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## Original research article

# The components of shoulder and elbow movements as goals of primary reconstructive operation in obstetric brachial plexus lesions

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## ABSTRACT

Most of the cases of obstetric brachial plexus lesions (OBPL) show satisfactory improvement with conservative management, but in about 25% some surgical treatment is indicated. The present paper analyzes the effects of primary reconstructive surgeries in aspect of achieving delineated intraoperatively goals.

Children operated before the age of 18 months with follow-up period longer than 1 year were selected. Therapeutic goals established during the operation were identified by analysis of initial clinical status and operative protocols. The elementary movement components in shoulder and elbow joints were classified by assessing range of motion, score in Active Movement Scale and modified British Medical Research Council scale of muscle strength. The effect was considered satisfactory when some antigravity movement was possible, and good when strength exceeded M3 or antigravity movement exceeded half of range of passive movement.

In 13 of 19 patients most of established goals were achieved at good level, in 2 at satisfactory level. Remaining 4 patients showed improvement only in some aspects of extremity function. In 2 patients improvement in some movements was accompanied by worsening of other movements.

The analysis of results separated into individual components of movements showed that goals were achieved in most of the cases, simultaneously clearly indicating which damaged structures failed to provide satisfactory function despite being addressed intraoperatively.

The good results were obtained mainly by regeneration through grafts implanted after resection of neuroma in continuity, which proves that this technique is safe in spite of unavoidable temporary regression of function postoperatively.

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## 1. Introduction

Obstetric brachial plexus lesions (OBPL) always put parents in great distress and raise concerns about future function of the impaired limb. Its frequency, despite achievements of modern obstetrics, remains relatively stable in developed countries, lying between 0.2 and 5.1 per 1000 live births (in Poland it is estimated to be 0.4–2/1000) [1]. Even though this entity is known since long time – it was mentioned for the first time by Smellie in 1764, the treatment method still evolves. After discouraging results of first attempts of surgical treatment in the beginning of XX century the development of microsurgery in 70s improved the effects (Millesi, 1977; Narakas, 1978; Gilbert et al., 1980; Terzis et al., 1986) [2] and the struggle for optimization of surgical strategy began. In the same time the questions aroused whether complicated and invasive treatment of illness, which is not life-threatening and may cure by itself, is indicated at all.

Metaanalysis done by Pondaag [3] showed that in 70–90% of cases the injured limb regains proper function without surgical intervention. Restoration of antigravity movements before the end of second month of life is a good prognostic factor allowing limitation of therapeutic process to physiotherapy alone. In cases with absent antigravity function of biceps muscle by the end of third month of life and no surgery performed persistent paresis can be expected with serious functional impairment. Among the patients with serious injuries (Narakas' group 3, Table 1) the ratio of conservatively treated patients with satisfactory function decreases radically to 23%, and in Narakas' group 4 – to zero.

Contemporary publications show considerably better final results in groups of patients treated surgically than can be expected from conservative treatment as described above [4].

Despite improvements in radiological visualization methods (myelo-CT, MRI) and electrodiagnostic studies (EMG), physical examination remains the basis of the qualification for the surgery and can be repeated every few months to select the patients in the earliest moment when the expected final result of spontaneous recovery is less than satisfactory. The most commonly used criteria recommend early operation (about 3 months of age) in total injuries comprising all levels of the plexus, especially if root avulsions are suspected [6]. Lack of biceps function at 3 months of age is another widely used criterion [4]. In cases of upper brachial plexus lesion without balanced recovery of shoulder and elbow movements at the age of 3 months the physiotherapy can be continued for another 3 months, which should be enough time to reach at least good level of function, and if impairment persists surgical management yields better final result [7]. If proximal recovery

is doubtful then coexisting weakness of hand function (usually extension of wrist or fingers) indicates the lesion wider than C5 and C6 roots and suggests the necessity of surgery. Profound impairment of external rotation of the arm with satisfactory improvement of other movements is frequently observed. It is an indication for neurotization of suprascapular nerve by distal part of accessory nerve, which can be performed relatively late – up to the age of 18 months [7].

The abundance of currently available and continuously developed surgical methods matches the complexity of brachial plexus injury problems. They can be divided in two groups: operations targeted at restoring of function of particular nerves and operations replacing the function of paralyzed muscle with another muscle. The operations regarding nerve function can further be classified as intraplexic reconstructions (mostly by autologous sural nerve grafts, anatomic – between proximal and distal stump of the same structure, and non-anatomic – grafts from the part of the plexus other than proximal stump of injured structure) and nerve transfers in order to supply the non-functioning nerve with regenerating axons from another, less important nerve (Fig. 1).

The progress in understanding of the impact of particular muscle groups, comprising the functional elements of the extremity, on global limb function led to development of therapeutic priorities in the management of paresis [2,7], which are summarized in Table 2 and provide useful guidance in frequently encountered insufficiency of sources of regenerating axons (for example in avulsion injuries, but also in cases of unbalanced recovery when improvement of some function would endanger already regained function of other injured structure). Applying this knowledge enables us to redirect the axons from the best available sources to the targets of the highest priority, independently from anatomic location, e.g. when lower roots are avulsed the restoration of hand function is of highest priority and can be achieved by grafting from the upper roots with preserved regeneration potential to the lower trunk of the plexus (Fig. 1).

This paper analyses the degree of achievement of therapeutic goals established according to the above described priorities.

## 2. Patients and methods

In July 2010 the whole spectrum of microsurgical reconstructive methods for brachial plexus injury was introduced to our hospital. Until October 2015 we performed 43 operations (36 in patients with OBPL and 7 operations in 6 patients with brachial plexus injury in later age). 30 patients with OBPL had primary

**Table 1 – Classification of obstetric brachial plexus injuries according to Narakas.**

Group	Range	Clinical presentation
I	C5–C6	Paralysis of shoulder and biceps
II	C5–C7	Paralysis of shoulder, biceps and forearm extensors, function of long flexors at the forearm is preserved
III	C5–Th1	Complete paralysis of limb (a trace of finger flexion may be present)
IV	C5–Th1 + Horner sign	As above with Horner sign (root avulsions probable)

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