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# Comparison of the results of surgical treatment after direct neurorrhaphy and reconstruction with sural nerve grafts in perinatal brachial plexus lesions

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## Abstract

*The neurotmesis of elements of the brachial plexus in perinatal lesions requires microsurgical reconstruction. In this study we present our own experiences in surgical treatment of postganglionic lesions in the fifth degree of injury in Sunderland's scale. The clinical material consisted of 14 children aged from 2.5 to 6 months treated surgically due to neurotmesis of the neural elements of the brachial plexus. In 8 cases direct neurorrhaphy and in 6 cases reconstruction with sural nerve grafts were performed. During the operations material from the proximal stumps of the brachial plexus trunks was collected for histopathological examination. The analysis of the material comprised: clinical type of injury, location of postganglionic lesion and type of surgical procedure. The results of surgical treatment were evaluated using generally accepted scales (Gilbert's, Raimondi's, Al-Qattan's and British Medical Research Council scales). Comparison of the results of treatment between the surgical methods was also performed. Better results of surgical treatment were observed after direct neurorrhaphy. In our opinion the indications for these two methods are different and both operative techniques are useful in surgical treatment of perinatal brachial plexus palsy.*

*Key words: direct neurorrhaphy, sural nerve grafts, neurotmesis, perinatal brachial plexus palsy.*

## Introduction

The choice of proper microsurgical technique during primary reconstructive operations depends on the intraoperative view [8,13]. Postganglionic lesions with total rupture of neural elements (fifth degree of injury on Sunderland's scale) require microsurgical direct neurorrhaphy [5,12] or reconstruction with autogenic cutaneous nerve grafts [7,10,17]. The following nerves are used as grafts: sural nerve, cutaneous medial brachial and antebrachial nerve, lateral cutaneous antebrachial nerve, superficial branch of radial nerve, and supraclavicular nerves [2,3,16]. Microsurgical anastomosis can be performed using sutures or fibrin glue [7,9,10,17].

## Material and methods

The clinical material consisted of 14 children of both sexes treated surgically in the period of 1996-2005 be-

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cause of postganglionic brachial plexus lesion (fifth degree on Sunderland's scale). The following surgical procedures were performed: in 8 cases direct neurorrhaphy and in 6 cases reconstruction with sural nerve grafts. Clinical type of injury, location of postganglionic lesion and detailed description of microsurgical techniques are presented in Tables I and II.

Intraoperatively during resections non-conducting parts of proximal stumps of ruptured nerve elements were collected as material for histopathological examinations. The results of surgical treatment (after a minimum 3-year observation period) were evaluated using the following scales:

1) Gilbert's scale for evaluation of shoulder function [10]:
   stage 0 = flail shoulder,
   stage I = abduction or flexion to 45°, no active lateral rotation,
   stage II = abduction < 90°, lateral rotation to neutral,
   stage III = abduction = 90°, weak lateral rotation,
   stage IV = abduction < 120°, incomplete lateral rotation,
   stage V = abduction > 120°, active lateral rotation,
   stage VI = normal.
2) Gilbert and Raimondi scale for evaluation of elbow function [10]:
   A. Elbow flexion:
      nil or some contraction = 1,
      incomplete flexion = 2,
      complete flexion = 3.
   B. Elbow extension:
      no extension = 0,
      weak extension = 1,
      good extension = 2.
   C. Extension deficit:
      0-30° = 0; 30-50° = –1,
      More than 50° = –2.
3) Al-Qattan's scale for evaluation of forearm rotation moves [1]:
   1 = pronated forearm causing a functional or cosmetic disability,
   2 = supinated forearm causing a functional or cosmetic disability,
   3 = functional forearm position (mid pronation-supination or slight pronation) with no or minimal active motion,
   4 = same as 3 but with good active pronation and supination,
   5 = normal power and range of motion.

**Table I.** Reconstructive operations with direct suture of ruptured elements of brachial plexus

| Case nº | Clinical type of injury | Patient's age (in months) | Intraoperative view | Type of surgical procedure |
|---|---|---|---|---|
| 1. | Upper | 3 | Rupture of ventral ramus of C5 + compression of ventral ramus of C6 and upper trunk | Ventral ramus of C5 reconstruction with direct neurorrhaphy + upper trunk neurolysis |
| 2. | Upper-middle | 3 | Rupture of upper and middle trunk | Upper and middle trunk reconstruction with direct neurorrhaphy |
| 3. | Upper-middle | 6 | Rupture of upper trunk + compression of middle trunk | Upper trunk reconstruction with direct neurorrhaphy + middle trunk neurolysis |
| 4. | Total | 4 | Rupture of ventral ramus of C5, C6, C7 + compression of lower trunk | Ventral ramus of C5, C6, C7 reconstruction with direct neurorrhaphy + lower trunk neurolysis |
| 5. | Total | 3 | Rupture of ventral ramus of C5, C6, C7 + compression of lower trunk | Ventral ramus of C5, C6, C7 reconstruction with direct neurorrhaphy + lower trunk neurolysis |
| 6. | Total | 5 | Rupture of upper trunk + compression of middle and lower trunk | Upper trunk reconstruction with direct neurorrhaphy + middle and lower trunk neurolysis |
| 7. | Total | 3.5 | Rupture of ventral ramus of C5, C6 + compression of middle and lower trunk | Ventral ramus of C5, C6 reconstruction with direct neurorrhaphy + middle and lower trunk neurolysis |
| 8. | Total | 3 | Rupture of upper trunk + compression of middle and lower trunk | Upper trunk reconstruction with direct neurorrhaphy + middle and lower trunk neurolysis |

4) Al-Qattan's scale for evaluation of wrist function [1]:
   0 = no contraction or flicker of contraction,
   1 = active movement with gravity eliminated,
   2 = active movement against gravity only,
   3 = active movement against resistance with motion reaching ≤ 1/2 of normal range,
   4 = active movement against resistance with motion reaching > 1/2 of normal range,
   5 = normal power and range of motion.
5) Al-Qattan's scale for evaluation of hand motor function [1]:
   0 = useless hand – complete paralysis or slight finger motion of no use, useless thumb,
   1 = poor function – only very weak grip possible,
   2 = fair function – there is some active flexion and/or extension of the fingers and some thumb mobility but the hand posture is intrinsic minus,
   3 = good function – same as 2 but there is no intrinsic minus posture (intrinsic balance),
   4 = excellent function – near normal active finger flexion/extension and thumb mobility, with some active intrinsic function,
   5 = normal function.
6) BMRC scale modified by Omer and Dellon for evaluation of hand sensory function [4,15] – only in total palsies.

During assessment of treatment results the effect of tenomyoplasty performed in some cases, indicated in Tables III and IV as (T), was also taken into consideration.

## Results

The results of surgical treatment are presented in Tables III and IV.

## Discussion

In postganglionic lesions with total rupture of nerve elements in our material we performed direct neurorrhaphy or reconstruction with sural nerve grafts. The possibilities of using direct neurorrhaphy in reconstructions of brachial plexus are, according to some authors, significantly limited [6,17,18]. It is obvious that use of this technique requires compliance with some specified conditions [11,14]. The lack in continuity of neural elements must be short. Ade-

**Table II.** Reconstructive operations with sural nerve grafts bridging ruptured parts of brachial plexus

| Case nº | Clinical type of injury | Patient's age (in months) | Intraoperative view | Type of surgical procedure |
|---|---|---|---|---|
| 1. | Upper-middle | 3 | Rupture of upper trunk + compression of middle trunk | Upper trunk reconstruction with sural nerve grafts (3 × 2 cm) + middle trunk neurolysis* |
| 2. | Upper-middle | 5 | Rupture of ventral ramus of C6, C7 + compression of upper and middle trunk | Ventral ramus of C6, C7 reconstruction with sural nerve grafts (4 × 1 cm) + ventral ramus of C5, upper and middle trunk neurolysis |
| 3. | Total | 5 | Rupture of upper trunk + compression of middle and lower trunk | Upper trunk reconstruction with sural nerve grafts (2 × 1.5 cm) + middle and lower trunk neurolysis |
| 4. | Total | 2.5 | Rupture of upper and middle trunk + compression of lower trunk | Upper and middle trunk reconstruction with sural nerve grafts (4 × 2.5 cm) + lower trunk neurolysis |
| 5. | Total | 4 | Rupture of upper and middle trunk + compression of lower trunk | Upper and middle trunk reconstruction with sural nerve grafts (3 × 1.5 cm) + lower trunk neurolysis |
| 6. | Total | 4 | Rupture of upper trunk + compression of middle trunk + partial rupture of lower trunk with neurinoma in continuity formation | Upper trunk reconstruction with sural nerve grafts (2 × 3 cm) + middle and lower trunk neurolysis |

**Reoperation – upper trunk neurolysis after earlier reconstruction*

**Table III.** Results of surgical treatment after reconstruction with direct neurorrhaphy

| Case nº | Evaluated function | | | | |
|---|---|---|---|---|---|
| | Hand | Wrist F/E[1] | Forearm | Elbow | Shoulder |
| 1. | 5 | 5/5 | 4 | 5 | V |
| 2. | 5 | 5/4 | 4 | 5 | IV |
| 3. | 5 | 5/5 | 4(T) | 5 | IV(T) |
| 4. | 4-S4* | 4/1 | 3 | 5 | III |
| 5. | 4-S4* | 4/1 | 3 | 5 | IV |
| 6. | 4-S4* | 4/3 | 1 | 5 | IV(2T) |
| 7. | 4-S4* | 4/3 | 3(T) | 5 | IV(T) |
| 8. | 4-S4* | 4/4 | 3(T) | 3 | III(T) |

*[1]F/E – flexion/extension*
**Level of sensibility in all examined areas (thumb, index, 5th finger)*

**Table IV.** Results of surgical treatment after reconstruction with sural nerve grafts

| Case nº | Evaluated function | | | | |
|---|---|---|---|---|---|
| | Hand | Wrist F/E[1] | Forearm | Elbow | Shoulder |
| 1. | 5 | 5/3 | 1 | 2 | 0 |
| 2. | 4 | 0/0 | 1 | 5 | IV |
| 3. | 4-S4* | 4/1 | 4 | 5 | IV(T) |
| 4. | 2-S3+* | 3/1 | 2 | 5 | IV |
| 5. | n/a | n/a | n/a | n/a | n/a |
| 6. | 2-S3+* | 3/3 | 3 | 4 | IV |

*[1]F/E – flexion/extension*
**Level of sensibility in all examined areas (thumb, index, 5th finger)*
*n/a – not available*

quate stump resection is necessary, because too restricted excision of damaged elements is one cause of failure in nerve reconstructions. Intraoperatively, in cases of rupture of brachial plexus trunks, we did not observe in the proximal stumps macroscopic features of neuroma, similar to neuromas formed after peripheral nerve sections (Figs. 1 and 2). It may cause difficulties in determining the range of resection. The excision of fibrous scar tissue (Fig. 3) and pathologically changed neural tissue is necessary (Figs. 4-6). The most important condition for success of this method is the possibility to perform anastomosis without any tension in the suture line (Fig. 7). The results that we achieved using direct neurorrhaphy in our material do not disqualify this surgical technique. This technique, after fulfilling all discussed conditions, is in our opinion very useful in primary reconstructive procedures in brachial plexus lesions. This is confirmed by the results reported by Kirjavainen and co-workers. They achieved the best results in operative treatment of brachial plexus injuries after using direct neurorrhaphy [12]. The possibility of reconstruc-

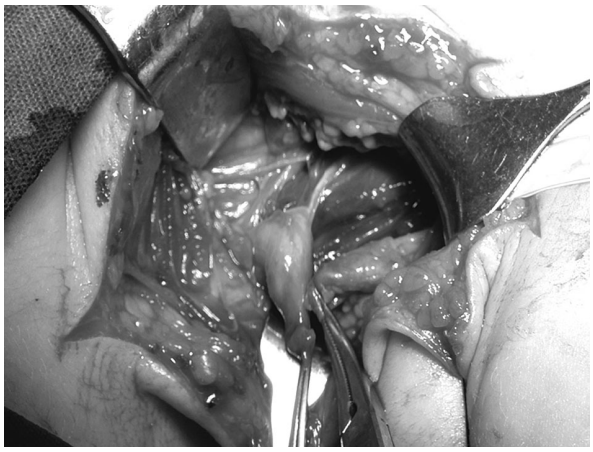

**Fig. 1.** Intraoperative view: rupture of the upper trunk of the brachial plexus without typical neuroma formation in the proximal stump.

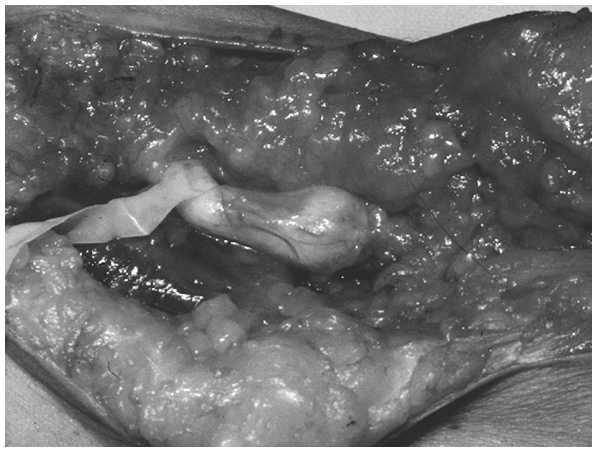

**Fig. 2.** Intraoperative view: posttraumatic neuroma in the proximal stump of the transected tibial nerve.

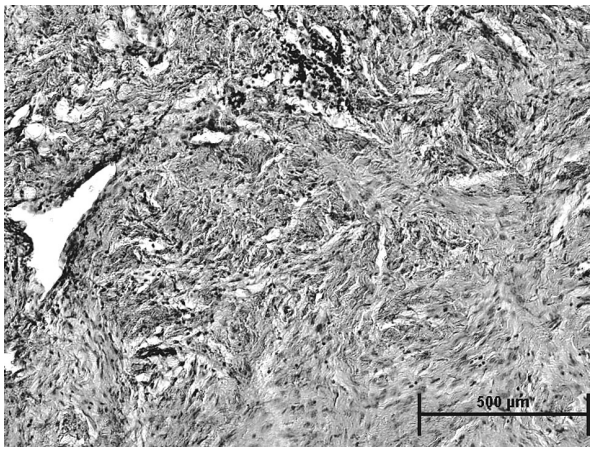


**Fig. 3.** Histopathological specimen result: fibrous scar tissue and lack of nerve structures in the section of the proximal stump of the upper trunk. Stain HE.

tion with direct neurorrhaphy informs indirectly about the smaller range of brachial plexus injury. The lack of continuity in neural elements which requires the use of autogenic nerve grafts is evidence for a greater range of brachial plexus injury. In our material in 8 cases in which direct neurorrhaphy was performed the gap between neural elements varied from 0.7 to 1.0 cm. A greater lack in continuity required the use of sural nerve grafts. The number of grafts was between 2 and 4, and their length was between 1 and 3 cm. In one case (Case 2, Table II) the possibility of mobilization of nerve stumps was limited and a decision in favour of reconstruction with sural nerve grafts was taken. In our opinion both applied methods are useful in surgical treatment of perinatal brachial plexus lesions.

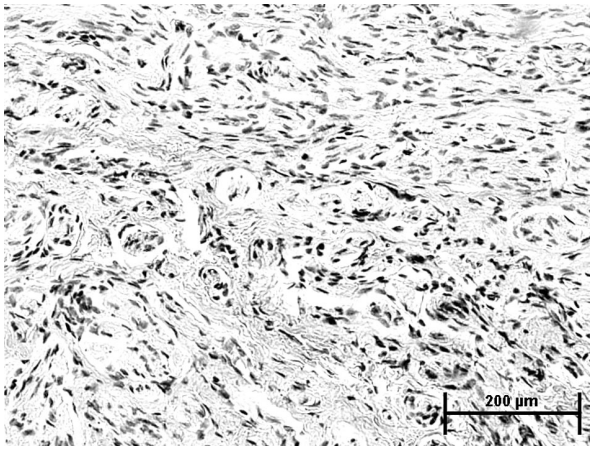


**Fig. 4.** (Case 3, Table I): Posttraumatic neuroma. Stain HE.

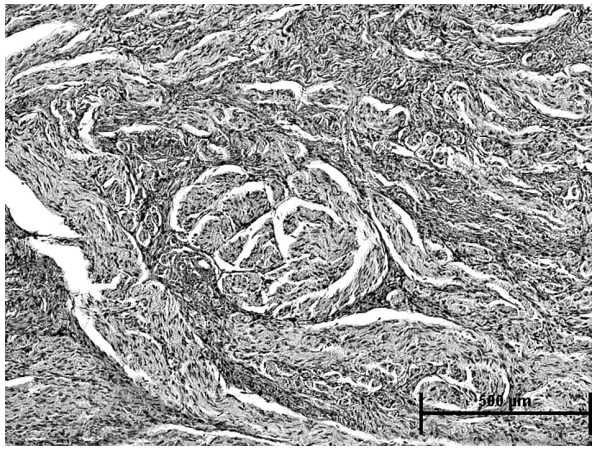


**Fig. 5.** (Case 6, Table I): Posttraumatic neuroma. Stain HE.

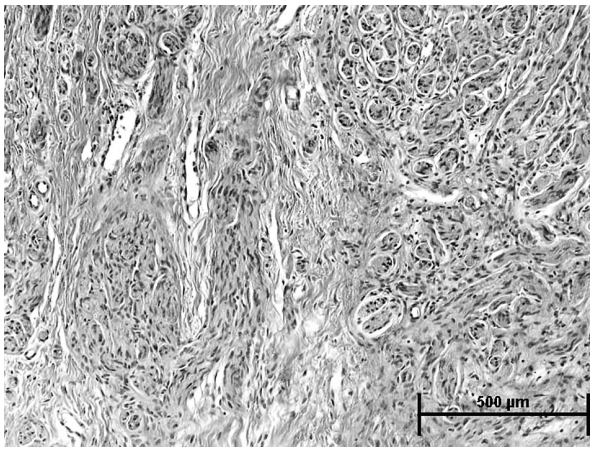


**Fig. 6.** (Case 1, Table II): Posttraumatic neuroma. Stain HE.

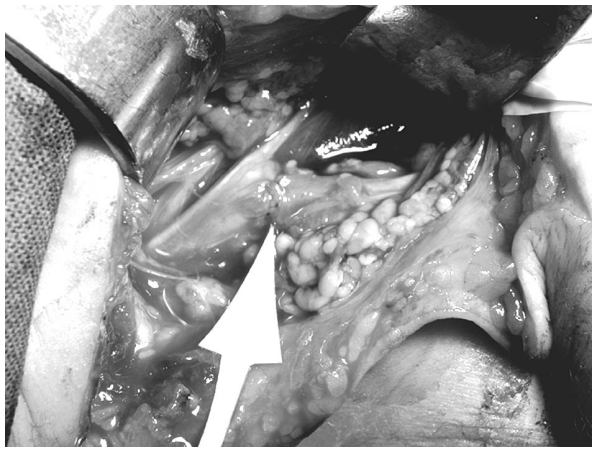

**Fig. 7.** Intraoperative view: status after direct neurorrhaphy of the upper trunk.

Conclusion: Direct neurorrhaphy is, in some favourable conditions, a useful technique in surgical treatment of perinatal brachial plexus injuries. The possibility of using this method indicates on less extension of the brachial plexus lesion.

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