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REVIEW ARTICLE

INTRAMUSCULAR DRY NEEDLING – POTENTIAL ADVERSE EVENTS AND COMPLICATIONS – LITERATURE REVIEW

ŚRÓDMIĘŚNIOWA IGŁOTERAPIA SUCHA – POTENCJALNE SKUTKI UBOCZNE I KOMPLIKACJE – PRZEGLĄD LITERATURY

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ABSTRACT
Trigger point (TrP) is defined as a site in the muscle, characterized by severe muscle's tenderness or hypersensitivity causing local and/or referred pain as well as many nonspecific dysfunctions and motor, sensory or autonomic symptoms. A therapy that allows TrP symptoms modulation is the dry needling (DN), also referred to as invasive intramuscular neurostimulation or intramuscular stimulation.

It has been stressed that for the DN therapy to be applied safely and effectively, many conditions must be met such as: (1) proper understanding of the underlying anatomy, which allows to assess the risk of adverse effects, (2) understanding and application of hygiene and antiseptics for invasive procedures, which enables the evaluation of possible side effects or any adverse events while planning the overall therapy for a specific patient.

Dry needling is recognized as effective and safe and it has been integrated into the physical therapy scope of practice in many countries. The most common adverse events such as bleeding, hematoma, pain during and after the procedure are said to be mild and transient. However, advanced knowledge of anatomy and the understanding of potential threats related to dry needling treatment of the areas with increased risk of adverse events have been emphasized due to potential occurrence of nervous structures injuries, pneumothorax, internal organs inflammation or infections if aseptic practices during the procedure are not respected.

Keywords: dry needling, trigger point, adverse event, nerve puncture, pneumothorax

STRESZCZENIE
Punkt spustowy (PS) definiowany jest jako okolica w obrębie mięśnia, charakteryzująca się silną tkliwością lub nadwrażliwością na bodziec mechaniczny oraz wywołująca dolegliwości bólowe lokalne i/lub przeniesione oraz szereg niespecyficznych dysfunkcji i objawów motorycznych, sensorycznych i autonomicznych. Jedną z form terapii, która pozwala na modulację objawów i dolegliwości związanych z PS jest technika igłoterapii suchej (ang. dry needling, DN), określana także jako inwazyjna neurostymulacja śródmięśniowa lub stymulacja śródmięśniowa. Podkreśla się, że w zakresie bezpiecznego, celowego stosowania terapii DN, wymagane jest spełnienie wielu warunków, m.in. 1. dokładna znajomość anatomii pozwalająca na ocenę stopnia ryzyka działań niepożądanych, 2. znajomość i stosowanie zasad higieny

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i aseptyki zabiegowej, a tym samym ocenę ewentualnych efektów lub skutków ubocznych, niepożądanych zdarzeń, podczas planowania całościowej terapii w danym przypadku.

Metoda suchej igły uznawana jest za skuteczną i bezpieczną technikę leczniczą, która w wielu krajach została wpisana w zakres kompetencji fizjoterapeuty. Najczęściej obserwowane skutki uboczne takie jak: krwawienie, krwiak, ból pozabiegowy oraz ból podczas zabiegu uznane się za łagodne i przejściowe. Niemniej jednak, podkreśla się konieczność posiadania pogłębionej wiedzy anatomicznej oraz znajomość ewentualnych zagrożeń związanych z wykonywaniem zabiegu igłoterapii suchej w okolicach o zwiększonym ryzyku wystąpienia efektów niepożądanych, które mogą skutkować uszkodzeniem struktur układu nerwowego, odmą opłucnową, stanem zapalnym narządów wewnętrznych lub zakażeniem przy braku zachowania aseptyki podczas wykonywania zabiegu.

Słowa kluczowe: igłoterapia sucha, punkt spustowy, skutki uboczne, nakłucie nerwu, odma opłucnowa

Introduction

Trigger points (TrPs) are defined as sites of severe muscle tenderness or hypersensitivity causing local and/or referred pain as well as many nonspecific dysfunctions and motor, sensory or autonomic symptoms (Travell *et al.* 1992). A therapy that allows TrP symptoms modulation is dry needling (DN), also referred to as invasive intramuscular neurostimulation or intramuscular stimulation. Dry needling is a minimally invasive adjunctive pain treatment therapy first described by Karel Lewit (Lewit 1979).

At present, one of the most common needling techniques applied worldwide, besides acupuncture, is the one introduced by Travell and Simons and aimed at pain modulation in the myofascial pain syndrome. It should be also mentioned that initially trigger points were injected with lidocaine. Next, the static intramuscular stimulation using an injection needle was applied. Finally, as a result of Hong's research, dry needling was modified to be more dynamic ("fast-in fast-out") with the aim of eliciting local twitch response defined as a spinal reflex typical of trigger points (Hong 1994). This kind of stimulation is said to be applied by over 80% of practitioners using TrPs dry needling (Kearns *et al.* 2019). Over the last couple of years, research proving a real, biological impact of the DN technique has developed dynamically. This method is more and more common all over the world. It has been added to the physical therapy scope of practice (e.g. the USA) (Caramagno 2015) and academic physical therapy curricula (e.g. at Georgia State University since 2006). As a result, there occurred a question as to the safety of its application and possible adverse effects or iatrogenic injuries associated with the intramuscular manipulation using a thin needle (Brady *et al.* 2014; Fernández-de-Las-Peñas *et al.* 2015; Halle *et al.* 2016; Kearns *et al.* 2018). It has to be emphasized that the diameter of used needles ranges from 0.16 to 0.35 mm, which is five times the diameter of a single muscle fibre.

At the same time, it has been stressed that for the DN therapy to be applied safely and effectively, many conditions must be met such as: (1) proper understanding of the underlying anatomy, which allows to assess the risk of adverse effects, (2) understanding and application of hygiene and antiseptics for invasive procedures, which enables the evaluation of possible side effects or any adverse events while planning the overall therapy for a specific patient.

An adverse event is any harmful and unintended response secondary to a procedure and common in people after treating a disease or dysfunction or modifying a physiological function.

An unexpected adverse event is an event whose character and intensity are in contradiction to the state-of-the-art knowledge about the performed procedure. A serious adverse event means any unexpected medical event which in any doses may cause death or threaten life, requires hospitalization or continued hospitalization, and causes permanent or significant disability/inability to work.

A side effect is a medical event, either positive or negative, associated with the procedure but not necessarily caused by it and secondary to the intended effect (Essential Medicines and Health Products Information Portal 2002).

Results

The analysis of the safety of DN application may begin with the analysis of adverse effects described for acupuncture owing to more numerous studies on adverse events after acupuncture treatment. However, it must be stressed that there are significant differences between how both therapies are performed and the acupuncture data should be treated as the evaluation of the potential for adverse events resulting from tissue integrity disruption with a thin needle (MacPherson *et al.* 2001; White *et al.* 2001; Ernst *et al.* 2003; Witt *et al.* 2009; Witt *et al.* 2011).

One of the largest acupuncture studies which evaluated over 230 thousand patients (2.2 million acupuncture treatments) confirmed adverse events in 8.6% of patients. In the majority of cases, they were reported to be mild (e.g. bleeding, hematoma, pain). Also, two cases of pneumothorax were observed (Witt *et al.* 2009). The results obtained by other authors were comparable as far as the incidence of adverse events is concerned. Again, the events were assessed to be mild and included also seizure, anxiety lasting 60 hours, and headache lasting 3 days (White *et al.* 2001; Ernst *et al.* 2013). Worth mentioning is also one study on a big sample that had a very low percentage (0.14%) of observed post-acupuncture adverse events (Yamashita *et al.* 2009).

Lately, it has been argued that for post-DN events that are mild and transient, with no alteration in function, the term 'adverse' should not be used (Carnes *et al.* 2010). In fact, some of the events such as mild bleeding (extravasation), hematoma or pain after the procedure are expected events and the patient's informed consent to their possible occurrence should be obtained. It has been recommended to classify such events as negative side effects. A need for standardized terminology for continued research has been argued. Further research has been claimed to be indispensable for safe DN application and teaching (Carlesso *et al.* 2010). The number of studies evaluating adverse post-DN events is much lower compared to acupuncture studies. One of the most significant studies that was performed on a big sample confirmed adverse events in 19.18% of patients (study group n = 1463), which should be considered very high based on the European Commission classification of adverse events (Brady *et al.* 2014). What is important is that, similarly to acupuncture, all observed adverse events were described as mild and the incidence of serious adverse events was statistically estimated as < 0.04% (Selmi *et al.* 2014). The whole list of adverse events observed after TrP DN and acupuncture with a potential for adverse events when appropriate safety rules are disregarded were presented in Table 1.

Discussion

POTENTIAL ADVERSE EVENTS POST-DN

Peripheral nerves injuries

When it comes to peripheral nerves injuries, the majority of iatrogenic injuries were seen for the sciatic nerve when a hypodermic needle and a dry needle were used in the gluteal region, especially in young patients with low BMI (Villarejo *et al.* 1993). In the case of dry needling, this kind of risk occurs mainly for the gluteus maximus and piriformis TrPs but a proper DN application and determining the sciatic nerve course using the Labat technique decrease the risk of sciatic nerve injury or irritation to the minimum.

Table 1. Potential adverse events after TrP dry needling treatment

Potential adverse events	Cause
Neurovascular puncture	DN of the muscles: lateral pterygoid, tibialis posterior, gluteus maximus, piriformis, iliacus
Pneumothorax	DN of the muscles: scalene, supraspinatus, upper trapezius, thoracic longissimus, thoracic iliocostalis, rhomboid, pectoralis major and minor, serratus anterior, external oblique
Visceral puncture	DN of the muscles: rectus abdominis, quadratus lumborum, psoas
Spinal canal, epidural/subarachnoid, spinal cord or foramen magnum puncture (extremely rare)	DN of the muscles: obliquus capitis inferior,
Cervical epidural hematoma (extremely rare)	DN of the muscles: cervical multifidus
Vasovagal syncope (not given for DN)	Highly possible if DN is performed on the patient the sitting position
Viral hepatitis, HIV and subacute endocarditis, bacterial infections such as staphylococcalsepticaemia etc. (not given for DN)	Insufficient hygiene and aseptic practices

When dry needling the lower iliacus muscle, below the inguinal ligament, some other complications may occur. Even if the procedure is properly applied, the femoral nerve may get injected owing to its anatomy. Below the inguinal ligament, the femoral nerve has numerous end branches and the vascular system in this area is patient-dependent and highly variable, which all together leads to an increased risk of a massive hematoma as a result of artery puncture. Because of that the dry-needling procedure needs to be performed with particular caution even if the practitioner has advanced technical skills.

The next muscles that are potentially problematic and require great anatomic knowledge and advanced technical skills are the suboccipital and lateral pterygoid muscles.

Risk of pneumothorax

When evaluating the potential for pneumothorax as a result of dry needling, it should be remembered that after the intentional penetration during lung biopsy the incidence of pneumothorax is about one-in-five patients (Kim *et al.* 2015). DN was developed taking into account the risk of pleural cavity puncture. Specific needle placement and length are indicated for all 'problematic muscles'. In spite of that, the literature shows some pneumothorax cases after acupuncture or dry needling treatments, which may be explained by patient-dependent anatomy, wrong tissue thickness estimation in very slim patients or medical errors. The following muscles are in the risk group: serratus anterior, rhomboid, supraspinatus, iliocostalis, the upper trapezius and the lower cervical paraspinals (Cummings *et al.* 2014).

In this area, the main principle besides the muscle-specific needling pattern is using ribs in a way that would prevent the needle from changing the direction or depth of penetration. However, it has been reported that despite these good practice rules accidental pleural cavity puncture can happen when the needle slips along the side of a rib (Cummings *et al.* 2014).

In addition to the above-mentioned risk factors of pneumothorax, other conditions must be taken into consideration. Honet *et al.* (Honet *et al.* 1986) state that patients with long necks, who have more vertebrae above the clavicle, must be given special attention. It has been noted that during excessive expiration like with the Valsalva manoeuvre, the lung apex may rise, which should be taken into account while needling.

The scapula is another critical area. Theoretically, it provides a bony backstop for the needle. However, the upper region of the scapula provides the potential for pleural

cavity puncture when needling the supraspinatus muscle. Also, the fully 'safe' infraspinatus muscle is said to be no longer safe when there is a congenital foramen, which is reported to be 2 to 5 mm in size and with the incidence of 0.8 to 5.4% in population (McCutcheon *et al.* 2011). One of the recommendations for the muscles close to the ribcage is for the needling to be as tangent to the ribs as possible, which minimizes the risk of extending the needle into the thoracic cage. Another recommendation is for the needle to be placed perpendicular to the rib, which can minimize the risk of penetrating the ribcage. This kind of method minimizes the risk of pleural cavity penetration as compared to using a rib as a blocking site, the risks of which were presented by Cummings *et al.* (Cummings *et al.* 2014).

Risk of causing inflammation of internal organs
The muscle indicated to be of the highest risk with respect to possible inflammation of internal organs is the quadratus lumborum muscle, which is placed in the vicinity of kidneys. Even with the knowledge of the anatomy of this region, it must be remembered that as far as kidneys are concerned their shape, size and position are often patient-dependent (Schiappacasse *et al.* 2015). That is why the importance of antiseptics is emphasized, as well as the necessity of checking the procedure parameters very carefully regardless of the practitioner's experience.

Possible complications have been stressed such as peritonitis after sigmoid puncture (left side) or descending colon puncture (right side) as a result of intentional needling of the iliacus muscle above the inguinal ligament. For these reasons, it has been recommended to tighten the aseptic procedures by reducing the standardized needling procedure to a single needle penetration in this area.

Vasovagal syncope
Classical vasovagal syncope is a neurocardiogenic syndrome characterized by a loss of consciousness after assuming an erect position due to a drop in blood pressure or reduced heart rhythm (Raj *et al.* 2013). This kind of reaction may be caused by factors stimulating the parasympathetic system such as fear or needling. The symptoms typical of an imminent syncope include: excessive sweating or lightheadedness. Attention has also been drawn to the fact that the sitting position during needling may increase the likelihood of syncope. Lagasse *et al.* confirmed this kind of reaction in 9% of patients examined by means of neurography when in the sitting position, which was claimed to be the most probable factor that led to syncope during the procedure (Lagasse *et al.* 2015). In the case of dry needling, more frequent than a sudden syncope are prodromal symptoms that demand that needling be stopped (Coffi *et al.* 2014). However, if a patient loses consciousness, it is recommended to place the patient on his or her side, loosen the clothes and instruct the patient to breathe calmly. The whole situation should be approached calmly not to make the patient anxious. Medical consultation is recommended only if some additional symptoms occur or if the syncope results in a head injury.

Infection and communicable diseases
Dry needling is an invasive therapy disrupting skin integrity, which functions as a barrier against infection. What it means is that DN exposes skin and the underlying soft tissue to infection by creating a pathway for an infection, and especially for pathogenic microorganisms, between the environment and the patient or between patients (Lewis 1998; Raghavan *et al.* 2004; Sutjita 2005). The risk of infection as a result of soft tissue integrity disruption by means of a thin needle is extremely rare (MacPherson *et al.* 2001; Vincent 2001; White *et al.* 2001).

Viral hepatitis, HIV and subacute endocarditis are among the most serious infectious complications reported for acupuncture (Ernst *et al.* 1997).

Viral hepatitis caused in particular by HBV and to a lesser degree by HCV is a very rare adverse effect of treatment procedures performed

by means of a thin needle (Ernst *et al.* 1997; White *et al.* 2001). Mostly, it results from insufficient hygiene and aseptic practices (Kent *et al.* 1988; Ernst *et al.* 2003; Rempel *et al.* 2016).

Cases of serious bacterial infections such as *staphylococcalsepticaemia* or subacute endocarditis have been reported as a result of acupuncture treatment. Nevertheless, such cases are extremely rare (Pierik 1982; Jefferys *et al.* 1983; Lee *et al.* 1985; Izatt *et al.* 1997; Woo *et al.* 2009). A significant increase in the incidence of infections caused by acupuncture like cutaneous mycobacteriosis has been observed. It has been suggested that mycobacterial infections occur because the fundamental hygiene and disinfection procedures are not applied and the gauze swabs, cotton pads, towels or cold compresses used right after the needle is removed are not sterile (Woo *et al.* 2001; Song *et al.* 2006; Woo *et al.* 2009). When a skin problem occurs, patients usually do not seek medical advice right away because mycobacteriosis symptoms develop slowly and are relatively mild. Owing to the relatively resistant nature of mycobacteria, a long incubation period of the infection and the difficulty in making the diagnosis (Franco-Paredes *et al.* 2018), cutaneous mycobacteriosis caused by the improper application of treatment procedures that disrupt skin integrity may be a greatly underestimated problem.

As a result of treatment procedures using a thin needle, also cases of intra- and periarticular infections (Ishibe *et al.* 2001; Daivajna *et al.* 2004; Tien *et al.* 2008; Woo *et al.* 2009; Tseng *et al.* 2014) as well as intra-articular and prosthetic implant infections have been observed (Laing *et al.* 2002; Nakajima *et al.* 2010). The infections are mainly caused by the disregard for aseptic procedures and insufficient practitioners' knowledge (Zhang *et al.* 2010). Also, the potential for postoperative immunocompromise in patients is overseen.

A low level of risk regarding infections after dry needling does not remove the clinician's responsibility when it comes to taking precautions and preventing infections or communicable diseases, and especially when it comes to using sterile disposable needles and gauze swaps, skin disinfection procedures, treatment room hygiene and aseptic storage of tools, or DN preparation and application.

Extremely rare post-DN complications as presented in the literature

The literature presents a case of cervical epidural hematoma as a complication of dry needling. The patient presented with the hematoma six hours after the DN treatment was applied to the cervical spine area and shoulder girdle muscles. The authors state, however, that the size of the needle and the character of the procedure minimize the likelihood of any significant bleeding and the noted case should be treated as extremely rare (Lee *et al.* 2011). Similar reactions have been confirmed after acupuncture treatment and they are also treated as extremely rare (White 2004).

Conclusions

Despite the possible adverse effects of dry needling described in this paper, the procedure is recognized as effective and safe and it has been integrated into the physical therapy scope of practice in many countries. The most common adverse events are said to be mild and transient. However, advanced knowledge of anatomy and understanding of potential threats related to the needling of the areas with increased risk of adverse events have been emphasized.

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