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RESTORATION OF FUNCTION IN PARALYSED ELBOW

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SUMMARY

Paralysed elbow results from lack of muscles function responsible for the movements of elbow joint. The aim of the paper was to review methods of paralysed elbow evaluation and treatment basing on the own experience and data from literature on the topic. Preoperative diagnosis is based on history of the injury and on coexisting congenital disorders, patient's physical status, results of clinical examination. What is more, the additional diagnostic tests must be included (for example X-rays, CT scans, MRIscans or electromiography) performed before the treatment. The currently available operative techniques for paralysed elbow are the direct nerve reconstruction or secondary reconstructive surgery such as the nerve transfer and muscle tendon transfers. Open or arthroscopic arthrolysis in the elbow contraction operative treatment is considered.

Keywords: elbow paralysis, muscle transfer, nerve transfer, nerve reconstruction

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ODTWORZENIE FUNKCJI W NIEDOWŁADACH ŁOKCIA

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STRESZCZENIE

Porażony łokieć jest objawem braku funkcji mięśni odpowiedzialnych za ruch w stawie łokciowym. Celem tego doniesienia było przedstawienie metod oceny funkcji, diagonostyki oraz leczenia porażonego łokcia w oparciu o własne doświadczenia jak i dostępne dane literaruty światowej w temacie. Diagnoza przedoperacyjna oparta jest na danych odnośnie uszkodzenia i ewentualnych współisniejący chorób wrodzonych, aktualnego stanu zdrowia chorego jak rezultatów badań klinicznych. Ponadto należy uwzględnić wyniki dodatkowych testów diagnostycznych (na przykład wyniki badań retngenowskich, tomografii komputerowej, rezonansu magnetycznego lub badań elektromiograficznych) przeprowadzonych przed podjęciem leczenia. Dostępnymi obecnie sposobami leczenia operacyjnego porażonego łokcia są bezpośrednie rekonstrukcje nerwów lub wtórne zabiegi rekonstrukcji chirurgicznej takie jak przeniesienia nerwów lub przeniesienia ścięgien mieśni. Otwarta lub artroskopowa artroliza w leczeniu operacyjnym przykurczu łokcia jest również brana pod uwagę.

Słowa kluczowe: porażenie łokcia, przeniesienie mięśnia, przeniesienie nerwu, rekonstrukcja nerwu

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Introduction

Paralysed elbow results from lack of muscles function responsible for the movements of elbow joint. This in turn may be caused by the nerve or muscle injury or may be the result of other causes of so-called pseudo-paralysis (Vekris and Soucacos 2001). Among causes of pseudo-paralysis of the elbow are its severe pain, changes in the joint (traumatic disorder of joint congruence, soft tissue contracture) and mental disorders. However, the most common cause is the nerve damage in the mechanism of perinatal brachial plexus palsy or the traumatic brachial plexus injury. Elbow movement disorders are accompanied by lack of sensory perception and autonomic dysfunction.

Aim

The aim of the paper was to review methods of paralysed elbow evaluation and treatment basing on the own experience and data from literature on the topic.

Material and methods

Diagnosis is based on patient's medical history and physical examination. Additional diagnostic tests are needed to plan the future treatment. Nerve injury can be revealed as lack of the innervated muscle contraction or even, in more advanced cases, in lack of the muscle tension. Most often the high-energy trauma to the injured elbow is confirmed in the examination of the patient. The Lovett's scale is used during examination for quantification of muscle strength. In most cases of muscles in paralytic elbow, the score is 0 points. Moreover, it is confirmed that even if the score is 1 or 2 points, the paralysis of elbow muscles can be confirmed. It is important to examine the sensory disturbances of the areas, which correspond to the injured innervation. The site of the potential nerve damage is indirectly defined by Tinel's signs evaluation. It is advisable to perform additional tests such as electroneurography, electromyography, ultrasound imaging and magnetic resonance imaging (MRI) when required. Electrodiagnostic evaluation may be helpful in diagnosing of the root avulsion, which may be excluded when the sensory nerve action potential and normal conduction velocity are detected (Vekris and Soucanos 2001). It is also worth to consider an arteriogram in case of, for example, vessel injury, vessel reconstruction with a vein graft.

Results

Treatment and results depend on the location and degree of the nerve injury. The degree of nerve injury is defined by the Seddon's and Sunderland's classification (Seddon 1943), the first being simple and sufficient in clinical practice (Sunderland 1951). Information as to the degrees of nerve injury allows planning the patient's observation or surgical treatment. The patient and the family must have been clarified with reference to the treatment plan, which will be helpful in the recovery and function restoration.

Table 1. Rate of the nerves recovery pattern

Type of injury	Recovery pattern	Rate of recovery	Surgical procedure
Neurapraxia I°	complete	fast (spontaneously) several weeks	none
Axonothmesis II°	complete	slow 1–2 mm/day	none
Neurothmesis III°	none	no recovery	surgical repair

Discussion

Surgical treatment of nerve injury involves the direct nerve repair end-to-end. Another possibility is to use the free cable grafts for nerve reconstruction when there is tension on anastomosis, nerve discontinuity, or post-ganglionic neuroma. The most common procedure is to use the sural nerve graft. In cases of irreversible nerve ruptures, non-anatomical reconstruction must be considered. The literature provides descriptions of operative techniques in cases in which the above reconstructive procedures are expected to be ineffective (Shin *et al.* 2004; Weber 2004; Carlsen *et al.* 2009). One of the operative techniques described is the nerve transfer, which consists of a transfer of the intact nerve branch to the more important sensory or motor nerve that has sustained the irreparable proximal damage (Bhandari et al., 2008; Weber 2004). For example, one of the motor branches of triceps muscle can be transferred on the musculocutaneous nerve, or C7 root from the opposite side can be used to rebuild of irreversibly damaged part of the brachial plexus (Shin *et al.* 2004; Vekris 2001). The study of Tu *et al.* (2014) compared the operative techniques of total and hemicontralateral C7 nerve root transfer. The authors underlined the possible risk of donor site complications. Elbow flexion can also be achieved with the,intercostal nerve transfer, medial pectoral nerve, phrenic nerve, thoracodorsal nerve, spinal accessory nerve (Dai *et al.* 1980, Allieu *et al.* 1988, Gu *et al.* 1989, Chuang *et al.* 1992, Samardzic *et al.* 2002). Another operative technique was introduced by Oberlin *et al.* (1994) in which a part of ulnar nerve is transferred to the biceps motor branch. In the postoperative regime after the nerve transfer it is important to perform electrostimulation procedures to the affected muscles or nerves and to maintain the full passive range of elbow motion. Another option is the intercostal nerve transfer, which is a valuable procedure when the intraplexus donors do not present the nerve impulses transmission (Lykissas *et al.* 2013). After this procedure, the results can be varied (Sedel *et al.* 1982, Friedman *et al.* 1990, Songcheroen 1998).

If it is impossible to restore the function of the elbow muscles due to ineffective treatment of the injured nerves or muscle dysfunction, the surgeon should consider the muscle transfer from a nearby muscle or a free vascularized muscle transfer. Most often used muscle transfers are pectoralis major, latissimus dorsi, part of the deltoid or proximal attachment of the finger flexor from medial epicondyle (Humphreys and Mackinnon 2003, Gohritz *et al.* 2008, Verkis *et al.* 2008).

In the postoperative period, the immobilization regime is required. Kumar *et al.* (2014) reported that the multiple muscle transfer such as transfer of trapezius, pectoralis major, latissimus dorsi muscles and Steindler procedure allowed to restore 110 degrees of the elbow's flexion. These authors also suggested the use of those procedures in older patients. An example of transposition of local muscle is the triceps to biceps transfer. In study of Rühmann *et al.* (2002), the patients after above transfer achieved 109 degrees of the elbow's flexion.

Weber *et al.* (2004) claimed that the nerve transfer has major advantages over a tendon transfer such as the capacity for restoring the sensory function in addition to a motor function, multiple muscle groups can be restored with a single nerve transfer, the original muscle function and tension is maintained when their attachments are not disrupted.

Joint damage itself can also be the reason for a limited range of elbow movement. A diagnosis where is the most common cause of elbow injury is based on the clinical examination. Sometimes, the patient has no changes the in brachial plexus or spinal cord nerve impulses transmission, but there can exists a limited active and passive range of elbow movement. Noteworthy is a proper tension of the muscles responsible for elbow

movements. X-ray images in classic projections and computer tomography should be performed in cases of patients presenting such dysfunctions. Both examinations will confirm changes in bones, which might explain the elbow contracture. The limitation may also result from the soft tissue contracture. In this case, the palpation of tightened muscles surrounding the elbow and elbow ultrasound imagining are worth considering. In most cases, the changes in the bone and soft tissue contractures occur together. Surgical treatment consists of releasing the contracture, removing soft tissue and blocking bone fragments. As surgical technology advanced in the pass years towards the arthroscopic arthrolysis and it was proved as to be safer then open technique (Wu *et al.* 2015). In the early postoperative rehabilitation, the patient's regime should be turned towards the exercising passive and active elbow range of movement. It is important to obtain a satisfactory intraoperative elbow movement. Very useful is the use of equipment for the continuous passive motion of the elbow. The surgeon and the physiotherapist should be constantly in touch. Also, it is crucial to show the achieved range of elbow motion to the patient immediately after the surgery. Moreover, if the surgeon suspects that the elbow paralysis is joined to the mental disorder, consultations with a psychologist or a psychiatrist must be considered (Vargas-Prada and Coggon 2015). The patient's family should also be informed about the surgeon's suspicions. The patient might be treated with the regional anaesthesia and/or muscle electrostimulation, which might show the functional recovery of the patient's elbow. As a result, the patient may subconsciously return to the health by means of normal elbow function and the lucky surgeon does not have to perform the extensive surgery.

Conclusions

In conclusion, it seems that multiple surgical approach is the most useful in treatment of the paralyzed elbow. It is also very important that the patient with paralyzed elbow should be treated in the multidisciplinary center with the experienced surgeons and physiotherapists.

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