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Eleni Anna Bekou
Department of Physiotherapy, Faculty of Health Sciences International Hellenic University - Alexander Campus P.O. Box 141, 57 400 Sindos, Thessaloniki, Greece

Paris Iakovidis
Department of Physiotherapy, Faculty of Health Sciences International Hellenic University - Alexander Campus P.O. Box 141, 57 400 Sindos, Thessaloniki, Greece

Georgios Chasapis
Department of Physiotherapy, Faculty of Health Sciences International Hellenic University - Alexander Campus P.O. Box 141, 57 400 Sindos, Thessaloniki, Greece

Ioannis Kottaras
Department of Physiotherapy, Faculty of Health Sciences International Hellenic University - Alexander Campus P.O. Box 141, 57 400 Sindos, Thessaloniki, Greece

Anastasios Kottaras
Department of Physiotherapy, Faculty of Health Sciences International Hellenic University - Alexander Campus P.O. Box 141, 57 400 Sindos, Thessaloniki, Greece

Dimitrios Lytras
Department of Physiotherapy, Faculty of Health Sciences International Hellenic University - Alexander Campus P.O. Box 141, 57 400 Sindos, Thessaloniki, Greece

Corresponding Author:
Eleni Anna Bekou
Department of Physiotherapy, Faculty of Health Sciences International Hellenic University - Alexander Campus P.O. Box 141, 57 400 Sindos, Thessaloniki, Greece

Comparison of the efficacy of electrotherapy and neuromuscular retraining techniques in restoring function of children with obstetric palsy

Eleni Anna Bekou, Paris Iakovidis, Georgios Chasapis, Ioannis Kottaras, Anastasios Kottaras and Dimitrios Lytras

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Abstract
Background: Obstetric palsy (OP) is defined as the paralysis or paresis of all or part of the upper limb that occurs in the newborn during childbirth. It can be treated surgically and conservatively. Physiotherapy and in particular electrotherapy and neuromuscular retraining techniques help to restore the function of the upper limb. The purpose of this review is to describe and compare recent research data on the efficacy of electrotherapy and neuromuscular retraining techniques in the rehabilitation of infants with OP. The Google Scholar and PubMed databases were searched in English and Greek with the following keywords: obstetric palsy, physiotherapy, electrotherapy, rehabilitation. The review included clinical trials, case studies and systematic reviews. The review included 10 articles: three clinical trials, two case studies, two research articles and three systematic reviews.
Conclusions: Electrotherapy and neuromuscular retraining techniques are equally useful methods for treating OP. Electrotherapy is applied during the acute stage, while the techniques begin in the 2nd week of life with the most common choices being the Vojta and Bobath methods and in older age the Proprioceptive Neuromuscular Facilitation and Constraint-Induced Movement Therapy.

Keywords: Obstetric palsy, physiotherapy, electrotherapy, rehabilitation

Introduction
Obstetric palsy (OP) is a condition of the peripheral nervous system and is defined as paralysis or paresis of all or part of the upper limb, which occurs in the newborn at birth [1]. It is the result of excessive stretching of the brachial plexus during childbirth and is divided into four types: (1) upper brachial plexus palsy (Erb's palsy), (2) lower brachial plexus palsy (Klumpke's paralysis), (3) complete brachial plexus palsy and (4) medial brachial plexus palsy [1, 2]. The main causes that lead to obstetric paralysis are the narrow pelvis of the mother, birth labor in situations where the newborn is overweight (over 4kg), shoulder dystocia, pelvic presentation and mishandling of the obstetrician [3]. The clinical picture of the newborn depends mainly on the level of the injury. The first serious signs appear immediately after childbirth. Erb's palsy is more common - the roots C5 and C6 are affected - thus preventing the movements of the abduction and external rotation of the shoulder, the bending of the elbow and the supination of the forearm [4]. The upper limb hangs to one side in an internal turn and pronation, while loss of finger extension may coexist. If it is Klumpke's paralysis (the lower roots of the brachial plexus are affected), the limb is paralyzed and pale in its entirety. Paralysis of all finger muscles is observed, while there may be vasomotor disorders or a unilateral Horner syndrome [2].
The number of cases of OP ranges from about 0.15 to 3 per 1000 births [5]. In terms of gender impact, it seems to be more common in boys, probably due to their greater weight than that of girls. It is more common in the upper right limb with a rate of 58.2% [3]. Regarding the severity of the injury, epidemiological data indicate that long-term functional disability is observed in 20-30% of cases [6]. Early diagnosis of severe cases of OP facilitates immediate referral to specialized health scientists and therefore better recovery of the patient. Regarding recovery rate, 60% of babies have a significant improvement in the first two months while this percentage increases to 75% by the first four months. After the fourth month, the recovery rate decreases rapidly and the chance of recovery is minimal [3].

OP can be treated surgically and conservatively. Physiotherapy is necessary in conservative treatment, in cooperation of course with other specialties. It has a variety of tools and techniques that have been proven to help treat obstetric paralysis, such as kinesiotherapy, electrotherapy, massages, splints, special neuromuscular rehabilitation techniques such as the Neuro-Developmental Treatment (NDT-Bobath) and the Vojta method. In recent years, a commonly used treatment method is Constraint-Induced Movement Therapy (CIMT), which seems to be particularly effective in restoring motor function and skill [7]. This technique is applied by physiotherapists or occupational therapists and is based on the exclusive use of the affected limb to perform daily activities. A special splint is placed on the healthy limb that prevents any movement.

The aim of this review is to highlight the efficacy of physiotherapy in the functional rehabilitation of the upper limb in children with OP and in particular to compare the usefulness of electrotherapy in relation to neuromuscular retraining techniques in the treatment program.

Literature review

The Google Scholar and PubMed databases were searched in English and Greek with the following keywords: obstetric palsy, physiotherapy, electrotherapy, rehabilitation. The review included clinical trials, case studies, research articles and systematic reviews. Rejection criteria for articles were a publication date before 2010 and physiotherapy programs that did not include either electrotherapy or neuromuscular retraining techniques. The main points of the articles included in this review are presented below.

Lewandowska *et al*. [8] suggest starting Vojta treatment from the 2nd week of life of the infant with OP. They claim that this method aims to stimulate the perception center of the Central Nervous System (CNS), thus activating already stored neuromuscular patterns. It is recommended to start the NDT-Bobath application at 3-4 months of age. This method helps to normalize the tone of the newborn, to restore the range of motion, to the sensory integration and to replace the pathological patterns with normal. Physiotherapists at this stage work hard on the grip and proper weight transfer. During the 11th-18th month the Proprioceptive Neuromuscular Facilitation (PNF) method can be applied, taking advantage of the reflex mechanism. PNF greatly facilitates the learning and automation of movements. It speeds up movement, increases range of motion and helps enhance stability and control.

In another study, Slonka *et al.* [9] studied the effect of a neuromuscular training techniques program in two cases of girls with OP. Both girls (9 and 13 years old) were born normally after a prolonged birth. They were diagnosed with Erb's palsy on the right side. They underwent a three-week physiotherapy rehabilitation program in a special center due to abnormalities in their posture. They were assessed using the Mallet scale in terms of the function of the affected upper limb, while posture was monitored with photographic material. The 9-year-old received physical therapy from five weeks with the Vojta method two times a week, while from the age of two she started NDT-Bobath once a week. At home she rarely received physical therapy from her parents. She was ranked in stage III of the Mallet scale for all range of motion tested. The 13-year-old started a physiotherapy program from the neonatal unit. For the first 3 years of her life, she performed a daily physiotherapy program, first with Vojta and then with NDT-Bobath, but also with exercises at home. There were no significant limitations on movement for abduction and external rotation, while attempting to bring the limb to the head was classified in stage IV of the Mallet scale. The movements limb to the back and limb to the mouth were classified in stage III. The results of the program were important for both girls, but the 13-year-old due to the daily treatment exhibited better functioning in the affected upper limb. The 9-year-old was reluctant to use the affected limb and often helped it with the healthy limb. The researchers concluded that neuromuscular retraining techniques are a key part of treating a child with OP.

Furthermore, Vata *et al.* [10] in their research article report their experience of treating children with OP using the NDT-Bobath and Vojta methods. Their researched involved a total of 30 cases of Erb's palsy. Of these, 15 concerned children 0-3 months, eight children 0-1 years and seven children older than one year. In addition, technical and special splints were used to prevent deformities. Physiotherapists worked to restore both motor and sensory function. They modified their interventions according to the age of the children (0-3 months old used techniques mainly from a supine position, while the older children from a quadruped). Eventually it was observed that the functioning and sensory ability of all 30 children improved; however, the more immediate the referral to the physiotherapist, the higher the recovery rate.

CIMT was used in the clinical trial of Abdel-Kafy, Kamal & Elshemy [11]. The sample included 30 children with OP, who were divided into two equal groups. They were assessed with the Mallet scale for upper limb function and with the Standard Universal Goniometer for the active range of motion of the internal and external rotation of the shoulder before intervention. The control group received a special exercise program to increase abduction and external rotation (gross and fine motor activities, daily movements, games), while the intervention group repeated the same program and in addition underwent CIMT. This method is based on the plasticity of the brain. It activates the affected upper limb, restricting the healthy one with a splint. Thus, all movements are performed by the affected limb. The program was implemented for two hours per day, six days per week and a total of 12 weeks. A follow-up was performed 12 weeks after the intervention. The results showed significant improvement in both groups, with a remarkable superiority of the intervention group in restoring the function and mobility of the affected upper limb (Mallet scale measurements before and after the intervention: abduction from 3.06 ± 0.59 to 4.26 ± 0.45, $p = .001$, external rotation from 2.66 ± 0.48 to 4.06 ± 0.25, $p = .001$, hand to neck from 2.40 ± 0.50 to 3.93 ± 0.59, $p < .001$, hand to spine from 2.40 ± 0.50 to 4.13 ± 0.35, $p < .001$, hand to mouth from 2.73 ± 0.79 to 4.26 ± 0.45, $p < .001$).

The recent single blind randomized study by Eren *et al.* [12] aims to compare the effect of CIMT and conventional physiotherapy on the function of the affected upper limb. The 39 patients who participated were divided into two groups. Patients were assessed at baseline, 1 day, 1 month, and 3 months after the end of the intervention with the Jebsen Taylor Hand Function Test for upper limb function, with the Standard Baseline 12-inch goniometer for active range of motion, with a hand dynamometer, with the Active Movement Scale and the Box and Blocks Test. The control group with 26 patients underwent a conventional

physiotherapy program for one hour each day for 14 consecutive days in total. This program included assisted and active exercises for the shoulder, elbow and wrist joints, 20-minute application of currents and resistance exercises for the respective muscles of the area. The intervention group with 13 patients underwent a program of CIMT for one hour daily for 14 consecutive days. The healthy upper limb was immobilized by orthosis for six hours a day. The results showed that the intervention group improved more in terms of internal shoulder rotation, forearm supination, elbow flexion, grip strength and overall upper limb function ($p < .05$).

Regarding the efficacy of electrotherapy, many articles mention its useful application in the physiotherapy program for children with OP. Canbay Durmaz *et al*. [13] suggest applying electrotherapy before or after surgery. Their case study involved a girl diagnosed with OP on the left side. The range of motion of the shoulder, elbow and wrist joints was assessed before the intervention that preceded the surgery, which was then performed again after the surgery. Electroacupuncture was applied with TENS for 15 minutes at intervals of 1000ms and with a pulse duration of 50ms. The square wave was chosen to ensure that there will be sufficient muscle contraction. Additionally, the same protocol was used postoperatively for analgesia. The physiotherapy program included additional therapy means, which limits the formulation of safe conclusions solely on the efficacy of electrotherapy. However, the program eventually managed to increase the range of motion of the upper limb joints, muscle strength, soft tissue elasticity and especially helped to reduce swelling and improve upper limb function.

On the same topic, Justice *et al*. [14] studied the effect of neuromuscular electrical stimulation in the treatment of OP. Their narrative review included four articles and a total of 11 patients with OP aged 2-4.5 weeks. Data were obtained before and after the intervention regarding the active range of motion, muscle strength and some somatometric characteristics. The results showed that in all patients the active range of motion improved, in some patients the circumference of the arm increased and in one patient the length of the arm increased, while the indications for improvement of the muscular strength are ambivalent. However, an important flaw in their review is the fact that there was a great heterogeneity in terms of measurements of physiotherapy devices (current type, pulse duration, duration of treatment, etc.).

Frade *et al*. [15] conducted a narrative review on the various methods of rehabilitation of OP and came up with 13 relevant articles. Among other conservative treatment means, they make special mention of electrostimulation and CIMT. As for the first, according to the authors it is a widely used method that promotes functional muscle recovery after injury to peripheral nerves, prevents muscle atrophy and accelerates the regeneration of nerve tissue. Electrostimulation and CIMT are used to recover the muscle tone, range of motion and muscle strength of the affected muscles and have significant effects.

Moreover, Nelson & Armenta [16] in their systematic review, in the context of conservative treatment recommend the daily use of electrical stimulation because it has been proven to improve the size and function of the affected muscles, even in the case of a denervated muscle. According to the authors, it is useful to start the electrotherapy program as soon as possible after the injury and apply it more than once a day.

Lastly, Kasnakova *et al*. [17] included in their study 17 children diagnosed with OP, who were randomly allocated into two groups. Participants were evaluated before and after the intervention with electromyography, Active Movement Scale, Mallet Scale and Manual Muscle Test. The intervention group received a complete physiotherapy program. Regarding electrotherapy, the following were applied: infrared radiation on the brachial plexus for 5-20 minutes, iontophoresis for 10-30 minutes (with Navalin), electrostimulation with low frequencies of 0.25-0.5Hz and pulse duration of 50-100ms and ultraviolet radiation. Additionally, the program included kinesiotherapy, massage, paraffin patches, pressure therapy, PNF diagonal patterns and Vojta method application. In 75% of cases the results were very satisfactory after the above program, especially in terms of range of motion in the shoulder joint. The changes were also positive for the condition of the affected muscles. The authors conclude that a combination program is the most appropriate, while physiotherapy at home by parents is imperative [17].

Discussion-Conclusions

The results of this review show that both electrotherapy and neuromuscular retraining techniques are effective methods for treating OP. No article was found in the literature comparing these methods in terms of their efficacy. Based on the included articles, it seems that they are equally important. Their combination, both with each other and with other physiotherapeutic means, leads to better recovery.

It is generally useful for rehabilitation through physiotherapy to begin as soon as possible, even from the neonatal unit, because then the best prognosis is provided [9]. Electrotherapy can be applied from the very early stages to acute conditions and throughout the long-term treatment program. In cases of surgical treatment, it can also be used postoperatively for analgesia [13]. Electrotherapy includes galvanic and faradaic currents, iontophoresis (10-30 minutes) for analgesia, selective muscle electrostimulation to avoid muscle atrophy (mainly with square waves), TENS, ultraviolet and infrared radiation (5-20 minutes) [13, 14, 17].

Neuromuscular retraining techniques are applied after the 2nd week of the life of the infant; initially with the Vojta method, in 3-4 months with NDT-Bobath and in 11-18 months with PNF, which requires the highest level of cooperation [8]. These sessions are usually one hour and daily. It is suggested for parents to be trained in these techniques, so that they are applied at home [9]. CIMT, which is also based on brain neuroplasticity, was applied to older children aged 3-5 years [11]. It should be performed six or seven days a week, while the splint that restricts the healthy limb should remain for several hours a day (e.g. for six hours as indicated by Eren) [12].

More clinical studies are needed for safe conclusions regarding the efficacy of a particular method. This issue requires further investigation.

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