to pursue this work under his supervision although not being an official supervisor.*

Last but not least, I would like to record thanks to my dear family and to all who have helped and encouraged me in the production of this work.

LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHES

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 never 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.