COPYRIGHT © BY THE JOURNAL OF BONE AND JOINT SURGERY, INCORPORATED MALESSY ET AL. NEONATAL BRACHIAL PLEXUS PALSY WITH NEUROTMESIS OF C5 AND AVULSION OF C6 http://dx.doi.org/10.2106/JBJS.M.00547 Page 1 of 6



Fig. E-1

Advantages and disadvantages of each nerve reconstruction strategy for restoration of elbow flexion and shoulder function in infants with neonatal brachial plexus palsy with neurotmesis of C5 and avulsion of C6. 1: The proximal stump of C5 is used for reconstruction of its main anatomical pathways⁵—namely, the suprascapular nerve (SSN) and the posterior division of the superior trunk (PDST). The goal of this strategy is restoration of shoulder abduction and external rotation, but not elbow flexion. A nerve transfer to restore elbow flexion has to be used. This strategy may compromise recovery of elbow flexion because the success rates of these transfers are between 70% and 90%²⁷. MCN = musculocutaneous nerve. 2: C5 is used for reinnervation of the biceps and brachialis muscles by reconstructing the pathway to C6 or the anterior division of the superior trunk (ADST). In addition to the biceps and brachialis muscles, proximal reconstruction of C6 and the anterior division of the superior trunk potentially contributes to reinnervation of the superior part of the pectoralis major, brachioradialis, and supinator muscles and C6 dermatome sensation. This strategy may compromise reinnervation of the shoulder. The accessory nerve (XIN) can be transferred to the suprascapular nerve (SSN) to restore shoulder function¹²⁻¹⁴. 3: C5 can be used as an axon source for grafts to the anterior division of the superior trunk, and suprascapular nerve. This strategy may compromise both elbow flexion and shoulder function recovery. Because of the mismatch in cross-sectional area between C5 and the distal stumps, the latter can be only partially covered by grafts. When the accessory nerve-suprascapular nerve transfer is used, one additional nerve graft can be directed to the anterior division of the superior trunk.

Copyright © by The Journal of Bone and Joint Surgery, Incorporated Malessy et al. Neonatal Brachial Plexus Palsy with Neurotmesis of C5 and Avulsion of C6 http://dx.doi.org/10.2106/JBJS.M.00547 Page 2 of 6



Fig. E-2

Intraoperative priorities and decision-making for nerve reconstruction to restore elbow flexion and shoulder function in infants with neonatal brachial plexus palsy with neurotmesis of C5 and avulsion of C6. The first goal of our reconstruction strategy was restoration of elbow flexion, and the second goal was restoration of shoulder function. XIN-SSN transfer = extra-intraplexal transfer of the accessory nerve (XIN) to the suprascapular nerve (SSN), ADST = anterior division of the superior trunk, and PDST = posterior division of the superior trunk. "One nerve graft, selective positioning" = in reconstruction of the suprascapular nerve with a sural nerve graft, coaptation should be performed in the rostroventral quadrant of the C5 cross-sectional area (between 9 and 12 o'clock from the nerve surgeon's point of view in a right-sided brachial plexus exploration). This will minimize axonal misrouting and may improve outcome⁵.

Copyright © by The Journal of Bone and Joint Surgery, Incorporated Malessy et al. Neonatal Brachial Plexus Palsy with Neurotmesis of C5 and Avulsion of C6 http://dx.doi.org/10.2106/JBJS.M.00547 Page 3 of 6

				Reconstruction							
				Biceps†		Ext. Rot.	Abd.#				
Age at Op. <i>(mo)</i>	Diagnosis† C5 C6 C		ст С7	Donor- Target	No. (Size in cm) of Graft(s)	Donor to SSN§	Donor-Target	No. (Size in cm) of Graft(s)			
5	N	Av	PN	C5-afC6	D	C5††	C5-C5§§	3 (2.2)			
9	Ν	Av	PN	C5-afC6	D	AN	C5-PDST	2 (2.5)			
4	Ν	Av	Av	C5-afC6	D	AN	C5-PDST	2 (2.5)			
7	Ν	Av	Norm	C5-afC6	D	AN	C5-PDST	2 (2.5)			
6	Ν	Av	PN	C5-afC6	1(1)	AN	C5-PDST	2 (2)			
5	Ν	Av	Ax	C5-afC6	D	AN	C5-PDST	2 (2)			
13	Ν	Av	Av	C5-C6	3 (2.5)	C5††	C5-C5§§	2 (2.5)			
5	Ν	Av	PAv	C5-C6	D	AN	C5-PDST	2 (1.5)			
8	Ν	Av	Norm	C5-C6	D	AN	C5-PDST	1 (1.5)			
7	Ν	Av	Norm	C5-C6	D	AN	C5-PDST	1 (2)			
5	Ν	Av	Norm	C5-C6	D	AN					
4	Ν	Av	Norm	C5-C6	D	AN					
5	Ν	Av	Norm	C5-C6	D	AN					
4	Ν	Av	Norm	C5-C6	D	AN					
5	Ν	Av	Norm	C5-C6	D	AN					
5	Ν	Av	Norm	C5-C6	D	AN					
8	Ν	Av	Ax	C5-C6	D	AN					

*Intraplexal transfer of C6 to C5. \uparrow N = neurotmesis, Av = root avulsion, PN = partial neurotmesis, Ax = axonotmesis, PAv = partial avulsion, and Norm = normal (undamaged). \dagger afC6 = anterior root filaments of C6 and D = direct coaptation. §SSN = suprascapular nerve. Either the accessory nerve (AN) or the C5 spinal nerve served as the donor of axons. #C5-PDST = grafting of the C5 spinal nerve to the posterior division of the superior trunk.**H-H = hand to head, H-B = hand to back, and H-M = hand to mouth. \dagger The function of the triceps muscle was not based on the end-stage of recovery after surgical reconstruction but on the severity of the nerve lesion assessed during the operation. \ddagger The distal stump of C5 contained the suprascapular nerve. §§Posterior division of the superior trunk through the distal stump of C5.

Copyright © by The Journal of Bone and Joint Surgery, Incorporated Malessy et al. Neonatal Brachial Plexus Palsy with Neurotmesis of C5 and Avulsion of C6 http://dx.doi.org/10.2106/JBJS.M.00547 Page 4 of 6

TABLE E-1 (continued)

	Grade of Result**									
Followup	Picono		Tricono							
(mo)	(MRC Grade ²⁰)	Abd.	Ext. Rot.	H-H	H-B	H-M	(MRC Grade ²⁰)††			
89	4	IV	I	Ш	Ш	Ш	5			
46	4	IV	I	IV	III	III	4			
30	4	IV	I	III	III	III	3			
46	4	IV	IV	IV		IV	5			
37	4	IV	IV	IV	III	IV	4			
41	4	IV	I	IV	III	Ш	5			
95	4	III	IV	III	I	III	3			
39	4	IV	III	III	III	IV	4			
16	4	III	I	Ш	III	III	5			
34	4	IV	III	IV	IV	Ш	5			
37	4	IV	IV	IV	IV	IV	5			
132	4	IV	Ш	III	IV	IV	5			
42	5	IV	I	III	IV	I	5			
18	4	IV	IV	IV	IV	IV	5			
26	4	Ш	I	Ш	Ш	Ш	5			
20	5	IV	IV	IV	Ш	IV	5			
21	5	IV	I	Ш	IV	IV	5			

Copyright © by The Journal of Bone and Joint Surgery, Incorporated Malessy et al. Neonatal Brachial Plexus Palsy with Neurotmesis of C5 and Avulsion of C6 http://dx.doi.org/10.2106/JBJS.M.00547 Page 5 of 6

Age at Op. <i>(mo)</i>				Reconstruction								
	Discussion			Bicepsŧ		Ext. Rot.	Abd.#					
	C5 C6 C7		C7	No. (Size in c Donor-Target of Graft(s)		Donor to SSN§	Donor-Target	No. (Size in cm) of Graft(s)				
6	Ν	IN	Av	C5-ADST	2 (3.0)	AN	C5-PDST	1 (3)				
6	Ν	IN	Norm	C5-ADST	? (2.0)	AN	C5-PDST					
7	Ν	IN	PN	C5-ADST	3 (2.5)	AN	C5-PDST	2 (2.5)				
6	Ν	IN	Av	C5-ADST	2 (3.0)	AN	C5-PDST	2 (3)				
6	Ν	Av	Av	C5-ADST	2 (2.5)	AN	C5-PDST	2 (2.5)				
5	Ν	IN	Av	C5-ADST	2 (2.0)	AN	C5-PDST	1 (2)				
7	Ν	IN	PAv	C5-ADST	2 (3.0)	AN	C5-PDST	1 (3)				
5	Ν	IN	PN	C5-ADST	2 (3.5)	AN	C5-PDST	2 (3.5)				
4	Ν	IN	PN	C5-ADST	3 (3.0)	AN	C5-PDST	2 (3)				
4	Ν	IN	Av	C5-ADST	3 (3.0)	AN	C5-PDST	1 (3)				
4	Ν	Av	PN	C5-ADST	? (3.0)	C5	C5-PDST					
7	Ν	Av	Norm	C5-ADST	3 (2.5)	C5		1 (2.5)				
4	Ν	Av	PN	C5-ADST	3 (2.0)	C5		1 (2)				
4	Ν	Av	Norm	C5-ADST	4 (2.5)	AN						
5	Ν	IN	Av	C5-ADST	3 (2.7)	AN						
6	Ν	Av	PAv	C5-ADST	3 (2.2)	AN						
4	Ν	IN	PN	C5-ADST	3 (4.0)	ANŧŧ						

*Grafting from C5 to the anterior division of the superior trunk. $\dagger N$ = neurotmesis, IN = intraforaminal neurotmesis. Av = root avulsion, PN = partial neurotmesis, PAv = partial avulsion, and Norm = normal (undamaged). $\dagger ADST$ = anterior division of the superior trunk. $\S SSN$ = suprascapular nerve. Either the accessory nerve (AN) or the C5 spinal nerve served as the donor of axons. #C5-PDST = grafting of the C5 spinal nerve to the posterior division of the superior trunk. **H-H = hand to head, H-B = hand to back, and H-M = hand to mouth. $\dagger \dagger$ The function of the triceps muscle was not based on the end-stage of recovery after surgical reconstruction but on the severity of the nerve lesion assessed during the operation. \ddagger With interpositioning of one graft of 2.5 cm.

Copyright © by The Journal of Bone and Joint Surgery, Incorporated Malessy et al. Neonatal Brachial Plexus Palsy with Neurotmesis of C5 and Avulsion of C6 http://dx.doi.org/10.2106/JBJS.M.00547 Page 6 of 6

TABLE E-2 (continued)

Followup	Biceps (MRC Grade ²⁰)		Tricopo				
(mo)		Abd.	Ext. Rot.	H-H	H-B	H-M	(MRC Grade ²⁰)††
122	4	Ш	I	Ш	IV	Ш	3
121	4	IV	IV	IV	IV	IV	5
160	4	Ш	Ш	Ш	Ш	Ш	5
114	4	IV	IV	IV	IV	IV	5
82	4	IV	IV	III	Ш	III	4
115	4	IV	I	III	III	III	5
31	4	IV	Ш	IV	Ш	IV	5
40	4	П	I	Ш	Ш	Ш	4
80	4	Ш	IV	III	IV	IV	5
64	4	Ш	Ш	III	Ш	IV	4
58	4	IV	Ш	III	Ш	Ш	5
21	4	IV	I	Ш	IV	Ш	5
144	4	IV	Ш	IV	Ш	Ш	4
92	4	П	I	Ш	Ш	IV	4
137	4	Ш	IV	III	Ш	IV	2
87	4	Ш	Ш	I	Ш	Ш	4
137	4	Ш	Ш	Ш	Ш	Ш	5