

Results of an operative treatment of the child with Duchenne – Erb's type obstetric brachial plexus injury – case report

Efekty operacyjnego leczenia dziecka z okołoporodowym uszkodzeniem splotu ramiennego typu Duchenne'a-Erba – opis przypadku

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ABSTRACT

Introduction and aim of the study: Obstetric brachial plexus injuries in neuropraxia cases retreat spontaneously. In case of axonotmesis and neurotmesis the permanent dysfunction of upper limb occurs. In the primary period of the child's life typical conservative treatment is applied and it consists of physical therapy. If the paresis is retreating too slowly and prognosis of regaining of function is poor the microsurgery get involved (including: neurolysis, neurotisation, and autografts) as well as orthopedic procedures. An aim of the study was the presentation of child's management's effects following the Quad Mod operation. **Material and methods:** One of the procedures involving both types of operation is Mod Quad Operation applied in Texas Nerve and Paralysis Institute in Houston. Mod Quad Operation consists of 4 elements: 1. Latissimus dorsi muscle transfer for external rotation. 2. Teres major muscle transfer for scapular stabilization. 3. Subscapularis muscle release for reduction of internal rotation, and. 4. Axillary's nerve decompression and neurolysis. Depending on individual needs procedure can be modified. It is worth mentioning that the best results are observed by children before 4 years. **Results:** The boy described in the study was operated on before he was 4 and the paresis of his upper limb was reduced significantly. He is currently able to swim the basic strokes, playing the piano and volleyball. The improvement is visible both in Mallet's Scale and in daily activities.

Key words: Obstetric brachial plexus injuries, Surgery operations of brachial plexus in children, Mallet's Scale, Quad Mod operation.

STRESZCZENIE

Wstęp i cel pracy: Uszkodzenia splotu ramiennego w okresie okołoporodowym w przypadku neuropraksji ustępują samistnie. W przypadku aksonotmesis i neurotmesis powstają trwałe zaburzenia funkcji kończyny górnej. W początkowym okresie życia dziecka postępowanie ma charakter zachowawczy i obejmuje kinezy- i fizykoterapię. Jeśli tempo ustępowania niedowładów jest zbyt wolne, a prognozowanie powrotu funkcji niepomyślne – wykonywane są zabiegi mikrochirurgiczne (obejmujące neurolizę, neurotyzację i autoprzeszczepy) oraz zabiegi ortopedyczne. Celem pracy jest prezentacja efektów usprawniania dziecka po operacji Quad Mod. **Materiał i metoda:** Jednym z zabiegów łączącym oba typy operacji jest stosowana w Texas Nerve and Paralysis Institute w Houston formuła Mod Quad złożona z 4 elementów, na którą składają się transfery – 1. *m. latissimus dorsi* – w celu uzyskania rotacji zewnętrznej i 2. *m. teres major* – w celu uzyskania stabilizacji łopatki, 3. uwolnienie *m. subscapularis* w celu likwidacji rotacji wewnętrznej ramienia oraz 4. dekompresja i neuroлиза nerwu pachowego (*n. axillaris*).

W zależności od indywidualnych potrzeb procedura jest modyfikowana. Warto dodać, że najlepsze rezultaty obserwuje się u dzieci przed ukończeniem 4 roku życia. **Wyniki:** Opisany w pracy chłopiec, operowany tuż przed ukończeniem 4 lat uzyskał znaczną poprawę funkcji niedowładnej prawej kończyny górnej. Obecnie pływa podstawowymi stylami, gra w siatkówkę i uczy się gry na pianinie. Poprawa zauważalna jest zarówno w ocenie skalą Malleta jak i w czynnościach dnia codziennego.

Słowa kluczowe: okołoporodowe uszkodzenia splotu ramiennego, operacje splotu ramiennego u dzieci, skala Malleta, operacja Quad Mod

The frequency of brachial plexus injuries in children vacillates in range of 0.7–2% [1–3] and improprieties of a labor are considered as the most often reason [2,4]. High body weight of a fetus (4–6 kg), when the size of a shoul-
















der girdle exceed the size of a head, as well as pelvic or crosswise lay of a fetus contribute to such injuries [3,5–7]. Abnormalities which are consequences of two basic mechanisms: traction (stretching) and compression (crush) can

be found in obstetrical injuries of brachial plexus [7–10]. Prognosis and course of a treatment are bounded up with regenerating process, conditioned by the degree of plexus injury (neuropraxy, axonotmesis, neurotmesis, and avulsion). The distance of an injury from stem cells is also important.

Injuries of brachial plexus include the following types: upper (Duchenne-Erb’s type), middle, lower (Klumpke’s type) and complete [1,6]. Most of the authors consider diagnosing of obstetrical injury of brachial plexus as not difficult on account of specific syndromes [8,11,12].

In the assessment of treatment and improvement Mallet’s classification can be also used as it allows to objectivization of upper limb function assessment in treatment course. Results of injury of brachial plexus have local and global effects. Local effects bound up shoulder girdle and a free part of upper limb and they are manifested by typical paresis and compulsory position as well as trophic disorders in form of hypoplasia of upper limb and shoulder girdle.

Tab. I. Mallet’s classification in the assessment of the injured plexus’ function [16] *Klasyfikacja Malleta w ocenie funkcji uszkodzonego splotu ramiennego [16]*

	Abduction		
II – below 30° 	III – 30–90° 	IV – over 90° 	
	External rotation		
II – 0° 	III – below 20° 	IV – over 20° 	
	Hand on a nape		
II – impossible 	III – difficult 	IV – easy 	
	Hand on a back		
II – impossible 	III – S ₁ 	IV – Th ₁₂ 	
	Hand to a mouth		
II – lack of horizontal adduction 	III – 50% of adduction 	IV – 100% of adduction 	

Injuries of brachial plexus can be accompanied by shoulder blade’s neck, clavicle and brachial bone fracture as well as by pain [2,7,10]. Global effects arise from asymmetry of motor and postural patterns connected with: 1. The lack of anti-gravitational activity of paralyzed upper limb (disorder of supporting function, limited reaching, limited activity in accommodative and balance reactions); 2. Asymmetric rolling; 3. Restricted abilities of crawling and on all fours; 4. Sitting down with the help of healthy upper limb; 5. Asymmetrical standing up (with load bearing on a healthy side). As a consequence the development of body pattern is disordered (bilateral control, midline orientation, lateralization of body posture development) [9]. The following can be observed: 1. Asymmetrical head placing (habitual torticollis); 2. Asymmetrical placing of shoulders and shoulders blades; 3. Trunk asymmetry; 4. Weakness of abdomen muscles; 5. Asymmetrical placing of a pelvis – increased anterior pelvic tilt; 6. Knock knees or club feet on the engaged side. Abnormal activity in orofacial sphere can be also observed sometimes.

Treatment includes conservative management (physiotherapeutic) and surgery management (microsurgery and orthopedic) [14–16].

Chart worked out in Houston presents the method of treatment depended on diagnosing of patient condition successively [16,22]. It includes conservative or/and operating treatment depended on pace of upper limb’s paresis’ retreating presented by chart 1.

Setting a date for undertaking the surgery treatment is currently the subject of a discussion. A. Gilbert considers that recommendation for an operation is a lack of functional improvement after three months of baby’s life [10,14]. Currently used surgery operations are of three types: microsurgery, orthopedic and – more rarely – mixed.

Microsurgery operations include the following techniques: neurolysis, neurotisation, and autografts (reconstruction with use of autografts) [10,17–19]. In orthopedic surgeries the most often are carried out: operation reducing muscle contractures (e.g. Sever) or facilitating function of a limb through transfer of selected muscles (e.g. l’Episcopo) [6,20].

Less popular is the treatment used in Houston and described as Mod Quad Operation which combine both orthopedic and microsurgery treatment such as: 1. Elimination of contractures. 2. Transfer of insertions of a few non-paralyzed muscles to the place of insertions of paralyzed muscles, and. 3. Neurolysis. The aim of the operation surgery is an improvement of multidimensional mobility in shoulder joint [21].

The aim of this study is to demonstrate effects of the operation mentioned above and carried out in USA by name Mod Quad Operation. Surgery was performed in Texas Nerve and Paralysis Institute in Houston on 4-years old boy with obstetrical injury of upper part of brachial plexus in order to improve the functions of limb’s paresis. The boy described in the study went to USA as the patient and a significant improvement of his functional condition resulted in another children trip.

Chart 1. Diagnostic and therapeutic procedures currently used in Houston Children Hospital [12,22] *Obecnie stosowane postępowanie diagnostyczno- terapeutyczne zaproponowane przez Children Hospital w Houston [12,22]*

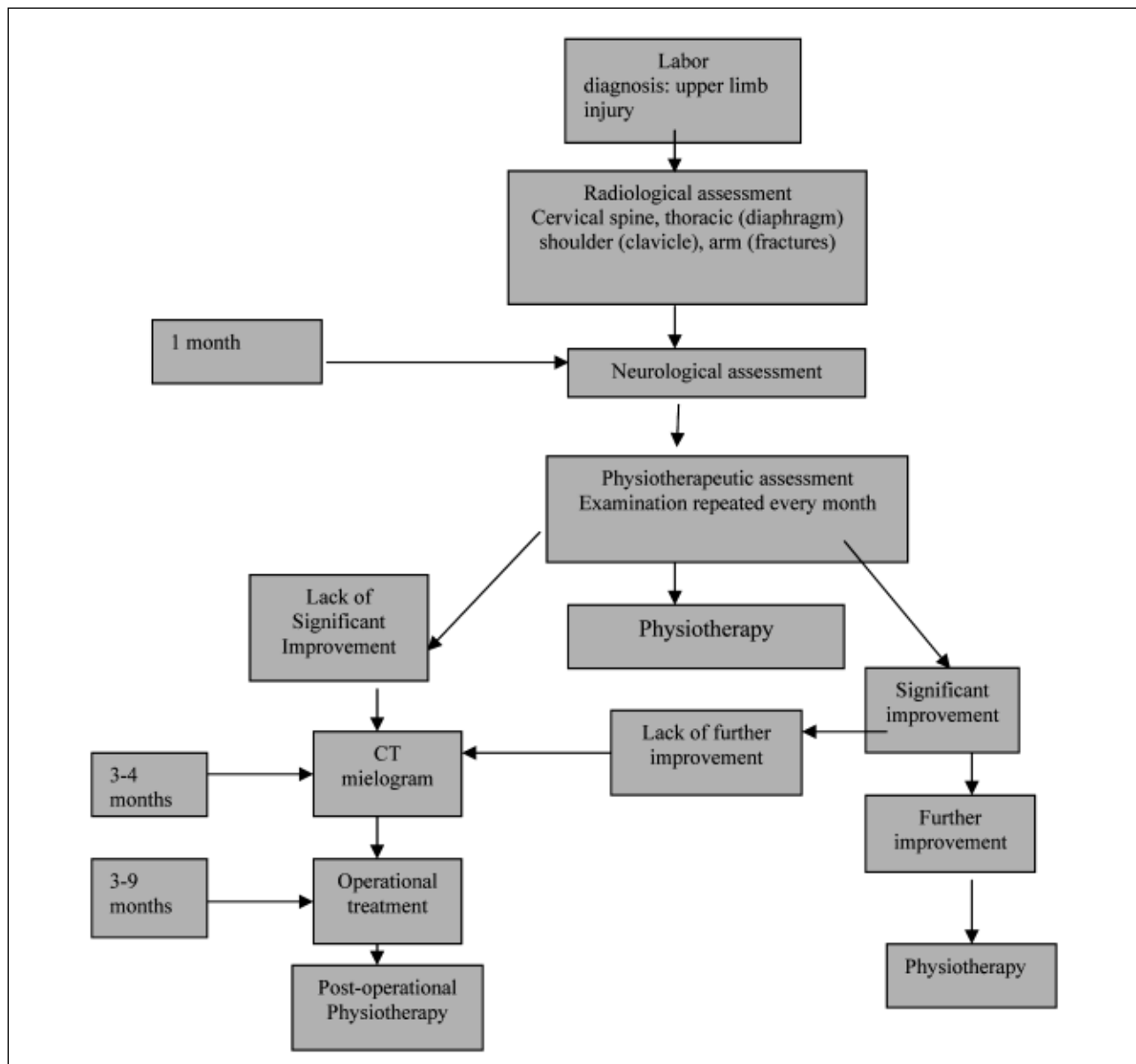


Fig. 1. Local and global effects of right brachial plexus injury by the described child *Skutki lokalne i globalne uszkodzenia prawego splotu ramiennego u opisywanego dziecka*

The boy was born on 6th April 1996 with birth weight 3700 g. Because of the labor erroneousness it came about Duchenne-Erb’s type injury of the upper part of brachial plexus on the right side. Treatment according to binding rules was applied from the first days of boy’s life. In scope of physical therapy positioning treatment, exercises according to V. Vojta then according to B. and K. Bobath were carried out. Physiotherapy was also used in form of selected heat and electrotherapy. As a result of such treatment no significant improvement of upper limb function was attained, because the injury – according to Seddon’s classification – was of axonotmesis and neurotmesis. As the boy grew, he started to use his left upper limb mainly while using the right one as a support to hold up the objects.

Within the right upper limb the following local effects were recognized: hypoplasia of shoulder joint, lack of shoulder blade stabilization, restricted mobility of shoul-

der and elbow joints, the lack of dissociation of shoulder and shoulder blade, slight flexional contracture in elbow joint, hand incapacity to reach to the mouth and to the head. Listed functional disorders were related to the typical layout of paresis mainly concerning flexors, abductors, and external rotators of the shoulder.



Fig. 2. Restriction: a. flexion, and; b. abduction of right arm
Ograniczenie: a. zgięcia i; b. odwiedzenia prawego ramienia

Global effects were also found in form of: asymmetrical head control, compensation trunk movements during right upper limb raising, what pose a high risk of lumbar section hiperlordosis fixation and paresis of hand function related mainly to the lack of shoulder blade stabilization.



Fig. 3. An example of the upper limb function compensation by lordotisation of lumbar section
Przykład kompensacji funkcji kończyny górnej przez lordotyzację odcinka lędźwiowego

Conservative treatment which had been applied did not bring satisfactory results, which induced the physiotherapists and the infant's parents to become interested in operational treatment methods. Children Houston Hospital had been chosen and the video type with an assessment of functional condition of paresis limb based on Mallet's classification was sent.

Combination of the results of pre - and post-operational condition is presented in table II at the end of the study. Based on achieved results Dr. R. N. from Houston Clinic had qualified the patient for surgery. Operation was carried out on March 28th, 2000 in Texas Institute for Rehabilitation and Research. Mod Quad Operation procedure was used including the following actions: 1. Subscapularis muscle release. 2. Axillary nerve decompression and neurolysis. 3. Latissimus dorsi muscle transfer. 4. Teres major muscle transfer. 5. Pectoralis major and minor muscle release. 6. Short head of biceps tendon release.

Described operation is a modification of basic 4-elements formula Mod Quad which contains transfers of: 1. Latissimus dorsi muscle – in order to achieve external rotation. 2. Teres major muscle – in order to achieve shoulder blade stabilization. 3. Subscapularis muscle release in order to eliminate internal rotation of shoulder, and 4. Decompression and neurolysis of axillary's nerve. Depending on individual needs procedure can be modified. It is worth mentioning that the best results are observed by children before 4 years [16].

As a result of carried out surgery the child, shortly after removing of the limb's stabilization scale, acquired the ability of raising upper limb over a head in standing position.

Year later the next video tape had been sent to USA based on which Dr. R. N. had qualified the boy for the second surgery. Operation had been carried out in Houston on June 5th, 2001 and the operating doctor was S. S., who performed transfer pronator teres. An expected result was not achieved. Improvement in scope of forearm's flexion and straightening as well as its pronation and supination was minor



Fig. 4. Results of both operations carried out
Efekty obu przeprowadzonych operacji

Next, the third operation, had been also carried out in Houston, on August 6th 2003 and its main goal was the correction of shoulder blade stabilization. The operating doctor was Dr. R. N. During this operation the following actions were applied: 1. Biceps Tendon Lengthening. 2. Pectoralis major muscle release. 3. Capsulography.



Fig. 5. Functional status of the child in the 1 year after third operation (the child 8 years old) *Stan funkcjonalny dziecka w rok po trzeciej operacji (wiek dziecka – 8 lat)*

The boy went through three surgeries, but the most spectacular effect had occurred after the first one. Achieved effects show that the operations of muscles insertion transfer are of great significance in treatment of obstetric brachial plexus injuries. The boy is currently capable of swimming the basic strokes, playing the piano and volleyball. The improvement is visible both in Mallet’s scale and in daily activities. An assessment of patient’s upper limb according to Mallet’s scale was carried out at Texas Nerve and Paralysis Institute in Houston.

Tab. II. Results in Mallet’s Classification before operations *Wyniki w skali Malleta przed zabiegami operacyjnymi*

Abduction		
II – below 30°	III – 30–90°	IV – over 90
External rotation		
II – 0°	III – below 20°	IV – over 20°
Hand on nape		
II – impossible	III – difficult	IV – easy
Hand on back		
II – impossible	III – S ₁	IV – Th ₁₂
Hand to mouth		
II – Lack of horizontal adduction	III – 50% of adduction	IV – 100% of adduction

Tab. III. Results in Mallet’s Classification after surgery operations *Wyniki w skali Malleta po wykonaniu omawianych operacji*

Abduction		
II – below 30°	III – 30–90°	IV – over 90
External rotation		
II – 0°	III – below 20°	IV – over 20°
Hand on nape		
II – impossible	III – difficult	IV – easy
Hand on back		
II – impossible	III – S ₁	IV – Th ₁₂
Hand to mouth		
II – lack of horizontal adduction	III – 50% of adduction	IV – 100% of adduction

DISCUSSION

The number of surgeries carried out among children with perinatal injury of brachial plexus increase. Opinions about the worth of these surgeries are diversified. Authors from Leuven (Belgium), on the base of analysis of treatment’s outcomes in 418 children – among whom 189 non-invasive treatment was applied and with the rest of children surgery treatment was carried out (104 microsurgery revisions and 121 transfers of muscles and tendons), claim that these operations are necessary on the condition of proper patients’ selection. Authors emphasize that in case of grave brachial plexus injury spontaneous recover should not be expected [23].

Experiences of Canadian authors show that surgery treatment is seriously recommended for patients with complete brachial plexus paralysis and only relatively recommended in patient with isolated upper brachial plexus neurotmesis [24]. 23 works on the subject of treatment of children with perinatal brachial plexus injury had been investigated by authors of one of the articles [25], and the outcomes of non-invasive management and surgery treatment were compared.

Authors have been trying to establish the principles of qualifying patients for surgery treatment. Results of both non-invasive therapy and surgery treatment were presented. Based on analysis of information given by authors of 23 works, evident superiority of non-invasive management and surgery treatment has not been stated. However, positive outcomes presented in many of the analyzed reports encourage surgeries – statistically remarkable improvement of upper limb function in comparison with pre-surgery condition had been obtained.

It is worthy of mentioning that in analyzed publications great diversification, in scope of factors which may influence obtained results, occurs unfortunately: different assessment scales were taken, degree of brachial plexus injury was composite, and both age of operated children and observation period were diversified. Reports from Texas Children's Hospital shows significant functions' improvement in children with injury of upper part of brachial plexus as a result of surgery – in 95% of cases statisti-

cally significant improvement of I level in Mallet's scale has been achieved [3, 26].

Experience and observations of the co-authors of the present article show that in children with upper part of brachial plexus injury, both micro-surgery and (especially) transfer of muscles and tendons cause significant improvement of upper limbs function. In case of lower part of brachial plexus injury these types of surgeries do not cause distinct improvement of the upper limb function currently.

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