

# A Rationale for Treatment of Complete Brachial Plexus Palsy

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## INTRODUCTION

Injuries to the brachial plexus present major problems in diagnosis and treatment. Often, associated life threatening injuries initially overshadow a brachial plexus injury. The evaluation and treatment of these patients involve many health care team members. Close cooperation and communication among all parties, including the patient, is essential. Once a definitive diagnosis is made, the majority of the elective treatment involves the prosthetist-orthotist, therapist, and vocational counselor or social worker, in cooperation with the managing orthopaedist.

This paper reviews our existing knowledge of complete brachial plexus palsy and methods of treatment. The elective care described pertains to those complete injuries which present no opportunity for return of normal nerve function. Since few centers treat large numbers of these injuries, this discussion will be based in part upon the data and experiences of other clinicians.

## MECHANISMS OF INJURY

The two major causes of brachial plexus palsy are childbirth complications and motor vehicle accidents. During childbirth, downward traction on the shoulder increases the angle between the head and shoulder, resulting in injury to, or avulsion of the upper (C-5 and C-6) roots. Upward

traction on the shoulder increases the angle between the arm and lateral thoracic wall, injuring the lower (C-8 and T-1) roots. Complete injuries involving the entire plexus (C-5 to T-1) may occur.

Motor vehicle accidents, especially motorcycle accidents, cause most brachial plexus injuries. Fletcher<sup>1</sup> reported 180 brachial plexus injuries and noted that 81 percent of the patients were under the age of twenty-four years and that 77 percent of the injuries resulted from motorcycle accidents. The injury may result from traction across the arm or across the head. Barnes<sup>3</sup> stated that root tension varies with position of the arm, elevation tenses the lower roots, while adduction tenses the upper roots. When the shoulder is forcibly depressed with the arm by the side, as may occur in a motorcycle accident, the greatest tensile stress falls on the upper roots. During arm abduction and extension, the axillary portion of the plexus, particularly the posterior cord, may be stretched across the head of the humerus as it dislocates anteriorly and inferiorly. When the abducted limb is forced behind the trunk and the head is thrust to the opposite side, tensile stress is exerted on all roots, and the most severe brachial plexus lesion, a complete palsy, may result.

Traction across the head may also be an important mechanism of brachial plexus injuries. In Fletcher's series,<sup>1</sup> most motorcycle accident victims wore helmets and

were involved in head-on collisions. The head was forced laterally, away from the shoulder, injuring the plexus.

## CLASSIFICATIONS OF INJURY

Brachial plexus injuries may be classified by the roots involved, by division of plexus injured, and by Sunderland's severity of injury to specific nerves.<sup>5</sup> Sunderland's five degrees of injury best correlate with prognosis for recovery of the injured nerve. A first degree injury produces temporary loss of nerve conductivity at the site of injury with loss of motor function and muscle tone, and a reduction in proprioception. First degree injuries recover completely and spontaneously. Second degree injuries involve the fascicles, resulting in complete loss of motor, sensory and sympathetic functions. Axon regeneration proceeds distally from the site of injury with proximally innervated muscles returning first. Third degree injury results in interruption of the internal structure of the fascicles. Regenerating axons are not aligned with appropriate tubules and clinical recovery is never complete. Fourth degree injury results in disruption of all fascicles. Complete loss of motor, sensory and sympathetic function occur and no motor or sensory function return spontaneously. Fifth degree injury is severance of the nerve trunk with loss of motor, sensory and sympathetic function. Although neuromas form, no neurologic recovery is possible.

## EVALUATION AND DIAGNOSIS

Early, accurate assessment of the plexus injury is necessary but difficult. It requires various neurological examinations and tests, most important of which is a thorough physical examination. Additional tests, including myelograms, electromyographs and nerve conduction velocities, are helpful, but require experience and

interpretative skills. A relatively new technique developed by Dr. Steven Jones in England, the spinogram, involves stimulation of the peripheral nerves at the wrist while recording over the plexus at the root of the neck. This non-invasive test departs from the usual procedure of stimulating proximally and recording distally in order to demonstrate preganglionic or root avulsion injuries.

Pain following brachial plexus injury is a common problem. Pain is often not experienced until two or three weeks after injury, and increases in intensity until it reaches its peak about six weeks post-injury. It may persist at this level for years. The pain may be described as burning, crushing, stabbing or like severe electric shocks. According to Wynn-Parry,<sup>2</sup> the presence of severe burning pain indicates a preganglionic lesion with root avulsion from the spinal cord. Dermatomal pain distribution correlates with the avulsed root.

## NON-OPERATIVE TREATMENT

Treatment begins with physical therapy to prevent joint stiffness, prevent soft tissue contractures, and assist in relief of pain. Pain relief is a monumental challenge, and neuromodulation may be beneficial in some patients. Splints are used to prevent joint contractures, or to optimize limb function. These programs require careful reevaluation of the patient at regular intervals to determine changes in muscles and joints. The therapist and orthotist share in encouraging the patient to comply with the prescribed regimen. The exercise program can often be performed by the patient or family at home and only requires checks by the managing team to assess progress.

Careful attention to detail and accurate communication among the team members will clarify goals and alert the physician to a change or lack of progress. Decisions are made by the patient based on a sound understanding of all options, thus the patient becomes the controlling factor in care management.

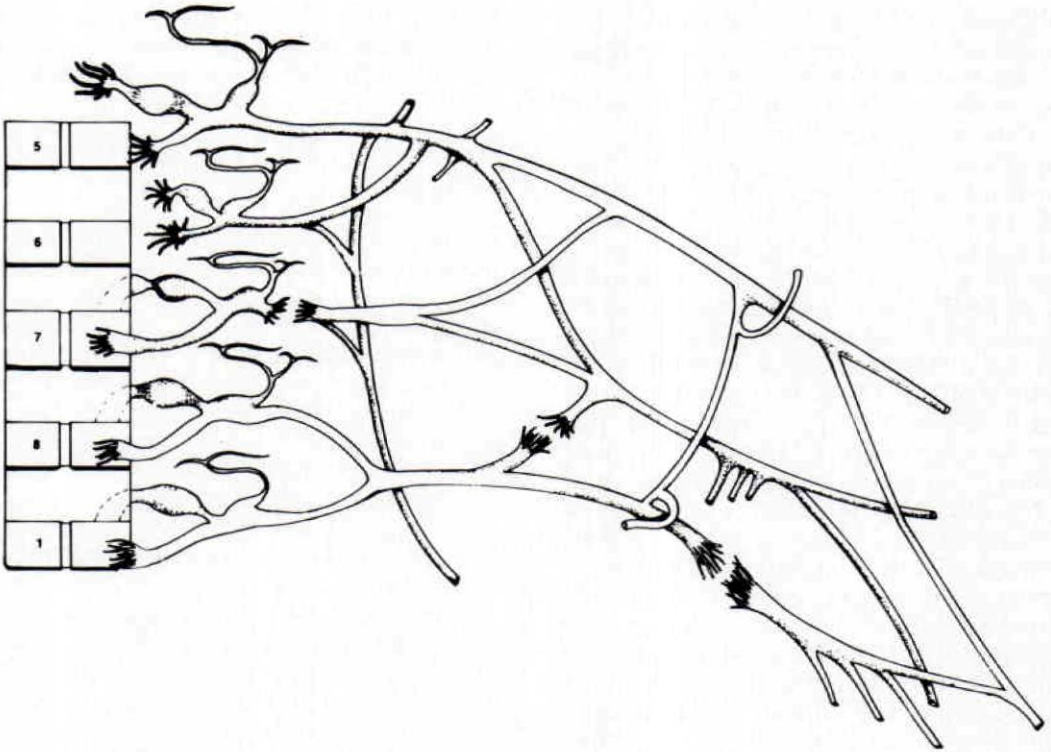


Figure 1. A representation of a complete brachial plexus injury.

## OPERATIVE TREATMENT

A complete brachial plexus lesion implies that all parts of the brachial plexus are involved: all five roots, all three trunks, all three cords, or a combination of root, trunk, and cord lesions (Figure 1). If no neurologic combination of recovery has occurred by six weeks after injury, and if physical findings (Horner's sign), paraspinial EMG's, or cervical myelography indicate a preganglionic component to the injury, the prognosis for recovery is poor. The treatment described will concern only the severe, complete injuries.

Given a permanent complete plexus palsy, the pivotal issue is whether the patient would become a successful prosthetic user. Patient sex, age, limb dominance, associated injuries, motivation, experience with mechanical equipment and the support and experience of the medical care team may influence this decision.

A positive relationship may exist between prosthetic use and the amputation of the patient's dominant hand, especially for those who are unable to transfer dominance to the non-dominant hand. Ransford and Hughes<sup>11</sup> state that if the patient is a manual worker, he or she will more likely use a prosthesis if he or she has difficulty converting hand dominance. They reviewed twenty cases at ten years. Thirteen patients were supplied prostheses, seven were dominant and six non-dominant. Only two of the seven were true prosthetic users. Since only two of 20 cases resulted in true prosthesis users, they recommended amputation and prosthetic fitting only if the dominant limb was affected.

The treatment plan is simplified if the patient is clearly not destined to use a prosthesis. No surgery may be indicated. The patient may elect to retain the limb for cosmetic reasons. If the patient is athletically inclined or if the flail nondomi-

nant limb is a nuisance, above elbow amputation is an accepted option.<sup>11</sup> It may also be indicated for the dominant limb in the patient who will not be a prosthetic user, who has carefully considered the alternatives and who requests the procedure for convenience (Case 1).

Careful consideration of surgical alternatives (including above elbow amputation and shoulder arthrodesis) is important for the potential prosthesis user (Case 2). Rorabeck<sup>10</sup> stated that amputation and fitting done within one year after injury are more likely to result in successful prosthetic fitting than are alternative approaches. He evaluated nineteen patients, fourteen with above elbow amputation alone, and compared them to five patients with above elbow amputation and shoulder arthrodesis. Only one of the five returned to gainful employment while six of fourteen returned to work. Yeoman and Seddon<sup>10</sup> believe that combined amputation and arthrodesis are the treatment of choice within two years of the injury. They reported on seventeen cases of above elbow amputation and shoulder arthrodesis. They compared their results to either no surgical treatment or to total limb reconstruction, but not to above elbow amputation with early prosthetic fitting. For those using a prosthesis, the average interval between injury and amputation was sixteen months. For those not using a prosthesis, it was three and a half years.

Wynn-Parry<sup>2</sup> reported on fourteen patients who underwent above elbow amputation and arthrodesis within six months of injury. Of these, ten returned to work within one year. Further follow-up revealed that these patients were working without their prosthesis, leading Wynn-Parry to a more conservative attitude towards early amputation.

Ransford and Hughes<sup>11</sup> felt that shoulder arthrodesis was necessary for the true prosthesis user. Because the true prosthetic user is rarely seen in clinical practice they recommended the procedure cautiously. They noted that arthrodesis of the shoulder produces potential for skin irritation over bony prominences, but that the procedure

resolved the problem of humeral head subluxation. Prosthesis fitting must be delayed until after fusion has occurred.

## PROSTHETIC FITTING TIME

The elapsed time between elective amputation and initial prosthetic fitting is important. Burkhalter<sup>13</sup> believes that early or immediate fitting does not adversely affect wound healing and helps maintain the two handed pattern for activities of daily living. However, only three of the eighty-seven patients in his series had brachial plexus injuries and none of these were using a prosthesis at follow-up. These data suggest that the patient with a brachial plexus injury may differ from other amputees treated similarly.

Rorabeck<sup>10</sup> states that amputation and fitting should be done within one year of injury, suggesting that the two parts together play an integral role in successful prosthesis wearing and return to work.

Leal and Malone<sup>14</sup> report that myoelectric fitting decreases rehabilitation time when compared with conventional immediate fitting. This suggests the important factor is prosthetic control. Patients who used to support this conclusion were all working prior to injury and returned to work after fitting. However, no job description or dominant hand data were reported. Additional follow up is needed to clarify long term results.

## PATIENT SATISFACTION

Perhaps the most interesting and perplexing data reported deals with patient satisfaction. Fletcher<sup>1</sup> reported on seventy-three patients contacted by questionnaire after one year post-amputation. Ninety-one percent reported wearing the prosthesis regularly at work, and all were glad they chose to have the arm amputated. We are not told what procedures each patient underwent.

Brewerton and Daniels<sup>12</sup> reported that at one year post-injury only 16 percent of the

patients recalled talking with their managing physician about long-term options and outcomes. They emphasized the existence of this void in the care of the brachial plexus injured patient.

## CASE REPORTS

### Case 1:

A 27-year-old male employed as an unskilled laborer suffered a complete avulsion of his nondominant limb brachial plexus. No spontaneous recovery occurred in six months. When offered amputation with early prosthetic fitting, he replied "I wouldn't use it if I had one." The patient later requested amputation since the arm was "always in the way." An uncomplicated above elbow amputation was completed eighteen months after the patient's accident. Since no prosthetic fitting was planned, shoulder arthrodesis was not performed. He described mild pain prior to and unchanged since the operation.

Since the accident he has remained unemployed, is now divorced and is currently residing with his parents. He has adapted to one handed activities of daily living. He believes that his care was satisfactory.

### Case 2:

A 34-year-old male semiskilled service station attendant sustained a complete brachial plexus avulsion. He suffered a C5 through T1 preganglionic injury to his dominant limb. He was advised of his poor prognosis. No recovery had occurred within fourteen months. He felt the arm was a nuisance and requested amputation, but sincerely wanted a prosthesis to aid him in his hobbies and with his wheel repair business. An above elbow amputation was completed fourteen months following his injury. A shoulder fusion was not performed, allowing early prosthetic fitting. He was fitted with a conventional above elbow body-powered system. He is able to control the elbow position and the terminal device. He uses both a stainless steel terminal device and an Otto Bock cosmetic hand.

Since his injury, the patient has changed extremity dominance and can eat, write

and work in his shop. He stated that he was never athletic but enjoyed fishing and fishing reel repair. The patient is satisfied with his treatment, and continues to gain skills with his above elbow prosthesis.

## CONCLUSIONS

Brachial plexus trauma results in a spectrum of palsies, including the severe, complete plexus palsy. When this injury includes a preganglionic component, the prognosis for recovery is poor. Early, accurate diagnosis is critical to planning treatment and counseling the patient. Nonoperative treatment of the complete brachial plexus palsy, under the supervision of the physical therapist, includes neuromodulation for pain control and prevention of joint contractures. Operative treatment includes above elbow amputation in the nonprosthetic user. For the potential prosthesis user, above elbow amputation and/or shoulder arthrodesis may facilitate prosthetic fitting and use.

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