End to Side Neurorraphy and End to End Neurorraphy in Mixed and Motor Nerves: Experimental Study in Rats

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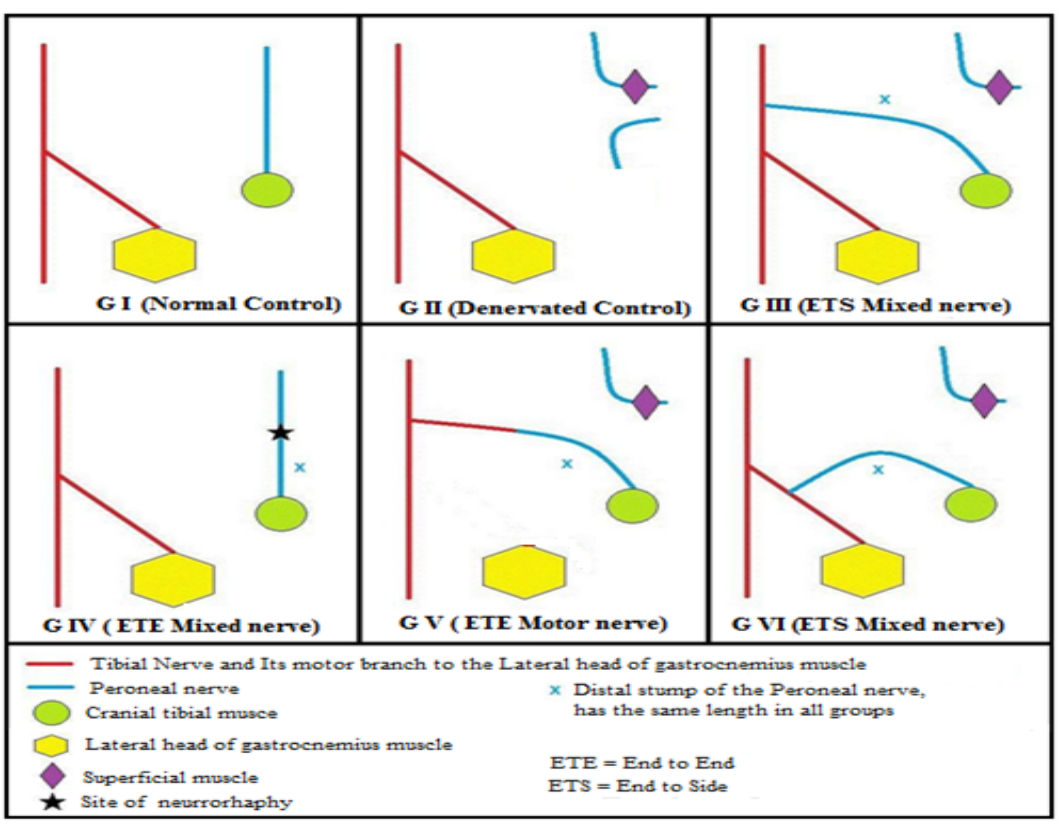
Introduction:

In problematic nerve injuries where primary neurorraphy or interposition nerve graft are not feasible, whether nerve transfer or end to side neurorrhphy (ETSN) are hopeful options. Nerve transfer is done in an end to end fashion, with complete sacrification of the donor nerve and its end organ. Motor nerve transfer is widely used and got many clinical applications especially in brachial plexus and upper limb nerve injuries. ETSN without harming the donor nerve was introduced by Viterbo et al 1992, this technique attains the interest of many researchers concerned with peripheral nerve surgery. There are still some controversial issues about ETSN, as the ability of both motor and sensory neurons to sprout. In this work we compared ETSN and the End to end neurorraphy (ETEN = nerve transfer) whether with mixed or motor nerves.

Methods:

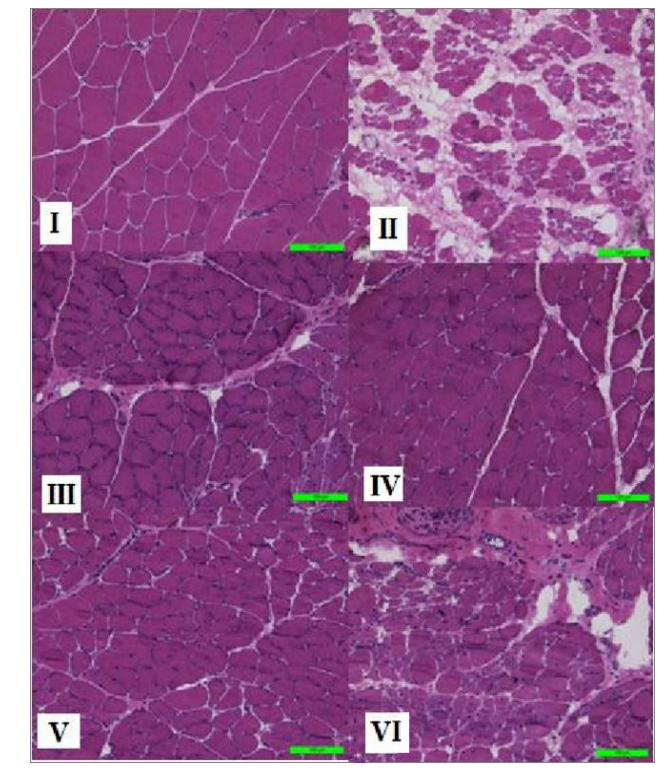
Sixty Wister rat weighting 200-300 g were divided into six groups. GI is normal control, GII denervated control where the Cranial tibial muscle (CTM) was denervated by cutting the peroneal nerve, GIII ETSN between the peroneal nerve and side of the tibial nerve (mixed nerve), GIV ETEN of the peroneal nerve (mixed nerve), GV ETEN between motor branch of the lateral head of gastrocnemius muscle (LGCM) and peroneal nerve (mixed nerves), and GVI ETSN between Peroneal nerve (mixed nerve) and motor branch of LGCM (motor nerve). After 60 and 120 (at time of sacrification) days walking track analysis and peroneal functional index (PFI), EMG, forced muscle contraction (FMC), muscle weight, muscle width, and histomorphometry of the nerves and muscles were done. In all the groups the CTM was examined , while LGCM only examined in groups I, III, V and VI to evaluate the effect on the muscle supplied by the donor nerve.



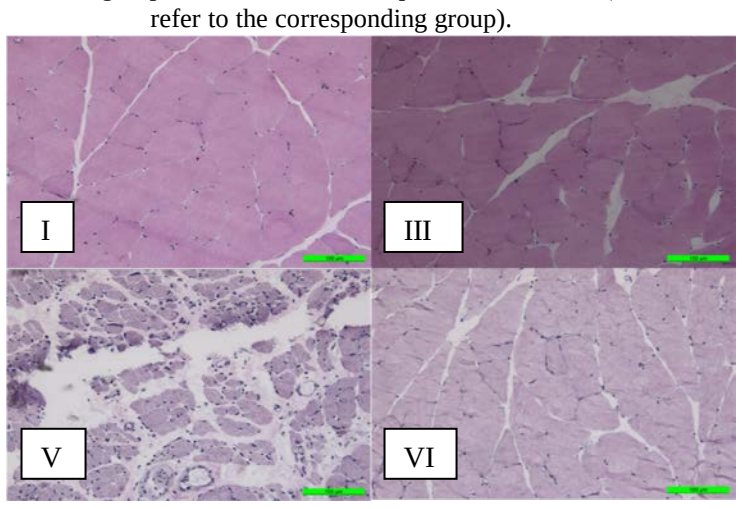
Results :

The four experimental groups were in between the normal control and denervated control. The best was group IV (ETEN with mixed nerve) and the worst was group VI (ETSN with motor nerve). Groups III (ETSN with mixed nerve) and V (ETEN with motor nerve) were so close in all the results, with almost no significant difference in between. In group V the muscle supplied by the donor nerve was completely lost, while in group III the muscle supplied by the donor nerve show no significant difference from the control muscles

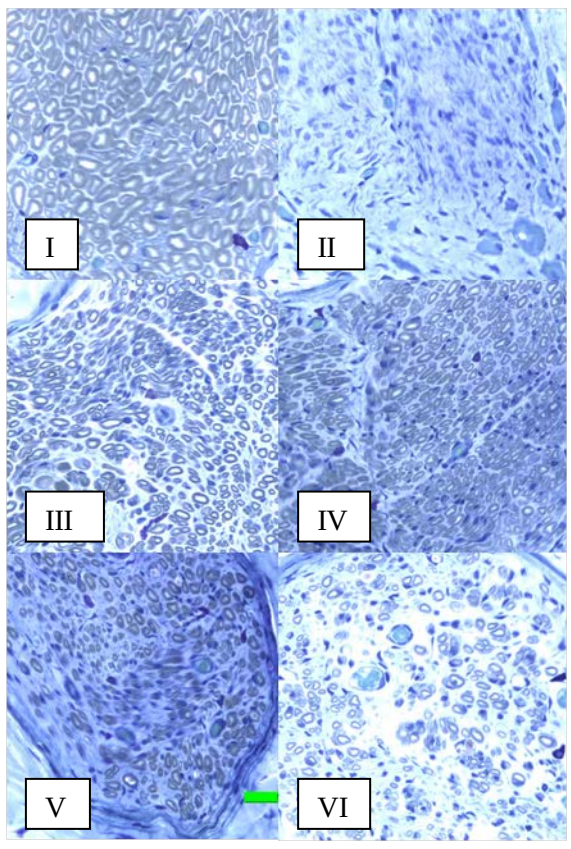
			I	II	III	IV	V	VI	Statistics (p value 0.05)
PFI	*After 60 days*		-16.98	-192	-149.95	-35.84	-76.2	-133.5	I=IV > V > III=VI > II
	After 120 days		-16.9	-198.8	-69.04	-25.1	-50.26	-131.3	I=IV=V > V=III > VI > II
EMG (Amplitude = mV)	*CTM*		26.56	2.4	12.79	21.24	11.88	8.39	I=IV > III=V=VI > GII
	LGCM		14.97	….	14.48	….	1.85	9	I=III > VI > II
FMC (N)	*CTM*		1.47	0	1.17	1.29	1.14	0.92	I=IV > IV=III=V > III=V=VI > II
	LGCM		1.6	….	1.45	….	0	1.33	I=III=VI > V
Weight (g)	*CTM*		0.95	0.19	0.4	0.68	0.57	0.28	I > IV=V > V=III > III=VI > VI=II
	LGCM		1.36	….	1.25	….	0.35	1.27	I=III=VI > V
Width (cm)	*CTM*		1.21	0.5	0.78	1.11	0.97	0.67	I=IV > IV=V > III=VI > VI=II
	LGCM		1.45	….	1.45	….	0.64	1.37	I=III=VI > GV
Muscle morphometry	CTM	*Fiber surface area (µm2)*	3502.4	327.47	2025.1	2703	2356.11	1431.6	I=IV > IV=V=III > VI=II
		Fiber perimeter (µm)	243.99	69.72	190.66	222.71	194.67	134.57	I=IV > IV=V=III > VI=II
		Minimal fiber diameter (µm)	58.42	16.15	41.62	48.73	42.24	29.14	I=IV > IV=V=III > VI=II
	LGCM	*Fiber surface area (µm2)*	4022.6	….	3766.9	….	453.17	2946.91	I=III=VI > V
		Fiber perimeter (µm)	263.79	….	263.8	….	81.96	231	I=III=VI > V
		Minimal fiber diameter (µm)	63.02	….	60.25	….	19.38	52.6	I=III=VI > V
Nerve morphometry	Axonal count		1544.2	52.6	661.8	1457.2	882.4	445.2	I=IV > V=III > III=VI >I
	Axonal surface area (µm2)		20.6	2.01	4.74	7.05	7	4	I> IV=V=III > III=VI > II
	Myelin surface area (µm2)		53.26	5.15	13.19	21.84	14.92	8	I> IV > V=III > VI > II
	Minimal axonal diameter (µm)		3.03	0.55	1.39	1.81	1.55	1.29	I > IV=V=III > V=III=VI > II
	Myelin thickness (µm)		2.13	0.56	1.04	1.18	1.12	0.97	I > IV=V=III > V=III=VI > II



Transverse section (Haematoxylin and Eosin 200X) of the CTM of the six groups, reveling normal organization of muscle fibers into bundles with less connective tissue in between in group I and IV. In group II and VI, there were different degrees of irregular orientation of muscle fibers, loss of fibers in many areas which are replaced by vacuoles with widening of the interstitial spaces and connective tissue, and increase condensation of nuclear infiltrates. These finding was more profound in group II. In groups III and V, the bundles are less organized, and diminished in size in comparison to groups I and IV, with more prominent nucleus (each label refer to the corresponding group).



Transverse section (Haematoxylin and Eosin) of the LGCM of groups I, III, V and VI (200X) reveling normal organization of muscle fibers into bundles with less connective tissue in between in groups I, III and VI. In group V there were different degrees of irregular orientation of muscle fibers, loss of fibers in many areas which replaced by vacuoles with widening of the interstitial spaces and connective tissue, and increase condensation of nuclear infiltrates (each label refer to the corresponding group)



Transverse section (Toludine blue) of the Peroneal nerve in the six groups (400X). Group I show normal architecture of the myelinated axons, in group II there is almost complete loss of the axons, which can be hardly localized, and it is replaced with scar tissue. In groups III, IV and V the nerve architecture is maintained, but the density and size of the axons are less then group I, and the degree of myelination is variable. In group VI areas of loss of axons, with wide spaces between them, and the axonal size is diminished (each label refer to the corresponding group).

Conclusion:

These results give the advantage of ETSN with mixed nerve over the ETEN with motor nerve (nerve transfer), although the evaluation values showed no significant difference, but in ETSN the donor muscle was preserved while in nerve transfer the donor muscle was totally denervated.

References:

1) Viterbo F, Trindade JC, Hoshino K, Mazzoni Neto A. Latero-terminal neurorraphy without removal of the epineural sheath: Experimental study in rats. *Revista Paulista de Medicin*a. 1992; 110: 267-275.