Chapter 1

Introductory Chapter: Brachial Plexus Injuries - Past, Present, and Future

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Additional information is available at the end of the chapter

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1. Introduction

Although they have a low incidence [1–3], brachial plexus injuries continue to be a cause of serious disability [4]. Their victims are mostly young people in the middle of their lives or newborns, always with worrisome long-term consequences [2–4]. Unfortunately brachial plexus lesions can also be the result of iatrogenic injuries [5]. The quality of life of those affected is devastated, with high personal [4, 6], familial [7], and societal costs [8, 9].

Nowadays, road accidents in young people continue to be the most common cause, particularly when the victim is thrown in the air and lands on the shoulder [2, 5, 10]. This is particularly common in developing Third World countries, where people have to recourse to the motorcycle for their daily transportation [1, 11–14], as a car is an option outside their reach. Other causes are wars [15–17] and assaults [18, 19]. The incidence is higher in males than in females [1, 2, 13, 20], probably related to the highest aggressiveness and violent behavior in the former [21]. In newborns brachial plexus injuries are usually due to problems during vaginal delivery [3, 22], particularly in case of a macrosomic fetus [23, 24], common in diabetic mothers [25]. In the developed countries, the fear of unpleasant medicolegal consequences in case of an obstetric brachial plexus injury has induced a significant increase in the proportion of cesarean section deliveries [26, 27]. The incidence of iatrogenic brachial plexus lesions unfortunately continues to be stable overtime with no signs of reduction [5, 28–30]. These iatrogenic lesions are induced while performing lymph node biopsy [5, 31, 32], vessel catheterization [33, 34], on applying radiotherapy in the treatment of cancer [35, 36] repairing upper limb bone fractures [37, 38], in programmed orthopedic procedures [39, 40], due to inadequate patient positioning [41, 42] or when restraining aggressive patients [43]. Preventing these iatrogenic injuries is particularly important, not only because they might lead to ugly medicolegal consequences [28] but because of our motto "primum non nocere"

(first do no harm) [44]. Any measure or technical improvement aiming to decrease the chance of these unwanted iatrogenic injuries will always be most welcomed. Knowledge, awareness, and training of all hospital personnel must be a priority in our daily basis [45].

2. Treatment modalities

The age of the patient, the mechanism of injury (blunt or penetrating), the location (proximal or distal in the upper limb), and the extent of the lesion will influence the type and timing of the treatment algorithm as well as the final result [46, 47]. When all brachial plexus roots are affected, particularly if avulsed, there will be very limited treatment options, and the end results will be a severe upper limb disability with a very limited chance of a useful functional recovery [48–50].

Particularly, it is important to find out if the lesion is pre- or postganglionic as the first one has no chance of spontaneous recovery [51]. Magnetic resonance imaging has proven very useful in this respect [52]. Waiting for spontaneous recovery will entail an inexcusable waste of time that will lead to an unsatisfactory recovery [50, 53]. Thus, once the diagnosis of the nerve root avulsion is confirmed, the repair will have to be done as soon as the patient is able to tolerate the surgical procedure needed to be done [54, 55]. The "urgent" repair, a few days after injury, has been reported by some in cases of confirmed avulsion and in clean nerve sections (i.e., glass) [56].

The treatment strategy is based on the mechanism of injury [54], the findings of the physical and neurological examinations [57], and the results of the complementary diagnostic tests (electrodiagnostic studies [58], magnetic resonance imaging [59], and ultrasonography [60]). This last one is relatively inexpensive and can be made available to places with very limited resources [61]. It can also been used intraoperatively to see the anatomy of the damaged nerves, helping to decide if the lesioned nerve segment has to be removed and the gap grafted or a neurolysis will solve the problem [62]. The evolution of their results overtime is particularly useful to locate the lesion(s), assess its severity, and control the response to the treatments (physiotherapy, observation, surgical repair, electrostimulation, etc.) [63]. Computerized myelo-tomography was used in the past to diagnose the nerve root avulsions, but nowadays it has been replaced by magnetic resonance imaging [59, 64–66].

Spontaneous recovery can be expected in most brachial plexus injuries [67], particularly in the case of obstetric patients [68]. Among them the rate of spontaneous recovery is particularly high (66–92%) [69]. Physical therapy is essential to correct muscle contractures and avoid neglect of the damaged limb while waiting for spontaneous recovery [69]. In the case of inadequate recovery, on-time surgical treatment might be indicated [3, 68].

Progressive improvement of the surgical techniques with direct nerve repair, nerve grafting, and particularly with nerve transfers has greatly improved the results in the brachial plexus injuries [47, 70–72]. Direct repair, when at all possible, is still the first choice, provided that there is no tension in the suture line [73]. Nerve grafts are required to cover the gaps, but the results are often not as good as expected [74, 75]. Meanwhile, the nerve transfers have expanded our treatment capabilities with excellent results [72, 76]. They are particularly

useful in nerve injuries affecting the distal parts of the upper limb, as other techniques like the nerve repair, direct or with nerve grafts, yield poor results [47, 70, 77]. The growing axons coming through the nerve repair take so long to reach the hand intrinsic muscles that when they do it find them atrophied and fibrotic [78–81]. Meanwhile, the nerve transfers provide new axons close to the injured muscles with an early and efficient repair [72, 76]. At times an end-to-side nerve transfer can be added to keep the muscles viable, while the growing axons from the direct primary nerve repair to reach their final destination in the motor end plates [82]. Nerve transfers solve the problem of a long distance between the lesion site and the motor end plates to be reinnervated [6, 49, 72, 76]. They can also be used in case of delayed patient referral [83] or dense scar at the primary injury site [84]. Sensory nerve transfer is another very promising area [85, 86], particularly in tetraplegic patients [87, 88], and can also help to control the neuropathic pain [89].

3. Future treatment possibilities

Currently, there is an intense research on pharmacological agents that accelerate the axonal regeneration, shortening the time needed to achieve the reinnervation [90, 91]. Other areas of research are the use of stem cells and growth factors as well as the search for artificial conduits that could substitute the autologous nerve grafts [90, 92]. The most serious injuries, the nerve root avulsions, are still awaiting an effective solution. Reimplantation has been attempted but the results are dismal [50].

Treatment of a complete brachial plexus avulsion with its resultant flail arm poses still a serious challenge [49]. Even with contralateral C_7 nerve root transfer, only some primitive movements are regained with limited use in the daily life [93]. Some have recommended upper limb amputation in these unfortunate cases [94].

Tetraplegic [88] and stroke [95] patient treatments are an area of expansion, aiming to recover some functions in the upper limbs that can improve their quality of life [88, 96]. The rationale behind is to use nerve transfers to recover specific functions (like finger movement) in areas of irreversible spinal cord or motor strip damage [76, 97].

Some technical refinements have been described attempting to reduce the chance of iatrogenic injury in cases of anesthetic brachial plexus block [98, 99]. The use of ultrasonography can be of invaluable help [100]. Some recommendations on patient positioning have also been forwarded [44]. The long-term commitment of every hospital employee is essential to minimize these unwanted mishaps.

4. The future in your own hospital

A final word should be said on how to start, develop, and consolidate a new peripheral nerve unit. This can be a major endeavor that demands continued devotion and long-term commitment. Once you start in this field, first you have to be known and accepted in your own hospital and then in your community. Time and persistence are needed to get the confidence of the referring doctors

as well as the respect of the public. A stepwise and cautious attitude is recommended. While good results not always are acknowledged by our colleagues, a bad case can ruin our reputation. Meanwhile, to get the needed equipment and personnel is something that needs continuous negotiation with the hospital administrators; fighting for resources is also demanded by many other members of your own hospital. But with long-term persistence and unrestricted commitment, one usually achieves the goals, as proven by the authors of one of our following chapters.

5. Conclusions

Brachial plexus injuries continue to pose serious treatment dilemmas. Although the proximal injuries have a reasonable good prognosis, the distal ones not always get a good functional recovery. There has been a big improvement over the years, but research is needed to further improve the functional results, particularly in pan-brachial plexus avulsions. To start a new peripheral nerve unit is an exciting endeavor that demands enthusiasm, long-term commitment, and daily persistence.

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