Acupuncture in Physiotherapy

www.aacp.org.uk

Acupuncture in Physiotherapy is printed twice a year for the membership of AACP. It aims to provide information for members that is correct at the time of going to press. Articles for inclusion should be submitted to the clinical editor at the address below or by email. All articles are reviewed by the clinical editor, and while every effort is made to ensure validity, views given by contributors are not necessarily those of the Association, which thus accepts no responsibility.

Editorial address
Dr Val Hopwood
18 Woodlands Close
Dibden Purlieu
Southampton SO45 4JG
UK

email: val.hopwood@btinternet.com

The Association
The British association for the practice of Western research-based acupuncture in physiotherapy, AACP is a professional network affiliated with the Chartered Society of Physiotherapy. It is a member-led organization, and with around 6000 subscribers, the largest professional body for acupuncture in the UK. We represent our members with lawmakers, the public, the National Health Service and private health insurers. The organization facilitates and evaluates postgraduate education. The development of professional awareness and clinical skills in acupuncture are founded on research-based evidence and the audit of clinical outcomes.

AACP Ltd
Sefton House, Adam Court, Newark Road,
Peterborough PE1 5PP, UK

Tel: 01733 390007

Printed in the UK by Henry Ling Ltd
at the Dorset Press, Dorchester DT1 1HD

Contents
Autumn 2018

Acupuncture in Physiotherapy

www.aacp.org.uk

Editorial

Welcome to the Autumn 2018 edition of *Acupuncture in Physiotherapy*. After our long hot summer, now it's time to concentrate on the interesting cases and current research in our chosen field. As usual we have a varied selection. In this issue we have included three papers previously published in other journals. On the research front we offer Chen *et al.* ("Types of control in acupuncture clinical trials might affect the conclusion of the trials: a review of acupuncture on pain management") (pp. 45–53), a really good look at some of the problems and also some of the solutions.

In the same vein we have offered Chae *et al.* ("How placebo needles differ from placebo pills?") (pp. 55–66), which originates in the field of psychiatry and provides an overview of the characteristics of placebo needles and how they differ from placebo pills in two aspects: (1) physiological response and (2) blinding efficacy. The authors discuss alternative control strategies for the placebo effects in acupuncture therapy.

Amos Ziv has allowed republication of his article "Practical applications of meridian theory in pain management – the meridian wave approach" (pp. 35–43), which previously featured in the *Journal of Chinese Medicine* (October 2017).

We also have an opinion piece on electro-acupuncture by Lynn Pearce (pp. 105–107) and an excellently comprehensive introduction to dry needling from Dr Thomas Perreault (pp. 17–26).

As usual, our members have provided an absorbing collection of case studies:

- André Manso on trochanteric bursitis
- Justin Walsh on epicondylalgia
- Suzanne Cronin on whiplash associated disorder
- Daniel Atkinson on hip arthroscopic surgery
- Diana Giura on low back pain.

Additionally, we also have some short summaries (compiled by Robert Millett) of the contributions from the speakers at the May conference, including John Cross, Lynn Pearce, Thomas Perreault, Johnny Wilson and Cheryl Mason.

Finally, you'll find a selection of book reviews, an equipment review and some exciting news regarding Helene Langevin.

Dr Val Hopwood FCSP, FAACP
Clinical Editor, Acupuncture in Physiotherapy

Chairman's report

Welcome to the latest edition of the Acupuncture Association of Chartered Physiotherapists (AACP) journal *Acupuncture in Physiotherapy*, in autumn 2018. Even through the long hot summer, the team at the AACP office has been working diligently to ensure the latter half of 2018 is as productive as the former was. Following on from the success of the AACP's annual conference held on 19 May in Reading, we had two other key dates for the AACP diary in the autumn: 13 October for the AACP's conference in Leeds, and 3 November for the AACP's Scotland study day in Edinburgh. These are part of the continuing efforts of the AACP to reach members across the country and to improve access to ever expanding knowledge in research and approaches in clinical practice.

Notable speakers in Leeds included Dr Giovanna Franconi, Dr Daniel Keown and Dr Amali Lokugamage. Dr Giovanna Franconi is assistant professor of Internal Medicine at Tor Vergata University in Rome, and a member of the editorial board of the *European Journal of Integrative Medicine*. Dr Franconi presented the intriguing topic of "Traditional Chinese Medicine (TCM) and Acupuncture in the Omics Era." Making a welcome return to the AACP conference stage was Dr Daniel Keown, author of the critically acclaimed book *What God Forgot To Tell Surgeons*. Following in the theme of this popular treatise, Dr Keown informed those in attendance why "Qi Exists!" Also presenting was internationally renowned consultant obstetrician and gynaecologist, and fellow of the Royal College of Obstetricians and Gynaecology, Dr Amali Lokugamage. Dr Lokugamage has been lauded for her work in promoting respectful care, dignity and autonomy in maternity services as well as lecturing on the origins of compassionate behaviour and social cohesion. Dr Lokugamage is a member of the board of directors of the UN-recognized International Motherbaby Childbirth Organization and sits on the advisory board of Human Rights in Childbirth, as well as being on the editorial board for the *International Journal of Childbirth*. Dr Lokugamage presented an insightful talk exploring "Why Women Seek Acupuncture and Complementary Medicine for Women's Health." Another speaker of note was Chris Nortley. Chris brings 30 years of experience to the AACP stage, first as a clinical specialist nurse in psychiatry, and then as an acupuncturist treating inpatients and outpatients with a range of mental health and general medical conditions in the National Health Service (NHS). A clinician of considerable standing, Chris was presented with an award by HRH The Prince of Wales for his work in integrating acupuncture into the NHS in 2003; in 2004 he was featured in the *Independent on Sunday* as one of the ten leading acupuncturists in the UK, and in 2011 he received an 'Acupuncture Hero' award from the British Acupuncture Council. Chris presented "an Introduction to Traditional Chinese Medicine." Other speakers included the ever popular Andy Harrop presenting the relationship of "the Adrenal Glands in Diagnosis and Treatment," and AACP Fellow, David Mayor, who was "Exploring Amplitude in Transcutaneous Electroacupuncture Stimulation (TEAS)."

The Scotland study day in Edinburgh welcomed four practicing clinicians to the stage to share their wealth of knowledge and clinical experience which informed their approaches to a variety of clinical scenarios. Subjects vary from "Acupuncture, Pain and the Emotional Mind" presented by John Wood, to "Acupuncture Within Sport" with Johnny Wilson, to "Acupuncture in Neurology" with Caroline McGuire. The day opened with Lynne Pearce's insightful reflections on "Fascial Connections" and their relationship and influence within acupuncture. Further information on the Leeds and Edinburgh events can be found on the AACP website.

This summer saw the appointment of a new AACP clinical advisor in the person of

longstanding AACP tutor and acupuncture BSc lecturer, Paul Battersby. Paul has taken up the reins and has relished the new challenge of dealing with members' enquiries in addition to reviewing research and supporting the development of a variety of AACP projects and member benefits. For support with your clinical queries please contact Paul directly at paulb@aacp.uk.com.

Following a recent update in IT services, the AACP has also opened up the archives and now the last ten years of the journal of the AACP is searchable online for members. Log in as an AACP member and search *Acupuncture in Physiotherapy* with a keyword, subject or author name. The system is updated every six months and forms a great research aid and another useful AACP member benefit.

There is also now more continuing professional development (CPD) available than ever this year with one- and two-day courses covering a variety of topics, from brushing up on basic skills to advanced needling techniques and concepts. Included within the CPD portfolio this year is the addition of another "Anatomy for Acupuncture" day. Now in its third year, this CPD event gives members the opportunity to work with Luke Welsh, Anatomy Teaching Fellow at Keele School of Medicine, and use state-of-the-art technology and cadavers to explore in intimate detail the human anatomy beneath the acupuncture points. From 2018 there will now be two events per year, one in May and one in November. This course is unique for the UK and has already attracted attendees from across the world who have an interest in expanding their knowledge of anatomy related to clinical application of acupuncture. If you are interested in attending any of the courses listed on the AACP website, or even hosting one and obtaining free places, then please contact course administrator Claire Buckingham at claire@aacp.uk.com.

The AACP's public relations and marketing officer Jennifer Clarkson (jennifer@aacp.uk.com) has been busy this year across a number of media platforms promoting the skills and experience of AACP members to the general public. Recent statistics show that over 9 million media contacts have been made in the last 12 months with potential patients of AACP members via a variety of print and electronic publications. Feel free to contact Jennifer directly to discuss promotional and media queries further.

This summer, the AACP team has also been working on the development of a significant new member benefit that is set for launch soon. Watch out for updates in the monthly e-newsletter on this great new resource free to AACP members.

Thank you as ever for your ongoing support for the AACP. Thanks to you, the AACP is approaching another milestone anniversary, with 2019 seeing its 35th year! Thirty-four years on, and the AACP administrative and management team continues to work hard to support members and deliver the best member experience possible. If, however, you feel there are issues the AACP need to be addressing or you have any ideas on how you would like to see the AACP develop or improve, particularly as we reach another landmark together, then please feel free to get in touch with the office or me directly (chair@aacp.uk.com). As ever, I look forward to catching up with you in person at an AACP event somewhere soon.

Jonathan Hobbs
AACP Chairman

Chief Executive Officer's report

Musings on membership mutuality

As we approach the AACP's 35th anniversary year in 2019, I would like to thank all AACP members, past and present, for their support of the Association through all those years. This has made us and kept us by far the longest established and largest organization representing acupuncture in the UK.

At the AACP's inaugural meeting in the autumn of 1984, its very first chairman, Mr Neville Greaves, couldn't have imagined that someday the AACP would represent around 6000 acupuncture-physiotherapists.

Thirty-five years after its conception, as a mature organization, the AACP is going strong in representing your interests and promoting your acupuncture services to the British public at large. In turn, we wouldn't be able to do this without the continued support of you, our members. For many years now you have helped us to be the largest acupuncture association in the country, and our size and clout is important in offering you the best possible support. This mutuality, this circularity of support, is the basis of our success: yours and AACP's.

This mutuality expresses itself also in our organizational structure. As a company limited by guarantee, we are owned by and operate only for the benefit of our members. The AACP is run by a board of directors elected by the membership at the annual general meeting. And a clear majority of board members are drawn from the membership. All income generated by the organization is spent for the benefit of AACP members now or in future years.

How much you are able to influence the AACP and what we do depends very much on your involvement with the organization. AACP committees regularly have a vacancy that needs to be filled. It isn't necessary to wait for that, though; we are always open to ideas from members and sometimes a simple email may be sufficient to influence direction. Just let me know via ceo@aacp.uk.com if there is anything you would like to share or discuss. It might be that one idea that makes the difference!

We may be 35 soon, but we will never stop innovating. In the coming few months we will be able to present some new technological developments that will be available to AACP members only. These new developments to support you in your application of acupuncture in physiotherapy are in turn only possible through your continued membership of, and support for, your AACP.

The continuation of this synergetic mutuality for another 35 years will strengthen the foundations of the AACP, ensuring that we are able to improve and enhance the support for our members for many years to come.

Caspar van Dongen
Chief Executive Officer

AACP Annual Conference, 19 May 2018

Introduction

This year's annual conference took place at the Hilton Hotel in Reading, where delegates were presented as usual with a wide range of informative and thought provoking material to develop their professional understanding and incorporate into their daily practice.

Summaries of the majority of these presentations follow below, while Chris Boynes' personal and clinical perspectives on the interaction and outcomes of Deep Oscillation® Therapy with acupuncture can be found in his article on pp. 27–34 in this issue of *Acupuncture in Physiotherapy*.

Acupuncture in women's health

Cheryl Mason

A key question for delegates at the conference was whether acupuncture could provide relief from pelvic girdle and low back pain in pregnancy. It was posed by Cheryl Mason, an acupuncturist with a private clinic in Leeds who has experience of working in NHS nursing, midwifery and pain management teams. In her presentation, she outlined research findings which indicate that acupuncture can provide relief to pregnant women with these types of pain.

"A 2006 study (Van de Pol *et al.*) showed that acupuncture did appear to reduce low back pain and pelvic girdle pain during pregnancy, increasing people's capacity to exercise and carry out daily activities," she said. "Another study in 2009 (Wang *et al.*), using one week of continuous auricular acupuncture on the ears, showed a significant reduction in pain compared to sham acupuncture control groups." She also cited the findings of a 2016 feasibility study and pilot randomized controlled trial which evaluated acupuncture and standard care for pregnant women with back pain. It was led by Chartered Society of Physiotherapy member Nadine Foster from Keele University. The study compared three groups of pregnant women with back pain. One group received standard care that included two to four sessions of one-to-one physiotherapy and a self-management booklet. The second group received standard care, plus six to eight sessions of acupuncture. The third group received standard care, plus non-penetrating sham acupuncture.

"At the eight-week follow-up they found that 74% of participants favoured the addition of acupuncture," said Ms Mason. She told delegates there were three possible ways acupuncture may ease pain: via a mechanical local action, a neurological action or a hormonal one. "The needles create a local trauma response – a flood of antihistamines, a mast cell response. And they have an influence on the muscle spindle, which is great if you are treating pelvic girdle pain, because you can treat local points and get results with the muscles, tissues and fascia. We also know acupuncture produces a neurological effect. For instance, there is the work of Hugh McPherson, who featured on the BBC's 'Trust Me I'm a Doctor' in October 2014, using MRI scanners to show that pain modification centres in the brain light up during acupuncture. A lot of scientific research shows it's not placebo. There are real effects produced by the needles."

Delegates also heard that acupuncture could also have an effect on hormones, so it was important not to needle contraindicated points when treating pregnant women. "We know acupuncture can stimulate serotonin and oxytocin production, as well as other neurotransmitters," said Ms Mason. "In pregnancy the nervous system and endocrine system are quite delicate and predisposed for labour. If we are stimulating oxytocin production by inserting needles into certain points we could theoretically stimulate labour. We need to be aware which points are safe to use." She referred to a Cochrane Database review into acupuncture or

acupressure for induction of labour, published in October 2017. The review highlighted that acupuncture showed some benefit in improving cervical maturity, making it more favourable for labour. Therefore, using the wrong points could potentially result in this effect.

Ms Mason said there had been more than 8000 randomized controlled trials into acupuncture in the last eight years. "But there is still some confusion over its effectiveness, so we need more quality research," she said. "What we do know, however, is that acupuncture has a good safety profile and is especially relevant for pregnancy and the treatment of pelvic girdle pain and other pregnancy-related conditions." She added that, if attendees were planning a treatment protocol for women with pregnancy-related pelvic girdle and low back pain, research by Matthew Bauer (2016) indicated that 16 or more treatments of acupuncture lead to the greatest success rates.

Robert Millett

Acupuncture-physiotherapy in sports

Johnny Wilson

Professional football players often experience low back pain which can be challenging and complex to treat, but acupuncture can help as part of a multimodal approach.

This was the message at the conference from Johnny Wilson, clinical director of Athlete Rebuild and former head physiotherapist for professional football clubs Notts County, Scunthorpe and Chesterfield. He shared his experience of how acupuncture could improve the outcomes of injuries in professional sport. Mr Wilson said: "In professional football we deal, on a day-to-day basis, with what are commonly known as 'the big four', because they carry quite a high burden of injury. They are hamstring, ankle, knee and groin injuries. But what is less well known is the prevalence of low back pain, which is what I spend the majority of my time dealing with. Players come to the clinic and have a lot of mobilization and manual therapy on their lumbar spines. It's generally self-limiting, but I've had two players over the last nine years whose careers have ended due to low back pain."

Mr Wilson, who has worked in professional sport for 17 years, said the high incidence of low back pain was down to the extreme physical demands of the sport. He explained that professional footballers usually played in at least 60 games and 160 training sessions over a 10-month season. In addition, while sprinting, players can reach top speeds of 32.8 km per hour and often cover in excess of 10 km per game. "Because of these demands we incorporate as many strategies as we can to keep the guys on the pitch."

He also told delegates that low back pain often presented a "conundrum" because there was a lack of consensus about how to provide the best care. This had led to what he described as a "management vacuum". However, he said several research groups have suggested that longstanding low back pain can be generated and maintained at the local tissues (the site of pain), as well as in the corresponding spinal segment and at a cortical level. As a result, he regularly offers acupuncture to athletes who complain of low back pain, as research has conclusively shown it can inhibit the sensation of pain locally, segmentally and cortically.

Mr Wilson said he advocated integrating acupuncture into a multimodal sports medicine approach and provided details of a case study of how this had worked with a young professional footballer. The player had complained of an intermittent dull ache at rest. This rose to a high pain level (8 out of 10) whenever he ran or engaged in extension-based exercises in the gym. He also experienced stiffness, discomfort in sustained postures and could only maintain a neutral pelvic tilt in any position. Adding to this, he had high anxiety levels as the pain was preventing him from playing or training at full intensity. He feared he might lose his place on the team. No red flags were identified and nothing remarkable was found on examination. In addition, an MRI scan showed no structural abnormalities. 'So we hypothesized that it must be neurophysiological and tested him using Peter O'Sullivan's movement and functional

impairment system for assessing low back pain," Mr Wilson said. "We did a lot of education with him, which was important, and his anxiety settled down. We talked about pain and tissue damage and possible neurophysiological drivers, which he thought were plausible. After that, he was keen to try acupuncture, which he'd never had before."

A multimodal approach was implemented, which included eight 20-min sessions of acupuncture and the outcomes were "very good . . . The sports medicine department was happy to advocate acupuncture as part of his programme because it kept him in training and helped to increase his levels of participation in terms of intensity of running and gym training," said Mr Wilson. "He also did other things as well, such as practising mindfulness. But post-acupuncture, he told us something had changed for him. He felt looser and we could all see a difference in him."

Delegates heard that it was common for athletes to report reduced pain levels, improved lumbar range and improved function on posterior chain strength tests after acupuncture. Mr Wilson uses it in conjunction with an extensive running, strength, power, neuromuscular control and lumbo-pelvic-hip complex stability and education programme. "I also offer it as an option to players to help modulate pain levels, help them carry out their rehab and return to training and competing in a timely and safe manner."

Robert Millett

Acupressure for neurological conditions

John R. Cross

Acupressure is not a diluted version of acupuncture, as some people mistakenly believe, and has the advantage of providing non-invasive treatment. This was one of the messages from Chartered Society of Physiotherapists Fellow John Cross. Mr Cross, a retired physiotherapist who has used acupressure for almost 40 years, was the first chartered physiotherapist to become a registered acupuncturist.

During his presentation, which focused on the use of clinical acupressure for neurological conditions, Mr Cross said: "Why do we use acupressure? Because it's non-invasive, which is great for patients and also, sometimes, for practitioners – because not all of us like needles. Also, I found that acupressure allows you to have a greater rapport and oneness with your client, because you receive constant feedback and confirmation about how treatment is progressing. Patients tend to relax more easily and it allows you to teach self-help procedures, which you can show them after a session and which they can use between treatments."

Mr Cross said there were many types of acupressure, and shared his theory that acupressure and reflexology are synonymous, citing examples of their similarity. "Every acupressure-point on the body is a reflex of something. A reflex is a reflected point or pathway, and every reflex point can be touched, massaged or needled. And there is a misconception that reflexology is just concerned with the feet and hands. Reflex points and areas are all over the body, not just on the feet and hands."

He described how therapists could use acupressure and reflexology to ease symptoms associated with neurological conditions, including stress, thermal imbalance, flaccidity, spasms, fatigue, incoordination and pain.

With the aid of pictures, he showed delegates relevant acupressure points and described their therapeutic uses. Mr Cross also highlighted how the spine, brain, cranial nerves and autonomic nervous system are thought, by some cultures and branches of traditional medicine, to be 'reflected' on other regions of the body.

Robert Millett

Temporomandibular disorders

Dr Thomas Perreault

Dr Thomas Perreault, clinical specialist physical therapist from the US, presented "Dry Needling for Myofascial Temporomandibular Disorders: Case Study and Review of the Literature."

Dr Perreault opened by defining temporomandibular disorder (TMD) as pathologies

of the temporomandibular joint, masticatory muscles, and related anatomical structures. Presenting a review of the current literature, he stated that myofascial TMD is prevalent in patients with orofacial pain and is strongly linked to central sensitization. He proposed that trigger point dry needling and acupuncture are widely accepted therapies used in the treatment of myofascial pain syndromes (MPS) which include myofascial TMD. He outlined several studies that showed that needling to trigger points of the temporalis, masseter, and lateral pterygoid can help to alleviate TMD pain and improve function.

Based on these opening statements, Dr Perreault went on to present a case study of a 13-year-old female with intermittent left-sided jaw and facial pain that had been ongoing for two months. The outcome of her case demonstrated the positive benefits of needling to trigger points within the masticatory muscles with subacute myofascial TMD. The needling techniques chosen included direct needling of the masseter and lateral pterygoid. Dr Perreault supported the outlined needling protocols with direct evidence from the literature that confirmed the positive effects of accurate and direct needling into the involved masticatory muscles. Discussing other interventions for TMD, he proposed that needling was selected as the primary intervention as literature reviews now conclude the lateral pterygoids are inaccessible to intraoral palpation, thus rendering manual therapy to this muscle ineffective. Describing the specifics of needling technique, he discussed empirical evidence that suggests that eliciting a local twitch response (LTR) during needling is essential. He then, however, highlighted a recent review of more up-to-date studies showing that eliciting a LTR does not necessarily correlate with positive changes in pain and disability but is linked to increased pain and inflammation. He went on to state that restoration of normal mandibular movement, function, and rapid relief of pain was observed at the conclusion of treatment. Treatment consisted of four sessions using manual needle winding to trigger points without inducing a LTR, as this approach was well supported in the literature.

In summary, Dr Perreault's presentation gave an insight into the clinical application of needling for TMD supported by relevant published literature. With reference to an example case study, he discussed the practical application of needling regarding angle of insertion, depth of needling, safety aspects and the accurate and effective location of target structures. Overall, he drew together the integral aspects of evidence-based practice; namely the integration of individual clinical expertise and experience blended with the best available published evidence, whilst considering patient preference to obtain a positive outcome. His style of presentation was fluid, engaging and informative throughout and raised several interesting clinically-related questions which he answered directly following his session.

Jonathan Hobbs
AACP Chairman

It's all in the anatomy – the merging worlds of fascia and meridian theory

Lynn Pearce

Lynn Pearce has been working with her acupuncture and physiotherapy skills and slowly moving towards a place of integration of the reality of anatomy which is our baseline as physiotherapists and the sometimes more esoteric concepts of meridians. She freely admitted that this talk was still a work in progress as there are so many avenues to try and pull together, but hoped there might be some new ideas and ways of looking at the body as a whole.

Starting with the anatomy, Ms Pearce outlined where we are with the study of fascia and the development of new ideas on its functional and sensory role, making it more than just a mechanical tissue. The 'new organ' – the interstitium, as suggested by Neil Thiese – adds another dimension to fascial anatomy that deserves enquiry. Challenging where people actually place their needles, the idea was to think about how techniques within superficial fascia can seem to have a widespread effect by relating that back to the nature of fascia itself.

Ms Pearce pointed to The Fascia Research Society – a group including Helene Langevin, Robert Schliep, Tom Myers, Siegfried Mense and many more – which is pushing the boundaries as to our understanding of the most interesting tissue of the day. Dan Keown, author of the book *The Spark in the Machine*, also outlines a fascinating view of the spaces within fascia as meridians and the concept that surgeons use these spaces to get round the body, not realising they may be using the meridian network.

Through works by Leonardo da Vinci, whose anatomical studies show us clearly the 'valleys and grooves' of the body/meridians, as explained in the *Huangdi Neijing*, Ms Pearce explored the placement of needles, and what you feel for as therapists, in longitudinal planes as opposed to transverse. She highlighted how Langevin's work shows that tissue displacement along fascial planes is more effective if a needle is placed in a 'groove' – i.e. within the inter-muscular tissue as opposed to intra-muscular tissue. This may also account for the bidirectional report of sensation some people get when having acupuncture. The effect of stress on the sympathetic system is well known, and Ms Pearce drew attention to Mense's work which shows a proportionally high number of free nerve endings within superficial fascia which are responsive to changes in the autonomic nervous system (ANS). This could provide some explanation as to how emotional stress can cause an increase in nociceptive pain and far flung signs and symptoms.

Looking at the combined pictures of main meridians, musculoskeletal meridians, trigger points and their referral, or Tom Myers' anatomy trains, Ms Pearce showed that if we pick key acupuncture points based on anatomical intersections, those points will readily transpose from one system to another, occurring in the same place and yet having different effects dependent on the therapist's belief systems. Regardless of those belief systems, the placement of an acupuncture needle will have far reaching effects, partly described by the role and structure of the fascial network that we needle into. Whether Qi, or current, or fluid, or all of them, flow through that target region, that is the mental struggle of definition that we face as scientific therapists who also play with energy in its raw form. We all like to have an answer, but sometimes there isn't just the one answer, and merging worlds just explain things in different ways.

Robert Millett

Acupuncture in Physiotherapy, Volume 30, Number 2, Autumn 2018, 17–26

LITERATURE REVIEW

Mechanisms and dose parameters of electric needle stimulation: clinical considerations – Part I

T. Perreault
Northern New England Spine Center, Department of Physical Therapy, Wentworth-Douglass Hospital, Dover, New Hampshire, USA

S. O. Flannagan
Founder One Accord Physical Therapy, Phoenix, Arizona, USA

M. T. Grubb
The University of Tennessee, Chattanooga, Tennessee, USA

R. Grubb
The University of Tennessee, Chattanooga, Tennessee, USA

Abstract

Recent studies support that electric needle stimulation (ENS) provides superior analgesic effects compared to manual needle stimulation alone, making it preferable for the clinical management of chronic pain. An electronic database search was performed with the aim of completing a narrative review of the literature to explore the neuronal mechanisms triggered by ENS from a clinical standpoint. The majority of studies on ENS mechanisms support the use of strong, noxious needle stimuli for greater pain inhibition at the spinal and supraspinal levels. Multiple studies support that noxious ENS enhances spinal serotonin (5-HT) and noradrenaline (NA) levels by activating supraspinal neurons that project down to the level of the spine, and that both NA and 5-HT have an overall effect of creating anti-nociception. Further, arginine vasopressin (AVP) is released due to noxious ENS leading to amplified effects of the descending pain inhibitory systems. Various studies supported the use of lower frequency ENS for inducing a potent anti-nociceptive effect in the periphery by enhancing anandamide levels, increasing the availability of its target receptor, and up-regulating the endogenous opioid system in the periphery. Additionally, longer durations of electric stimulation (between 15 to 30 min) resulted in longer lasting analgesic effects and increased pressure pain thresholds in human subjects. A multitude of analgesic mechanisms are triggered with electric needle stimulation; however intensity of stimulation, needle placement within the segmental distribution of pain and duration of ENS seem to be the most important dose parameters for greater anti-nociceptive effects.

Keywords: acupuncture, analgesia, needle, pain, stimulation.

Correspondence: Thomas Perreault, Physical Therapy Department, Wentworth-Douglass Hospital, 789 Central Avenue, Dover, New Hampshire 03820, USA (email: thomas.perreault@wdhospital.com).

Introduction

Dry needling and acupuncture are routinely administered treatments for the management of chronic pain conditions (Zhou *et al.* 2015).

Both procedures use needle stimulation to trigger endogenous mechanisms that are advantageous for altering sensory perception (Baeumler *et al.* 2014) and decreasing pain in neuromusculoskeletal (NMSK) disorders (Yuan *et al.* 2016). According to a recent review, the analgesic effects following a course of needling treatments in patients with chronic pain have been reported to last for up to a 1-year period (MacPherson *et al.* 2017). Fundamentally, manual stimulation occurs when needles are inserted into the body and positioned to the desired depth; however, manipulation of the indwelling needle is required for the activation of local (Yin *et al.* 2018), spinal (Kagitani *et al.* 2010, Huang *et al.* 2018) and supraspinal (Niddam *et al.* 2007) analgesic effects. It is currently unknown what an optimal needling dosage is for any musculoskeletal condition, however, strength of needle manipulation (Choi *et al.* 2013), increasing the number of needles used (MacPherson *et al.* 2013) and administering repeated needling sessions (Vickers *et al.* 2018) are dosage parameters that have been shown to enhance clinical outcomes. Clinically, electrical stimulation of needles is added to enhance or even replace the therapeutic effects of manual needling due to the elicitation of unique biological effects (Langevin *et al.* 2015). Recent studies support that electric needle stimulation (ENS) provides a greater analgesic effect making it preferable to manual stimulation alone (Manheimer *et al.* 2010; Baeumler *et al.* 2015), and that repeated application of strong ENS can be safely used with other therapies for both reducing pain and opioid medication usage (Zheng *et al.* 2018). The aim of this narrative review is to explore the neuronal mechanisms triggered by ENS from a clinical perspective. More specifically, this review will summarize relevant literature focusing on dosage and stimulation parameters of ENS that best contribute to analgesic effects in patients with painful NMSK conditions.

Materials and methods

Literature research

Literature for this narrative review was sought that investigated mechanisms and/or dosage parameters of electric needle stimulation for anti-nociception. With the intent of performing a narrative review, included articles were not limited to randomized controlled trials, systematic reviews or meta-analyses, nor were they limited to studies only on human subjects. An electronic database search of PubMed, MEDLINE, Science Direct and Google Scholar was performed using the following terms: dry needling, acupuncture, electroacupuncture, electric AND needle stimulation, dry needling AND segmental, acupuncture AND segmental, acupuncture AND analgesia. No restrictions were placed on date of article publication and only articles written in English were reviewed. Additionally, the reference lists of included studies were also hand searched to identify any articles relevant to the selected topic. Irrelevant articles were discarded.

Discussion

ENS effects are intensity dependent

The neural pain inhibitory mechanism that is activated via ENS is dependent on the intensity of stimulation. Whether the intensity parameter is noxious or non-noxious will govern which afferent fibres are stimulated and also if local, spinal segmental, or more systemic analgesic effects are triggered. According to Xin *et al.* (2016), segmental analgesia is triggered by applying ENS of low intensity (i.e. below pain threshold) to a local point on the side of pain. Applied at higher intensities (i.e. at or above the noxious level), ENS was shown to increase thermal and mechanical pain thresholds within and beyond the segmental distribution of needle stimulation on the ipsilateral and contralateral sides, respectively (Xin *et al.* 2016). In an earlier study on human subjects, depression of the nociceptive reflex and pain sensation was achieved using ENS applied at and beyond pain thresholds, reaching depression levels of 58.8% and 60.7% respectively (Xu *et al.* 2003). Taken together these studies support the use of strong, noxious needle stimuli for greater segmental pain inhibition. However, according to both studies, ENS had no effect on pain or reflex inhibition when low intensity ENS was applied

to a contralateral acupoint within the same segmental level. Zhu *et al.* (2004) reported that at the segmental level, analgesia was enhanced in an intensity-dependent manner with ENS and strongest when applied to homo-segmental locations. More specifically, as the strength of needle stimulation increased, thereby reaching and surpassing activation range of Aδ and/or C-fibres, it resulted in greater and longer lasting depression of the C-fibre reflex response. In addition, contralateral stimulation to the same acupoint also produced potent inhibitory effects in an intensity dependent manner. However, only noxious contralateral stimulation to the same point was effective in inducing segmental effect; while innocuous stimuli was ineffective (Zhu *et al.* 2004). Additionally, strong stimulus to a remote heterotopic acupoint (i.e. remote to the side of pain) in the forelimb was shown to produce trans-segmental analgesia through involvement of diffuse noxious inhibitory controls (DNIC) and induced a clear depression of the C-fibre reflex response on the ipsilateral hind limb. It is known that Aβ afferent fibres, which mediate light touch, are preferentially stimulated with innocuous ENS (Kagitani *et al.* 2010), resulting in the activation of GABAergic inhibitory interneurons in the superficial laminae of the dorsal horn that inhibit Aδ and C-fibre input, which leads to pain relief within the stimulated segment (Baeumler *et al.* 2015). Noxious stimulation also triggers a release of endogenous opioids and inhibitory neurotransmitters (GABA and glycine) in the spinal cord (SC). Several studies show ENS induces a release of spinal endogenous opioids (Zhao 2008), up-regulates the release of GABA (Qiao *et al.* 2017), and potentially leads to a release of glycine in the SC (Zhou *et al.* 2008; Butts *et al.* 2016). Accordingly, this contributes to spinal segmental inhibition and suppression of glutamate activity in post-synaptic dorsal horn neurons. It is proposed that inhibition will also occur in ascending spinal neurons that project to the basal forebrain, leading to activation (i.e. dis-inhibition) of a spino-supraspinal opioid-dependent mechanism in the nucleus accumbens (Tambeli *et al.* 2002; Tambeli *et al.* 2003). That is, endogenous neuromodulators released by noxious ENS suppress ascending nociceptive activity, triggering a potent supraspinal mechanism that induces trans-segmental or global pain inhibition.

ENS induces segmental inhibition

Pain inhibition occurs in a pattern relative to the spinal segmental distribution of the patient's symptoms when needles are inserted (and electrically stimulated) within that same distribution (i.e. segmental inhibition). Using non-painful electrical stimuli, Baeumler *et al.* (2015) concluded that short term increases in pain pressure threshold (PPT) were confined to a sensory region of the L4-L5 segment in close proximity to the needling sites. This was noted on both the treated limb and contralateral lower leg. In comparison to manual acupuncture, electrical stimulation provided a more robust improvement in PPT, however, no changes in pressure sensitivity were observed heterosegmentally when measured at the C6 segment with either modality (Baeumler *et al.* 2015). Similarly, Lang *et al.* (2010) reported using non-noxious electric stimuli to four needles in the anterior lower leg and found a bilateral increase in PPT over the sensory region of the peroneal nerve within the L4 segment. Manual needle stimulation was similar in effect for providing bilateral increases in PPT with unilateral stimulation (Lang *et al.* 2010). Collectively, the above studies support the concept of a segmental needling approach that can be complemented with ENS. A limitation in the above studies is that they were performed on healthy volunteers and not on patients with pain. However, a recent meta-analysis of 85 studies reported significant short-term and long-term effects of acupuncture on PPT in patients with painful musculoskeletal disorders. Additionally, it was concluded that ipsilateral needling close to the measurement sites elicited the strongest effects on sensory thresholds than remote or contralateral needling (Baeumler *et al.* 2014). This supports the concept that segmental inhibition is dependent on stimulation of primary afferents that carry noxious and non-noxious input to the spinal level, thereby assisting with analgesia in the same segment of the needle stimulus. Thus, there do appear to be

compelling clinical precedents for using a spinal segmental approach to needling for painful musculoskeletal disorders.

ENS local analgesic effects

ENS can help to relieve inflammatory pain via down-regulation of nociceptive ion channels. Manual needle manipulation has been shown to mechanically activate pain channels that induce anti-nociceptive effects (Wu *et al.* 2014). The aim with ENS, however, is to reduce influx of cation currents to sensory receptors to inhibit pain related action potentials. More specifically, ENS has been shown to target and suppress transient receptor potential vanilloid-1 (TRPV1), a channel that is involved in detection of mechanical, thermal, and acid-induced pain in the periphery, dorsal root ganglion (DRG), and SC level (Yang *et al.* 2017). TRPV1 activation occurs under inflammatory conditions, leading to both increased nociceptive action potentials and enhanced expression of the TRPV1 receptor in neurons of the DRG and spinal dorsal horn. A novel study reported that low frequency ENS to a point segmentally related to the area of pain induction decreased inflammatory pain in an animal model by reducing the expression of TRPV1 and TRPV4 receptors in ipsilateral DRG neurons projecting to the L3-L5 segments (Chen *et al.* 2012). Additionally, non-local ENS applied contralaterally but within the spinal segment of inflammatory-induced pain can similarly decrease TRPV1 expression and decrease sodium current influx at the DRG and SC dorsal horn neurons respectively (Lu *et al.* 2016). A recent study reported that strong low frequency ENS triggers release of adenosine to activate A1 receptors (A1R) and opioids to act on the μ-receptors, resulting in suppression of nociceptive ion channels in DRG neurons. More specifically, A1R activation may lead to decreased adenylyl cyclase activity and inhibition of protein kinase A (PKA), resulting in receptor down-regulation by limiting receptor phosphorylation (Chen *et al.* 2011; Liao *et al.* 2017). Taken together, these studies suggest that low frequency ENS can treat inflammatory pain detected by primary afferents by reducing synaptic transmission in DRG neurons and the dorsal horn of the SC to alter pain sensation.

ENS reduces inflammatory pain

ENS has been shown to reduce pain from inflamed tissue through activating the endocannabinoid and endogenous opioid systems. Anandamide is an endogenous cannabinoid that activates two receptor types (CB_1 and CB_2) that inhibit nociceptive input to the SC dorsal horn. CB_1 receptors are localized on primary afferent neurons, within the spinal dorsal horn, and the Central Nervous System (CNS). CB_2 receptors are located primarily on immune cells to include mast cells, macrophages, keratinocytes, and T-lymphocytes. Application of low or high frequency ENS can elevate anandamide levels in the periphery by promoting its synthesis and release from epidermal keratinocytes. Importantly, the anti-nociceptive effects of ENS are correlated with the subsequent increase in peripheral anandamide levels that rely on activation of local CB_2 receptors (Chen *et al.* 2009). Additionally, ENS of high or low frequency can up-regulate the expression of CB_2 receptors on resident immune cells and leukocytes that are recruited to areas of inflamed tissue (Zhang *et al.* 2010). By activating CB_2 receptors, anandamide can stimulate opioid-containing leukocytes to release β-endorphin and contribute to analgesia by binding to peripheral opioid receptors (Su *et al.* 2011). Additionally, contralateral ENS applied pre-treatment away from the site of pain was effective at reducing inflammatory pain and involves specific μ-opioid receptor activation at the spinal level (Yang *et al.* 2011). Taken together, these studies show that ENS induces a potent anti-nociceptive effect in the periphery by enhancing anandamide levels, increasing the availability of its target receptor, and up-regulating the endogenous opioid system in the periphery.

At the spinal level, cannabinoids have an inhibitory effect on primary afferents and at the substantia gelatinosa of the dorsal horn by decreasing glutamate release from primary afferent terminals through CB_1 receptor activation. Several studies show that low concentrations of anandamide are sufficient to activate

CB_1 receptors, significantly reduce calcitonin gene-related peptide (CGRP) release in the spinal dorsal horn, and reduce neuronal excitability (Morisset *et al.* 2001). This modulation of neuropeptide release in the dorsal horn likely occurs through a reduction in adenylyl cyclase. In contrast, high concentrations of anandamide will elicit excitatory nociceptive input to dorsal horn neurons by activating the TRPV1 receptor that enhances the release of substance P (SP) and CGRP (Ahluwalia *et al.* 2003a; Ahluwalia *et al.* 2003b). Thus, anandamide has a regulatory effect on neurotransmitter release at the spinal level and the subsequent effect is concentration dependent (Tognetto *et al.* 2001).

ENS duration parameters

ENS activates all afferent nerve fibre groups according to nerve conduction velocity measures in animal models (Kagitani *et al.* 2010). ENS has an initial pain modulatory effect through either noxious Aδ or innocuous Aβ fibre stimulation that results in segmental inhibition. A supraspinal mechanism may also be triggered with longer time durations of ENS, shifting away from pain inhibition that is spinally mediated to a form of descending pain inhibition that is much more potent and global in effect. In a study by Leung *et al.* (2008), bilateral increases in sensory thresholds were confined to the L4 dermatome of the lower leg and correlated to the areas of unilateral needle insertion that received brief electrical stimulation. However, a longer duration of electric stimulation (between 15 to 30 min) resulted in longer lasting analgesic effects and increased pressure pain thresholds that extended beyond just the segmental levels of the needling sites (Leung *et al.* 2008). In contrast, even a short stimulation time of 5 min with ENS is sufficient to deliver strong and fast onset analgesia compared to manual needling but the effect is limited to only a few minutes duration (Schliessbach *et al.* 2011).

ENS and descending pain inhibition

ENS triggers descending pain inhibition by activating neurons in the rostral-ventral region of the medulla and the locus coeruleus of the pons. These regions contain supraspinal nuclei that extend fibres down the dorsolateral funiculus (DLF), delivering serotonin (5-HT) and NA to superficial laminae of the SC dorsal horn to inhibit pain when activated. Li *et al.* (2007) reported that creating a spinal lesion on the DLF in an inflammatory pain model eradicates the pain inhibition ENS created by eliminating the delivery of 5-HT and NA at the spinal level (Li *et al.* 2007). The authors also reported low ENS intensity was sufficient to increase ipsilateral (but not contralateral) pain thresholds, indicating that the SC on the side of pain is hyper-responsive to the needle stimulus compared to the contralateral uninvolved side at the same level. Zhang *et al.* (2012) concluded that ENS alleviates pain in part through $5\text{-}HT_{1A}$ receptors on post-synaptic dorsal horn neurons resulting in modulation of the NMDA receptor. Additionally, the authors provided supporting evidence that ENS enhances spinal serotonin levels by activating supraspinal serotonin-containing neurons that project to the level of the spine. Furthermore, ENS increased spinal release of norepinephrine by activating noradrenergic-spinal projection neurons in the locus coeruleus. NA preferentially activates the alpha-adrenergic receptors (α2A) on primary afferent nerve fibres (Aδ fibres specifically), leading to pre-synaptic reduction of glutamate release to the SC (Zhang *et al.* 2012). Both NA and 5-HT have an overall effect of anti-nociception. Both also produce membrane hyperpolarization in neurons of the substantia gelatinosa of the dorsal horn, decrease excitatory neurotransmitter (glutamate) release from primary Aδ and C-fibres pre-synaptically, and increase inhibitory neurotransmitter release (GABA and glycine) from interneurons (Yoshimura & Furue 2006).

Importantly, noradrenergic descending inhibitory system activation can enhance the opioid effects at the SC level during periods of inflammation. When the opioid effect is not strong enough to induce anti-nociception, the effects are enhanced by spinal adrenergic mechanisms. Thus, painful stimulation applied ipsilaterally can stimulate the noradrenergic system (or even serotonergic system) to provide this effect. One study reported that ENS applied at

noxious levels stimulated α2A receptor activation via spinal NA, promoting analgesic effect in the SC. This may perhaps be more powerful than the opioid effect, as α2A receptor anatagonists abolished ENS effects whereas opioid receptor antagonists did not (Koo *et al.* 2008). Mechanistically, α2A receptor activation increases K+ conductance in dorsal horn neurons, causing hyperpolarization, decreased neuron excitability, and decreased glutamate release in the dorsal horn leading to analgesia. This is mainly brought about through Aδ-fibre stimulation that leads to adrenergic system activation. Furthermore, the analgesic actions of opioid receptors are enhanced under inflammatory conditions and thereby more potent on the affected side of inflammation (Stein & Kuchler 2013), thus demonstrating why α2A receptor agonists exhibit enhanced effects at the level of the SC during inflammation.

ENS has also been shown to restore descending pain inhibitory system function in chronic pain situations. Low frequency and moderate intensity (2 Hz and 1 mA) ENS has also been shown to enhance CB_1 receptor levels on GABAergic neurons in the midbrain periaqueductal gray (PAG). Activation of the CB_1 receptor will inhibit GABA release from PAG neurons, disinhibit serotonin release from neurons in the PAG and Rostral Ventromedial Medulla (RVM) and promote restoration of and improved function to diffuse noxious inhibitory controls (DNIC) and the descending pain inhibitory systems by reversal of the reduced CB_1 receptor expression in situations of chronic pain. (Yuan *et al.* 2018).

ENS induces supraspinal analgesic effects

At the level of the brain, there are potent mechanisms triggered with ENS that originate and act centrally and then transport spinally to inhibit pain. Noxious electric needle stimulation has been shown to trigger the release of arginine vasopressin (AVP) from the hypothalamic paraventricular nucleus (PVN) and promote its transport via nerve fibres and ventricles in the brain to the PAG, nucleus raphe magnus (NRM) of the medulla, and caudate nucleus in the basal ganglia (Deng *et al.* 2015). AVP is synthesized in selected neurons of the hypothalamus, mainly in the PVN and supraoptic nucleus (SON). Painful stimulation has been shown to increase noradrenaline (NA) that interacts with PVN neurons to promote synthesis and secretion of AVP that can assist in pain modulation (Zhou *et al.* 2010). AVP also enhances descending pain inhibition by stimulating the synthesis and secretion of the endogenous opioids enkephalin and β-endorphin in the PAG (Yang *et al.* 2007b), stimulating the serotonergic system in the NRM (Yang *et al.* 2009) that leads to 5-HT release in the dorsal horn, and the subsequent spinal release of endogenous opioids via activation of serotonin receptors (Pan *et al.* 2012). Thus, ENS of noxious intensity can trigger release of AVP and has a potent effect on analgesia at the spinal level leading to increased pain thresholds. In the treatment of primary sciatica, a positive correlation between pain relief and levels of AVP in the cerebrospinal fluid (CSF) was observed after a session of bilateral ENS to segmentally-related acupuncture points. More specifically, 60 min of low frequency and low intensity ENS induced larger increases in AVP levels than a 30-min duration (Zhao *et al.* 2015). AVP levels in the CSF increased dose-dependently when treatment duration was the dosage parameter.

A recent review supports that needling inhibits pain via supraspinal increase of oxytocin levels, resulting in transport to oxytocin receptors on spinal neurons, interneurons, and primary afferents at the dorsal horn (Butts *et al.* 2016). Several studies suggest oxytocin acts to inhibit inflammatory pain by modulating acid sensing ion channel (ASIC) function through activation of vasopressin receptors and up-regulation of calcineurin to decrease current amplitudes on sensory receptors (Yang *et al.* 2007a; Qiu *et al.* 2014). ENS has been shown to promote release of oxytocin from the SON of the hypothalamus and facilitate the transfer of oxytocin to the PAG, NRM, and spinal cord, thereby resulting in analgesia through its influence on endogenous opioid release in neurons of the DRG. Interestingly, AVP was able to induce the same ASIC regulation and analgesic effect as oxytocin by activating the same V_{1a} receptor

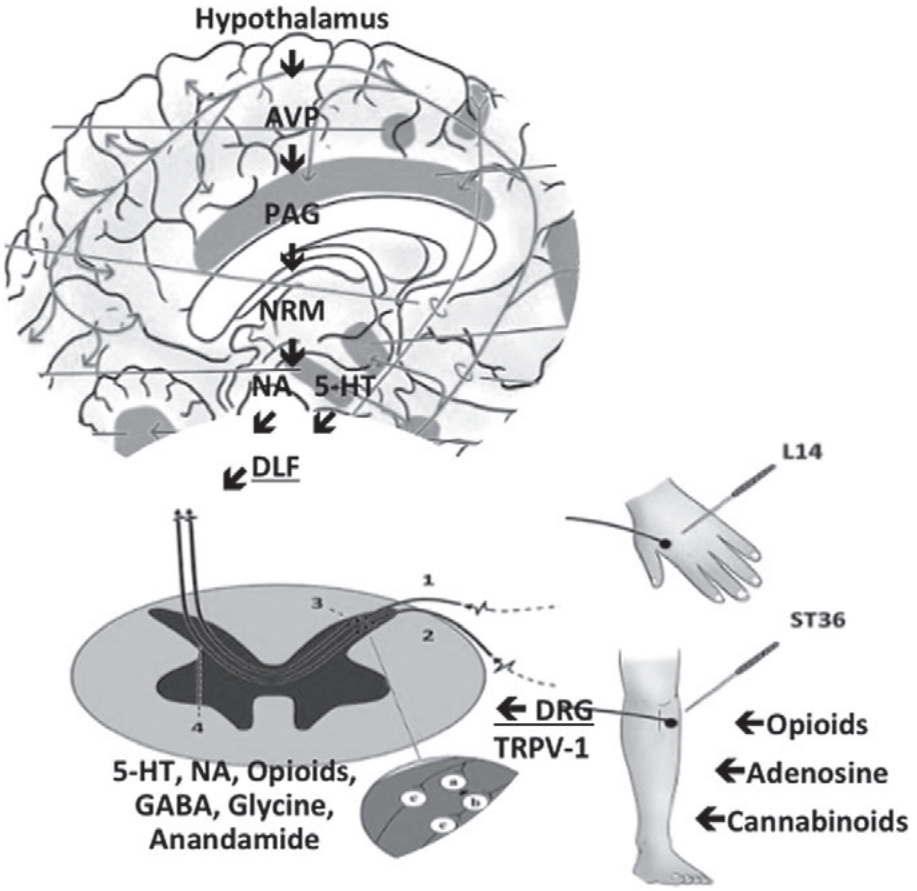

Figure 1. Diagram showing primary mechanisms of ENS-induced analgesia.

that mimics the effect of oxytocin (Qiu *et al.* 2014). Collectively, these studies display that supraspinal mechanisms are triggered with the application of ENS and pain control is heavily modulated at the spinal level through activation of endogenous neuromodulators (see Fig. 1).

Conclusions

According to clinical studies on subjects with pain conditions, electrical stimulation of needles applied in place of, or in addition to, manual manipulation may result in superior analgesic effects. The anti-nociceptive effects of ENS are strongly mediated by spinal segmental inhibitory processes that are engaged when afferent nerve fibres are stimulated. At the spinal level, strong low frequency ENS promotes release of 5-HT, NA, anandamide and endogenous opioids that act to decrease excitability of nociceptive neurons and decrease glutamate release in the dorsal horn leading to analgesia. Beyond this, noxious ENS triggers AVP release supraspinally resulting in greater activation of the serotonergic and noradrenergic descending inhibitory systems that amplify analgesic effects at the spinal level. Locally, strong low-frequency ENS has been shown to suppress inflammatory pain by increasing anandamide concentrations, up-regulating the endogenous opioid system in the periphery and regulating neuropeptide release in the SC. Additionally, ENS triggers release of adenosine locally resulting in activations of A1 receptors and suppression of nociceptive ion channels in DRG neurons and pain suppression. A multitude of analgesic mechanisms are triggered with electric needle stimulation, however, intensity of stimulation, needle placement within the segmental distribution of pain, and duration of ENS seem to be the most important dose parameters for better anti-nociceptive effects.

References

Ahluwalia J., Urban L., Bevan S. & Nagy I. (2003a) Anandamide regulates neuropeptide release from

capsaicin-sensitive primary sensory neurons by activating both the cannabinoid 1 receptor and the vanilloid receptor 1 in vitro. *European Journal of Neuroscience,* **17** (12), 2611–8.

Ahluwalia J., Yaqoob M., Urban L., *et al.* (2003b) Activation of capsaicin-sensitive primary sensory neurones induces anandamide production and release. *Journal of Neurochemistry* **84** (3), 585–91.

Baeumler P. I., Fleckenstein J., Benedikt F., *et al.* (2015) Acupuncture-induced changes of pressure pain threshold are mediated by segmental inhibition – a randomized controlled trial. *Pain* **156** (11), 2245–55.

Baeumler P. I., Fleckenstein J., Takayama S., *et al.* (2014) Effects of acupuncture on sensory perception: a systematic review and meta-analysis. *PLoS One* **9** (12): e113731.

Butts R., Dunning J., Perreault T., *et al.* (2016) Peripheral and spinal mechanisms of pain and dry needling mediated analgesia: a clinical resource guide for health care professionals. *International Journal of Physical Medicine & Rehabilitation* **4** (327).

Chen L., Zhang J., Li F., *et al.* (2009) Endogenous anandamide and cannabinoid receptor-2 contribute to electroacupuncture analgesia in rats. *Journal of Pain* **10** (7), 732–9.

Chen W. H., Tzen J. T., Hsieh C. L., *et al.* (2012) Attenuation of TRPV1 and TRPV4 expression and function in mouse inflammatory pain models using electroacupuncture. *Evidence-Based Complementary Alternative Medicine* **2012**: 636848.

Chen Y., Yang C. & Wang Z. J. (2011) Proteinase-activated receptor 2 sensitizes transient receptor potential vanilloid 1, transient receptor potential vanilloid 4, and transient receptor potential ankyrin 1 in paclitaxel-induced neuropathic pain. *Neuroscience* **193**, 440–51.

Choi Y. J., Lee J. E., Moon W. K. & Cho S. H. (2013) Does the effect of acupuncture depend on needling sensation and manipulation? *Complementary Therapies in Medicine* **21** (3), 207–14.

Deng X.-H., Wang Y.-L., Yuan Y., *et al.* (2015) The roles of vasopressin in acupuncture analgesia. *Journal of Pharmaceutical Medicine* **3**, 11–16.

Huang M., Wang X., Xing B., *et al.* (2018) Critical roles of TRPV2 channels, histamine H1 and adenosine A1 receptors in the initiation of acupoint signals for acupuncture analgesia. *Scientific Reports* **8**: 6523.

Kagitani F., Uchida S. & Hotta H. (2010) Afferent nerve fibers and acupuncture. *Autonomic Neuroscience* **157** (1–2), 2–8.

Koo S. T., Lim K. S. Chung K., *et al.* (2008) Electroacupuncture-induced analgesia in a rat model of ankle sprain pain is mediated by spinal α-adrenoceptors. *Pain* **135** (1–2), 11–19.

Lang P. M., Stoer J., Schober G. M., *et al.* (2010) Bilateral acupuncture analgesia observed by quantitative sensory testing in healthy volunteers. *Anesthesia and Analgesia* **110** (5), 1448–56.

Langevin H. M., Schnyer R., MacPherson H., *et al.* (2015) Manual and electrical needle stimulation in acupuncture research: pitfalls and challenges of heterogeneity. *Journal of Alternative and Complementary Medicine* **21** (3), 113–28.

Leung A. Y., Kim S. J., Schulteis G. & Yaksh T. (2008) The effect of acupuncture duration on analgesia and peripheral sensory thresholds. *BMC Complementary and Alternative Medicine* **8** (18).

Li A., Wang Y., Xin J., *et al.* (2007) Electroacupuncture suppresses hyperalgesia and spinal Fos expression by activating the descending inhibitory system. *Brain Research* **1186**, 171–9.

Liao H. Y., Hsieh C. L., Huang C. P. & Lin Y. W. (2017) Electroacupuncture attenuates CFA-induced inflammatory pain by suppressing Nav1.8 through S100B, TRPV1, opioid, and adenosine pathways in mice. *Scientific Reports* **7**: 42531.

Lu K. W., Hsu C. K., Hsieh C. L., *et al.* (2016) Probing the effects and mechanisms of electroacupuncture at ipsilateral or contralateral ST 36-ST 37 acupoints on CFA-induced inflammatory pain. *Scientific Reports* **6**: 22123.

MacPherson H., Maschino A. C., Lewith G., *et al.* (2013). Characteristics of acupuncture treatment associated with outcome: an individual patient meta-analysis of 17,922 patients with chronic pain in randomised controlled trials. *PLoS One* **8** (10): e77438.

MacPherson H., Vertosick E. A., Foster N. E., *et al.* (2017) The persistence of the effects of acupuncture after a course of treatment: a meta-analysis of patients with chronic pain. *Pain* **158** (5), 784–793.

Manheimer, E., Cheng, K., Linde, K., *et al.* (2010) Acupuncture for peripheral joint osteoarthritis. *Cochrane Database of Systematic Reviews* CD001977.

Morisset V., Ahluwalia J., Nagy I. & Urban L. (2001) Possible mechanisms of cannabinoid-induced antinociception in the spinal cord. *European Journal of Pharmacology* **429** (1–3), 93–100.

Niddam D. M., Chan R. C., Lee S. H., *et al.* (2007). Central modulation of pain evoked from myofascial trigger point. *Clinical Journal of Pain,* **23** (5), 440–8.

Pan Y.-J., Yin Z.-K., Yang J., *et al.* (2012) Serotonin influences the endogenous opiate peptides in the rat spinal cord to participates in pain modulation. *Open Journal of Anesthesiology* **2** (2), 29–35.

Qiao L. N., Liu J. L., Tan L. H., *et al.* (2017) Effect of electroacupuncture on thermal pain threshold and expression of calcitonin-gene related peptide, substance P and gamma-aminobutyric acid in the cervical dorsal root ganglion of rats with incisional neck pain. *Acupuncture in Medicine* **35** (4), 276–283.

Qiu F., Qiu C. Y., Cai H., *et al.* (2014) Oxytocin inhibits the activity of acid-sensing ion channels through the vasopressin, V1A receptor in primary sensory neurons. *British Journal of Pharmacology* **171** (12), 3065–76.

Schliessbach J., van der Klift E., Arendt-Nielsen L., *et al.* (2011) The effect of brief electrical and manual

acupuncture stimulation on mechanical experimental pain. *Pain Medicine* **12** (2), 268–75.

Stein C. & Küchler S. (2013) Targeting inflammation and wound healing by opioids. *Trends in Pharmacological Sciences* **34** (6), 303–12.

Su T. F., Zhang L. H., Peng M., *et al.* (2011) Cannabinoid CB2 receptors contribute to upregulation of β-endorphin in inflamed skin tissues by electroacupuncture. *Molecular Pain* **7**: 98.

Tambeli C. H., Parada C. A., Levine J. D. & Gear R. W. (2002) Inhibition of tonic spinal glutamatergic activity induces antinociception in the rat. *European Journal of Neuroscience* **16** (8), 1547–53.

Tambeli C. H., Quang P., Levine J. D. & Gear R. W. (2003) Contribution of spinal inhibitory receptors in heterosegmental antinociception induced by noxious stimulation. *European Journal of Neuroscience* **18** (11), 2999–3006.

Tognetto M., Amadesi S., Harrison S., *et al.* (2001) Anandamide excites central terminals of dorsal root ganglion neurons via vanilloid receptor-1 activation. *Journal of Neuroscience* **21** (4), 1104–9.

Vickers A. J., Vertosick E. A., Lewith G., *et al.* (2018) Acupuncture for chronic pain: update of an individual patient data meta-analysis. *Journal of Pain* **19** (5), 455–474.

Wu S. Y., Chen W. H., Hsieh C. L. & Lin Y. W. (2014) Abundant expression and functional participation of TRPV1 at Zusanli acupoint (ST 36) in mice: mechanosensitive TRPV1 as an "acupuncture-responding channel". *BMC Complementary and Alternative Medicine* **14** (96).

Xin J., Su Y., Yang Z., *et al.* (2016) Distinct roles of ASIC3 and TRPV1 receptors in electroacupuncture-induced segmental and systemic analgesia. *Frontiers in Medicine* **10** (4), 465–472.

Xu W. D., Zhu B., Rong P. J., *et al.* (2003) The pain-relieving effects induced by electroacupuncture with different intensities at homotopic and heterotopic acupoints in humans. *American Journal of Chinese Medicine* **31** (5), 791–802.

Yang E. J., Koo S. T., Kim Y. S., *et al.* (2011) Contralateral electroacupuncture pretreatment suppresses carrageenan-induced inflammatory pain via the opioid-mu receptor. *Rheumatology International* **31** (6), 725–30.

Yang J., Hsieh C. L. & Lin Y. W. (2017) Role of transient receptor potential vanilloid 1 in electroacupuncture analgesia on chronic inflammatory pain in mice. *Biomed Research International* **2017**: 5068347.

Yang J., Yang Y., Chen J. M., *et al.* (2007a) Effect of oxytocin on acupuncture analgesia in the rat. *Neuropeptides* **41** (5), 285–92.

Yang J., Yang Y., Xu H. T., *et al.* (2007b) Arginine vasopressin induces periaqueductal gray release of enkephalin and endorphin relating to pain modulation in the rat. *Regulatory Peptides* **142** (1–2), 29–36.

Yang J., Yuan H., Chu J., *et al.* (2009) Arginine vasopressin antinociception in the rat nucleus raphe magnus is involved in the endogenous opiate peptide and serotonin system. *Peptides* **30** (7), 1355–61.

Yin N., Yang H., Yao W., *et al.* (2018). Mast cells and nerve signal conduction in acupuncture. *Evidence-Based Complementary and Alternative Medicine* **2018**: 3524279.

Yoshimura M. & Furue H. (2006) Mechanisms for the anti-nociceptive actions of the descending noradrenergic and serotonergic systems in the spinal cord. *Journal of Pharmacological Sciences* **101** (2), 107–17.

Yuan Q. L., Wang P., Liu L., *et al.* (2016) Acupuncture for musculoskeletal pain: a meta-analysis and meta-regression of sham-controlled randomized clinical trials. *Scientific Reports* **6**: 30675.

Yuan X. C., Zhu B., Jing X. H., *et al.* (2018) Electroacupuncture potentiates cannabinoid receptor-mediated descending inhibitory control in a mouse model of knee osteoarthritis. *Frontiers in Molecular Neuroscience* **11**: 112.

Zhang J., Chen L., Su T., *et al.* (2010) Electroacupuncture increases CB2 receptor expression on keratinocytes and infiltrating inflammatory cells in inflamed skin tissues of rats. *Journal of Pain* **11** (12), 1250–8.

Zhang Y., Zhang R. X., Zhang M., *et al.* (2012) Electroacupuncture inhibition of hyperalgesia in an inflammatory pain rat model: involvement of distinct spinal serotonin and norepinephrine receptor subtypes. *British Journal of Anaesthesia* **109** (2), 245–52.

Zhao X. Y., Zhang Q. S., Yang J., *et al.* (2015) The role of arginine vasopressin in electroacupuncture treatment of primary sciatica in human. *Neuropeptides* **52**, 61–5.

Zhao Z. Q. (2008) Neural mechanism underlying acupuncture analgesia. *Progress in Neurobiology* **85** (4), 355–75.

Zheng Z., Gibson S., Helme R. D., *et al.* (2018) Effects of electroacupuncture on opioid consumption in patients with chronic musculoskeletal pain: a multicenter randomized controlled trial. *Pain Medicine* [Epub ahead of print.] doi: 10.1093/pm/pny113.

Zhou H.-Y., Zhang H.-M., Chen S.-R. & Pan H.-L. (2008) Increased C-fiber nociceptive input potentiates inhibitory glycinergic transmission in the spinal dorsal horn. *Journal of Pharmacology and Experimental Therapeutics* **324** (3), 1000–1010.

Zhou K., Ma Y. & Brogan M. S. (2015) Dry needling versus acupuncture: the ongoing debate. *Acupuncture in Medicine* **33** (6), 485–90.

Zhou X. J., Yang J., Yan F. L., *et al.* (2010) Norepinephrine plays an important role in antinociceptive modulation of hypothalamic paraventricular nucleus in the rat. *International Journal of Neuroscience* **120** (6), 428–38.

Zhu B., Xu W. D., Rong P. J., *et al.* (2004) A C-fiber reflex inhibition induced by electroacupuncture with different intensities applied at homotopic and heterotopic acupoints in rats selectively destructive effects on myelinated and unmyelinated afferent fibers. *Brain Research* **1011** (2), 228–37.

Part II of this Literature Review will appear in the Spring 2019 issue of Acupuncture in Physiotherapy.

Dr Thomas Perreault graduated with a BSc in Kinesiology from The University of Maine in 2004 and earned his doctoral degree in Physical Therapy from Franklin Pierce University in 2008. Dr Perreault is a graduate of the Institute of Orthopedic Manual Therapy Clinical Fellowship in Woburn, Massachusetts and he is a Board Certified Orthopedic Specialist through the American Physical Therapy Association. He is also a member of the Acupuncture Association of Chartered Physiotherapists and has practiced in the outpatient orthopedic setting for 10 years. Dr Perreault is currently a Clinical Specialist at Wentworth Douglass Hospital in Dover, New Hampshire for the Northern New England Spine Center with a focus on dry needling for chronic spinal pain, temporomandibular disorders and headache. He lectures internationally on dry needling for the management of musculoskeletal disorders. Dr Perreault is also lead author of "The local twitch response during trigger point dry needling: is it necessary for successful outcomes?" which was published in 2017 in the ever popular Journal of Bodywork and Movement Therapies.