Injured C7 Spinal Nerve as Neurotizer

C.H.J. Tzou and D.C.C. Chuang

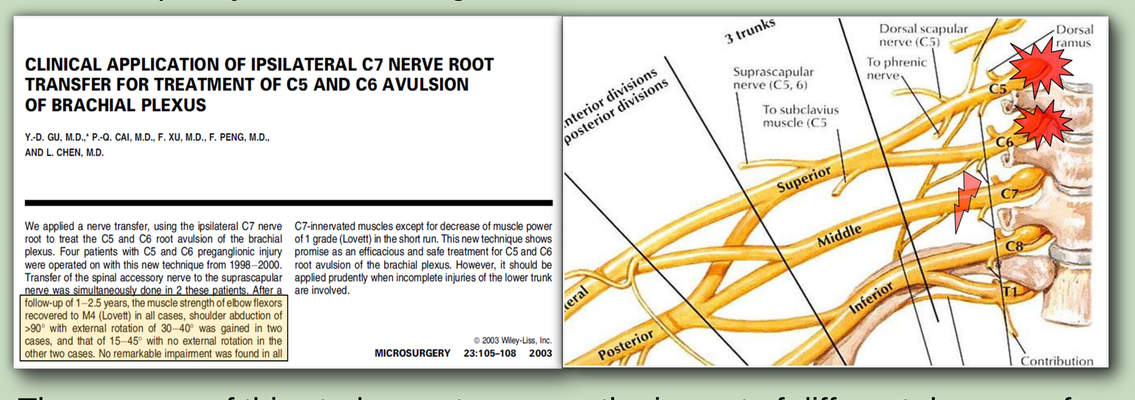
長庚紀念醫院 Chang Gung Memorial Hospital
Division of Plastic Reconstructive Microsurgery
Department of Plastic and Reconstructive Surgery
Chang Gung Memorial University Hospital Taipei, Taiwan

MEDICAL UNIVERSITY OF VIENNA
Division of Plastic and Reconstructive Surgery
Department of Surgery
Medical University Vienna, Austria

Introduction

Ipsilateral C7 nerve transfer is an available procedure in C5 and C6 two-root avulsion injury of the brachial plexus.

However, when the C5 and C6 roots are avulsed, concomitant injury of a macroscopically normal-looking C7cannot be ruled out.



CLINICAL APPLICATION OF IPSILATERAL C7 NERVE ROOT TRANSFER FOR TREATMENT OF C5 AND C6 AVULSION OF BRACHIAL PLEXUS

Y.-D. GU, M.D.,* P.-Q. CAI, M.D., F. XU, M.D., F. PENG, M.D., AND L. CHEN, M.D.

We applied a nerve transfer, using the ipsilateral C7 nerve root to treat the C5 and C6 root avulsion of the brachial plexus. Four patients with C5 and C6 preganglionic injury were operated on with this new technique from 1998–2000. Transfer of the spinal accessory nerve to the suprascapular nerve was simultaneously done in 2 these patients. After a follow-up of 1–2.5 years, the muscle strength of elbow flexors recovered to M4 (Lovett) in all cases, shoulder abduction of >90° with external rotation of 30–40° was gained in two cases, and that of 15–45° with no external rotation in the other two cases. No remarkable impairment was found in all C7-innervated muscles except for decrease of muscle power of 1 grade (Lovett) in the short run. This new technique shows promise as an efficacious and safe treatment for C5 and C6 root avulsion of the brachial plexus. However, it should be applied prudently when incomplete injuries of the lower trunk are involved.

© 2003 Wiley-Liss, Inc.

MICROSURGERY 23:105–108 2003

3 trunks
Anterior divisions
Posterior divisions
Suprascapular nerve (C5, 6)
To subclavius muscle (C5
Dorsal scapular nerve (C5)
To phrenic nerve
Dorsal ramus
C5
C6
C7
C8
T1
Superior
Middle
Inferior
Lateral
Posterior
Contribution

The purpose of this study was to assess the impact of different degrees of injury of C7 on its outcomes when used as a donor nerve for transfer to the musculocutaneous nerve.

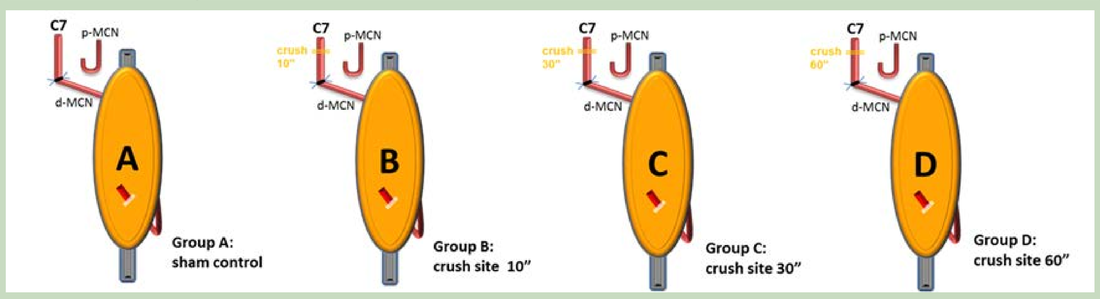
Materials and Method

40 Sprague–Dawley rats underwent ta two stage procedure.

In the first stage via dorsal approach, left C5 and C6 roots were avulsed and C7 was crushed with jeweler's forceps simulating different degrees of nerve injury: Group A (n=6) C7 not injured ; Group B (n=10) C7 crushed for 10 seconds (Sunderland-I); Group C (n=10) C7 crushed for 30 seconds (Sunderland-II); Group D (n=10) C7 doubly crushed for 60 seconds (Sunderland-III), and Group E (n=6) C7 resected (Sunderland-V). In the second stage, four weeks later, the C7 was re-explored via volar approach, transected and coaptated to the musculocutaneous nerve.

At 12 weeks, functional outcomes were assessed: grooming test, electromyography, muscle tetanic contraction force and weight, and axon counts.

Groups	*Number of animals*	*Art of Group*	*crush duration*
Group A	10	Experimental control	no crush
Group B	10	Experimental	10" sec.
Group C	10	Experimental	30" sec.
Group D	10	Experimental	60" sec. double

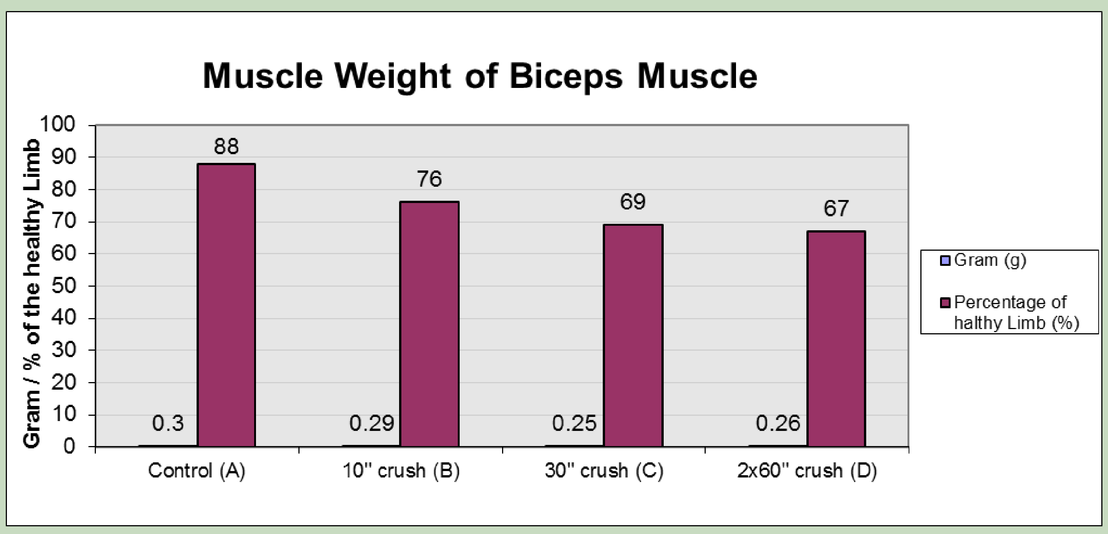


Results

To avoid animals' weight-dependent result discrepancies, each animal's experimental side was also expressed in ratio (experimental / healthy of the same animal, E/H, percentage of the healthy side), percentage (%) values are in parenthesis.

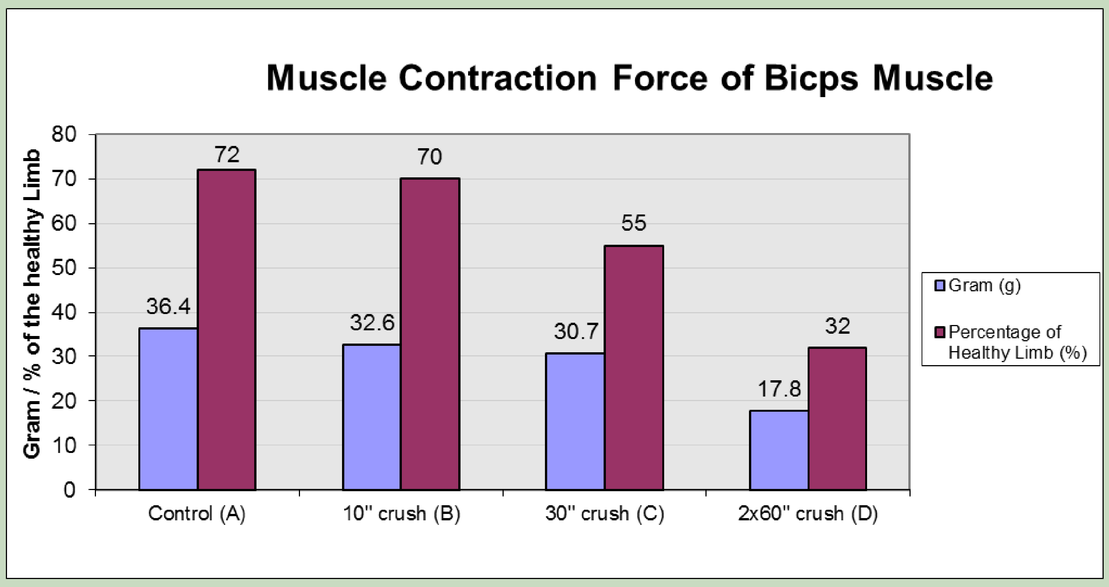
Muscle Weight

Muscle weight evaluation presented the heaviest muscle weight in the healthy group 0.38±0.04g, following with Group A 0.30±0.02 g (88%), Group B 0.29±0.03g (76%), Group C 0.25±0.02 g (69%), and then Group D the lowest of 0.26±0.03 g (67%). Statistically significant differences ($p<0.001$) were observed between the experimental and healthy groups. Statistically significant differences between the experimental groups were seen between Groups A/C, A/D and B/C, with $p<0.035$.



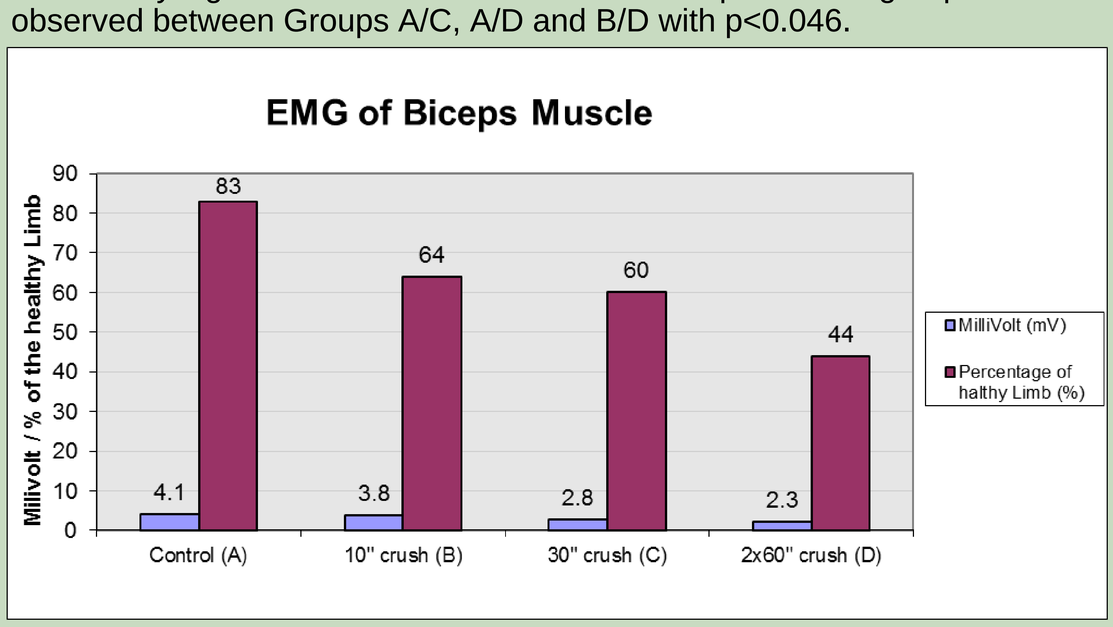
Muscle Tetanic Contraction Force Measurement

Biceps muscle tetanic contraction force decreased with the more injury of the C7 nerve: Group A showed 36.40±3.79g (72%), Group B 32.65±12.40g (70%), Group C 30.72±9.76 g (55%) and Group D 17.88±14.16 g (32%). Statistically significant differences ($p<0.001$) could be seen when compared to the healthy side of 50.29±12.65 g. Statistically significant differences between the experimental groups were seen between Groups A/C, A/D and B/D, with $p<0.035$.



Electrophysiologic Testing

Electromyography of the biceps muscle after stimulation of the musculocutaneous nerve on the operative and nonoperative sides were performed (Table 1). In the operative side, it showed low amplitudes in Groups C (30"Crush) and D (60"Double Crush), with an average of 2.82±0.58mV (50% of healthy side) and 2.38±0.89mV (44%), respectively. Group B (10"crush) scored 3.81±0.90mV (64%) and Group A (no crush) 4.05±0.37mV (83%). These results were statistically significant (<0.05), compared with those of the healthy side (Group H = 5.56±0.82mV). Statistically significant differences between the experimental groups were observed between Groups A/C, A/D and B/D with $p<0.046$.



Axon Counts

Axon counts of healthy C7 spinal nerves (Table 2) were, on average, 1413±380.04. Axon counts of the musculocutaneous nerve (MCN) distal of the coaptation site in Group A were 826±163.4, Group B 529±169.1, Group C 425±284.5 and Group D 603±191.7. Though substantial differences existed between the groups, they are not statistically significant ($p=0.055$). Statistic significant correlation was only observed between axon counts and muscle contraction $p<0.024$.

Groups	Axon counts (p-value=0.055)
A MCN (control)	826.4 ± 163.4
B MCN (10" crush)	529.0 ± 169.2
C MCN (30" crush)	425.0 ± 284.5
D MCN (60" double crush)	603.6 ± 191.8
C7 (healthy)	1413 ± 380.0
Pearson's Correlations Coefficient between Axon Counts and	
Muscle Weight in gram	0.362 (p=0.098)
Muscle Contraction in gram	0.124 (p=0.024)
EMG in mV	0.397 (p=0.397)

Conclusion

An injured but macroscopically normal-looking ipsilateral C7 can still be used as a motor source to restore function. The result is directly proportional to the severity of injury, potentially implying that better results will be achieved when longer regeneration time is allowed.