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SHORT COMMUNICATION

USE OF ELECTRICAL STIMULATION IN THE TREATMENT OF HEMIPLEGIC SHOULDER POST-STROKE

ZASTOSOWANIE ELEKTROSTYMULACJI U CHORYCH Z NIEDOWŁADEM BARKU PO UDARZE MÓZGU

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ABSTRACT

Introduction

Stroke is the third most frequent cause of death in adults in high-income countries and the main cause of acquired adult disability. Hemiplegic or hemiparetic shoulder is a term that refers to secondary musculoskeletal complications that often occur after stroke, resulting in glenohumeral subluxation, shoulder stiffness and shoulder pain. Electrical stimulation is one of physical therapy modalities that are commonly used as an addition to conventional rehabilitation treatment of hemiplegic or hemiparetic upper limb after stroke.

Aim

The objective of this paper was to sum up recent clinical studies and reviews on effectiveness of electrical stimulation as an adjunct therapy in the course of rehabilitation treatment of hemiplegic or hemiparetic post-stroke shoulder.

Material and methods

Two most recent meta-analyses of clinical trials that addressed use of electrical stimulation in the treatment of hemiplegic shoulder post-stroke were identified. Clinical trials published in PubMed database between January 2017 and October 2019 were reviewed.

Results

It has been demonstrated that electrical stimulation is a physical therapy modality that can effectively prevent or reduce hemiplegic shoulder subluxation after stroke. The effectiveness of electrical stimulation in the treatment of hemiplegic shoulder pain still remains not clear, although there is a big number of clinical studies that demonstrated pain reduction.

Conclusions

Electrical stimulation should be included in the post-stroke upper limb rehabilitation protocols to prevent or reduce shoulder subluxation. Further, well-designed clinical trials are needed to investigate the role of electrical stimulation in the treatment of hemiplegic shoulder pain.

Keywords: electrical stimulation, ES, NMES, stroke, rehabilitation, hemiplegic shoulder

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STRESZCZENIE

Wstęp

Udar mózgu jest trzecią co do częstości przyczyną zgonów w krajach rozwiniętych i główną przyczyną nabytej niepełnosprawności wśród dorosłych. Niedowład lub porażenie barku jest częstym następstwem udaru mózgu, skutkującym podwichnięciem w stawie ramiennym, bólem barku oraz jego sztywnością. Elektrostymulacja jest jednym z zabiegów fizykalnych powszechnie stosowanym przez wiele ośrodków jako dodatek do leczenia konwencjonalnego w przebiegu rehabilitacji kończyny górnej dotkniętej niedowładem lub porażeniem po udarze mózgu.

Cel

Celem niniejszej pracy jest podsumowanie ostatnich prac badawczych i przeglądowych oceniających skuteczność zabiegu elektrostymulacji jako terapii dodatkowej w przebiegu leczenia rehabilitacyjnego barku dotkniętego niedowładem lub porażeniem nie udarze mózgu.

Materiał i metody

Dokonano analizy dotychczasowych prac dotyczących zastosowania elektrostymulacji w leczeniu rehabilitacyjnym barku niedowładnego po udarze mózgu. Uwzględniono dwie najnowsze metaanalizy oraz dokonano przeglądu najnowszych prac badawczych opublikowanych w bazie PubMed pomiędzy styczniem 2017 a październikiem 2019 roku.

Wyniki

Dotychczas udowodniono, że elektrostymulacja jest zabiegiem medycyny fizykalnej, który może być z powodzeniem stosowany w celu zapobiegania lub redukcji podwichnięcia w stawie ramiennym po udarze mózgu. Skuteczność elektrostymulacji w leczeniu rehabilitacyjnym bólu barku niedowładnego jest nadal niepewna, pomimo dużej liczby doniesień naukowych, które wykazały zmniejszenie bólu po jej zastosowaniu.

Wnioski

Zabieg elektrostymulacji powinien znaleźć się w standardach leczenia rehabilitacyjnego kończyny górnej dotkniętej niedowładem po udarze mózgu w celu zapobiegania lub zmniejszenia podwichnięcia w stawie ramiennym. Aby ocenić skuteczność elektrostymulacji w leczeniu bólu barku niedowładnego po udarze mózgu konieczne są dalsze dobrze zaplanowane, wiarygodne badania kliniczne.

Słowa kluczowe: elektrostymulacja, ES, NMES, udar mózgu, rehabilitacja, niedowład barku

Introduction

Stroke is the third most frequent cause of death in adults in high-income countries and the main cause of acquired adult disability. Parker *et al.* (1986) evaluated that about 40% of people who survive a stroke still have significantly impaired function in their affected arm after 3 months, 40% have mild to moderate impairments and only 20% have entirely normal function. Hemiplegic or hemiparetic shoulder is a term that refers to secondary musculoskeletal complications that often occur after stroke, resulting in glenohumeral subluxation, stiffness and shoulder pain (Fotiadis *et al.*, 2005). Although the connection between glenohumeral subluxation and shoulder pain has not been fully explained, some authors consider glenohumeral subluxation an important source of shoulder pain

(Paci *et al.*, 2005). The incidence of shoulder subluxation ranges in stroke patients, from 17% (Fitzgerald-Finch *et al.*, 1975) to 81% (Najenson *et al.*, 1965). Active physical therapy, also called kinesiotherapy, is the essential part of rehabilitation treatment of post-stroke hemiparetic shoulder. Kinesiotherapy is often supported by passive physical therapy modalities which are often considered to be optional and applied half-heartedly due to few reliable data on their effectiveness. However, some of the passive modalities have developing evidence that supports their use for upper limb recovery after stroke. Electrical stimulation is one of the modalities that can be used in the group of patients above mentioned with various goals: strengthening weak muscles, increasing range of motion, reducing spasticity, improving motor control, reducing shoulder subluxation, reducing pain associated with shoulder subluxation and spasticity, improving sensory and proprioceptive awareness.

Aim

The objective of this paper was to review what do we already know about the application of electrical stimulation in the treatment of hemiplegic shoulder post-stroke basing on available clinical studies and reviews.

Material and methods

Two most recent meta-analyses of clinical trials that addressed use of electrical stimulation in the treatment of hemiplegic shoulder post-stroke were identified. Clinical trials published in PubMed database between January 2017 and October 2019 were reviewed. The following keywords were used in the search: electrical stimulation, NMES (neuromuscular electrical stimulation), ES (electrical stimulation), stroke, hemiplegic shoulder. The selected clinical trials were divided into 3 groups, depending on their research goals.

Results

Effectiveness of use of electrical stimulation in the treatment of hemiplegic shoulder was studied in various aspects by different authors, evaluating e.g. shoulder pain, or upper extremity function, or shoulder subluxation. Lee *et al.* published in 2017 a systematic review with meta-analysis examining the effectiveness of neuromuscular electrical stimulation for the management of shoulder subluxation after stroke including assessment of short (1 hour or less) and long (more than one hour) daily treatment duration. Lee *et al.* included 11 studies that were published in databases from inception to January 2017. Lee *et al.* concluded from their review that neuromuscular electrical stimulation with daily duration under or over one hour reduces shoulder subluxation for persons with acute/subacute stoke. Qiu *et al.* (2019) published a meta-analysis of randomized controlled trials that examined the use of electrical stimulation in the treatment of hemiplegic shoulder pain and included 6 studies that were published up to January 2018. The authors stated that due to low number of available studies definitive conclusion was difficult to be made, however the use of electrical stimulation seemed beneficial over conventional physical therapy alone.

Further research has been done for purpose of this paper in order to obtain the most up-to-date overview. Most recent clinical trials that were published in PubMed between January 2017 and October 2019 were retrieved (88 clinical trials), from which only those were selected that addressed the use of electrical stimulation in the treatment of hemiplegic shoulder post-stroke (5 clinical studies). The selected studies were divided into two groups, depending on the type of assessment they demonstrated: 1. Shoulder pain 2. Shoulder subluxation. Five studies showed beneficial effect of addition of electrical stimulation to conventional physical therapy in terms of reduction of shoulder and/or preventing shoulder subluxation. One study showed that combination of electrical stimulation with conventional treatment is no superior to conventional treatment alone to prevent hemiplegic shoulder pain. Table 1 lists the clinical studies that were selected.

Table 1. List of evaluated clinical studies

No.	Author	Year	Group size	Post-stroke phase	Effect of electrical stimulation
SHOULDER PAIN					
1	Karaahmet *et al.*	2019	21	Acute-subacute	Reduction
2	Zhou *et al.*	2018	90	Acute-subacute	Reduction
3	Wilson *et al.*	2018	28	Chronic	Reduction
4	Hochsprung *et al.*	2017	31	Acute, subacute, chronic	No effect
5	Jeon *et al.*	2017	20	Subacute	Reduction
GLENOHUMERAL SUBLUXATION					
1	Jeon *et al.*	2017	20	Subacute	Reduction

Discussion

Upper limb dysfunction related to hemiparetic or hemiplegic shoulder after stroke is often treated as a problem of minor priority in rehabilitation plans. Most efforts of rehabilitation treatment are usually put on lower limbs dysfunction that would allow ambulation. However, it should be remembered that apart from its obvious function, upper extremity takes an important part in gait pattern and if left without proper rehabilitation management, it may become a source of severe shoulder pain. We should maximize our efforts to better understand and treat hemiplegic shoulder.

Lee *et al.* (2017) in their systematic review, consistent with previous reviews by other authors (Price *et al.* 2001, Ada *et al.* 2002, Van Peppen *et al.* 2004, Vafadar *et al.* 2015), showed that there is a significant reduction in shoulder subluxation when electrical stimulation was added to shoulder management programs in the early phase after stroke – in acute or subacute phase (up to 6 months after stroke). Effective parameters included frequencies of 10–36 pulses per second, pulse duration of 200–250 μs; 3–7 times per week for 4–8 weeks. Chaco *et al.* (1971) demonstrated that glenohumeral subluxation most often occurs in the first 3 weeks after stroke, during the flaccid phase, in particular when the supraspinatus muscle is inactive. The analyses and studies reviewed prove that the sooner is the start of electrical stimulation therapy, the better is the outcome. It may suggest that this method can prevent shoulder subluxation (Linn *et al.*, 1999). Moreover, Lee *et al.* demonstrated that electrical stimulation was not effective for reducing subluxation in the chronic phase after stroke (> 6months). There was only one clinical trial published after the review of Lee *et al.* that showed that electrical stimulation reduces shoulder subluxation when used in the subacute phase, at the same time proving an improvement in upper limb function and reduction in shoulder pain (Jeon *et al.*, 2017).

Evaluating the use of electrical stimulation to control pain in hemiplegic shoulder post-stroke, Qiu *et al.* (2019) concluded in their meta-analysis that due to low number of available studies definitive conclusion was difficult to be made, however the use of electrical stimulation seemed beneficial over conventional physical therapy alone. Qiu *et al.* noticed that all studies included in their meta-analysis had outcome in favour of electrical stimulation, although there were too many differences between studies such as electrical stimulation application method (TENS or PNS), stimulation parameters, patient ethnicity, treatment duration, use of placebo stimulation, and measurement scales. In the review of most recent clinical trials, 4 showed reduction in hemiplegic shoulder pain after the application of electrical stimulation, 1 showed no effect. These findings suggest that there is a need for more well-designed randomized controlled trials examining the long-term effects of electrical stimulation.

Conclusions

It has been shown that electrical stimulation is an effective physical therapy modality that can prevent or reduce hemiplegic shoulder subluxation and it should be included in the post-stroke upper limb rehabilitation protocols, only if started early after stroke.

The effectiveness of electrical stimulation in the treatment of hemiplegic shoulder pain after stroke is still not clear. Further, well-designed clinical trials are needed.

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