



available at www.sciencedirect.com



journal homepage: www.elsevier.com/jbmt



PAIN DISTRIBUTION

Referred pain areas of active myofascial trigger points in head, neck, and shoulder muscles, in chronic tension type headache

César Fernández-de-las-Peñas, PT, PhD ^{a,b,c,*}, Hong-You Ge, MD, PhD ^b,
Cristina Alonso-Blanco, PT, MSc ^d, Javier González-Iglesias, PT ^e,
Lars Arendt-Nielsen, DMSc, PhD ^b

^a Department of Physical Therapy, Occupational Therapy, Physical Medicine and Rehabilitation of Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain

^b Center for Sensory-Motor Interaction (SMI), Department of Health Science and Technology, Aalborg University, Aalborg, Denmark

^c Esthesiology Laboratory of Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain

^d Department of Health Sciences II, Universidad Rey Juan Carlos, Madrid, Spain

^e Centro de Fisioterapia Integral, Candás, Asturias, Spain

Received 2 April 2009; received in revised form 27 June 2009; accepted 28 June 2009

KEYWORDS

Tension type headache;
Muscle trigger points;
Referred pain areas

Summary Our aim was to analyze the differences in the referred pain patterns and size of the areas of those myofascial trigger points (TrPs) involved in chronic tension type headache (CTTH) including a number of muscles not investigated in previous studies. Thirteen right handed women with CTTH (mean age: 38 ± 6 years) were included. TrPs were bilaterally searched in upper trapezius, sternocleidomastoid, splenius capitis, masseter, levator scapulae, superior oblique (extra-ocular), and suboccipital muscles. TrPs were considered active when both local and referred pain evoked by manual palpation reproduced total or partial pattern similar to a headache attack. The size of the referred pain area of TrPs of each muscle was calculated. The mean number of active TrPs within each CTTH patient was 7 (95% CI 6.2–8.0). A greater number ($T = 2.79$; $p = 0.016$) of active TrPs was found at the right side (4.2 ± 1.5) when compared to the left side (2.9 ± 1.0). TrPs in the suboccipital muscles were most prevalent ($n = 12$; 92%), followed by the superior oblique muscle ($n = 11/n = 9$ right/left side), the upper trapezius muscle ($n = 11/n = 6$) and the masseter muscle ($n = 9/n = 7$). The ANOVA showed significant differences in the size of the referred pain area between muscles ($F = 4.7$, $p = 0.001$), but not between sides ($F = 1.1$; $p = 0.3$): as

* Corresponding author: Facultad de Ciencias de la Salud, Universidad Rey Juan Carlos, Avenida de Atenas s/n, 28922 Alcorcón, Madrid, Spain. Tel.: +34 91 488 8884; fax: +34 91 488 8957.

E-mail address: cesar.fernandez@urjc.es (C. Fernández-de-las-Peñas).

determined by a Bonferroni post hoc analysis the referred pain area elicited by levator scapulae TrPs was significantly greater than the area from the sternocleidomastoid ($p = 0.02$), masseter ($p = 0.003$) and superior oblique ($p = 0.001$) muscles. Multiple active TrPs exist in head, neck and shoulder muscles in women with CTTH. The referred pain areas of TrPs located in neck muscles were larger than the referred pain areas of head muscles. Spatial summation of nociceptive inputs from multiple active TrPs may contribute to clinical manifestations of CTTH.

© 2009 Elsevier Ltd. All rights reserved.

Introduction

Headache is one of the most prevalent neurological disorders (Bendtsen and Jensen, 2009). Tension-type headache is the most common form of headache and its chronic form (chronic tension-type headache: CTTH) is one of the most neglected (Bendtsen and Jensen, 2006) and is difficult to treat. It has been reported a prevalence rate of 38.3% for episodic tension type headache and 2.2% for CTTH (Schwartz et al., 1998). The prevalence of this headache has increased over the years (Lyngberg et al., 2005). CTTH may cause substantial levels of disability, not only to patients and their relative families, but also to the global society due to very high prevalence (Stovner et al., 2007).

Although there has been an increasing interest in the pathogenic mechanisms of CTTH, the real patho-anatomical mechanisms remain to be fully elucidated (Fumal and Schoenen, 2008). It seems clear that hyper-excitability of nociceptive pathway plays an important role in CTTH (Bendtsen and Schoenen, 2006). It has been recently postulated that CTTH pain, at least in part, may be associated with referred pain elicited by trigger points (TrPs) in head, neck and shoulder muscles (Fernández-de-las-Peñas et al., 2007a). A myofascial TrPs is defined as a hypersensitive spot within a taut band of a skeletal muscle that elicits a referred distant pain (Simons et al., 1999). From a clinical point of view, TrPs may be active or latent. Active TrPs cause symptoms and both their local and referred pain evoke a familiar pain for the patient. In CTTH, active TrPs evoke symptoms similar to those patients perceive during their headache attacks. We have demonstrated that CTTH is associated with active TrPs in the suboccipital (Fernández-de-las-Peñas et al., 2006a), upper trapezius (Fernández-de-las-Peñas et al., 2007b), superior oblique (Fernández-de-las-Peñas et al., 2005), sternocleidomastoid (Fernández-de-las-Peñas et al., 2006b), temporalis (Fernández-de-las-Peñas et al., 2007c), and lateral rectus of the eye (Fernández-de-las-Peñas et al., 2009) muscles. Additionally, we also formulated an updated pain model for CTTH involving both peripheral sensitization from active muscle TrPs and central sensitization in which active TrPs located in those muscles innervated by C1–C3 segments or the trigeminal nerve may be responsible for peripheral nociception producing a continuous afferent barrage into the nucleus caudalis of the trigeminal nerve sensitizing the central nervous system in CTTH (Fernández-de-las-Peñas et al., 2007d).

Previous studies in patients with CTTH have shown larger referred pain areas elicited from TrPs in the upper trapezius (Fernández-de-las-Peñas et al., 2007b) and the temporalis (Fernández-de-las-Peñas et al., 2007c) muscles as compared to controls. In addition, there are a number of

muscles in which TrPs can refer pain to the head and hence contribute to CTTH (Figure 1), e.g. masseter, splenius capitis, levator scapulae (Simons et al., 1999), which have not been included in recent published studies. Therefore, the aim of this study was to analyze the differences in the referred pain patterns and size of the areas of those muscle TrPs involved in CTTH including a number of muscles not investigated in previous studies.

Material and methods

Patients

Thirteen women diagnosed with CTTH, aged from 30 to 50 (mean age: 38 ± 6 years) years of age participated in this study. Patients were recruited from an advertisement in a local newspaper. All subjects were right-handed. Patients were interviewed by an experienced clinician to be certain that they fit the inclusion criteria of the International Headache Society (IHS) criteria for CTTH (IHS, 2004). Headache pain features, temporal profile, family history, and past and current medications were ascertained from the history. To be included, patients had to describe all the characteristics typical of this headache: bilateral location, pressing and tightening pain, mild or moderate intensity (≤ 6 on a 11-point numerical pain rate scale from 0 to 10) and no aggravation of headache during physical activity. No patient reported photophobia, phonophobia, vomiting or evident nausea during headaches. In addition, patients had to have headaches for at least 15 days/month. Other primary headaches were excluded. Each patient fulfilled the criteria for CTTH, and there was no apparent evidence of secondary headaches. Medication-overuse headache as defined by the IHS was also ruled out. Furthermore, patients completed a headache diary for 4 weeks in order to substantiate the diagnosis (Phillip et al., 2007).

All patients had received several prophylactic drugs several years ago, but none of them were taking any prophylactic drug at the time the study was conducted. Furthermore, patients who received any non-pharmacological treatment (physical therapy, relaxation) within 6 months prior to the study were not considered for the study. Ethical approval of the study was granted by the Local Ethics Committee (VN 2005-0041). Informed consent was obtained from all subjects, and all procedures were conducted according to the Declaration of Helsinki.

Headache characteristics

An 11-point numerical pain rating scale (Jensen et al., 1999) (NPRS; range: 0 = no pain, to 10 = maximum pain)

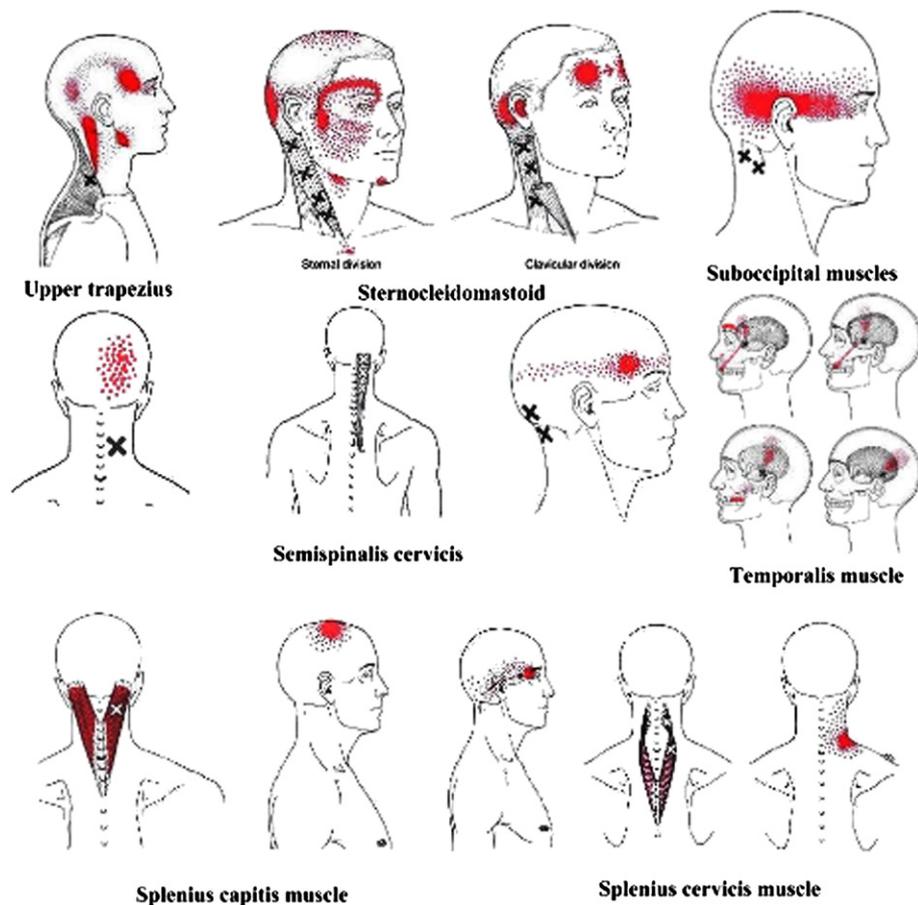


Figure 1 Referred pains from upper trapezius, sternocleidomastoid, suboccipital, splenius capitis, splenius cervicis, semispinalis capitis and temporalis muscle TrPs as described by Simons et al. Reprinted with permission from Simons, D., Travell, J., Simons, L., 1999. Travell & Simons' Myofascial Pain and Dysfunction: The Trigger Point Manual, Vol. 1, second ed. Williams & Wilkins, Baltimore.

was used to assess headache intensity. The headache diary was used to calculate the following variables: (1) headache intensity, calculated from the mean of the NPRS of the days with headache; (2) headache frequency, calculated by dividing the number of days with headache by the number of analyzed weeks (days/week); and (3) headache duration, calculated by dividing the sum of the total hours of headache by the number of days with headache (hours/day). Patients also drew their headache pattern on an anatomical map.

Muscle trigger point examination

Patients were asked to avoid any analgesic or muscle relaxant 48 h prior to the examination, and they were examined when their headache intensity was less than 4 on the NPRS. Myofascial TrPs were bilaterally explored in upper trapezius, splenius capitis, sternocleidomastoid, masseter, superior oblique, levator scapulae and suboccipital muscles by an observer assessor who had more than 8 years of experience in TrP diagnosis. For the upper trapezius, sternocleidomastoid, splenius capitis, masseter and levator scapulae muscles, TrP diagnosis was conducted following the diagnostic criteria described by Simons et al.

(1999): (1) presence of a palpable taut band within a skeletal muscle; (2) presence of a hypersensitive tender spot in the taut band; (3) local twitch response elicited by snapping palpation of the taut band; and (4) reproduction of the typical referred pain pattern of the TrP in response to compression. For suboccipital and superior oblique muscles we adopted the previous published guidelines (Fernández-de-las-Peñas et al., 2005, 2006a). Briefly, the diagnosis of suboccipital TrPs was made when there was tenderness in the suboccipital region, referred pain evoked by maintained pressure for 10 s, and increased referred pain with muscle contraction [extension of the head-neck] (Fernández-de-las-Peñas et al., 2006a). For the diagnosis of superior oblique muscle TrPs, we searched for both local and referred pain elicited by palpation of the superior-internal corner of the orbit and increased referred pain with both contraction [infra-adduction of the eye] and stretching [supra-abduction of the eye] of the muscle (Fernández-de-las-Peñas et al., 2005). TrPs were considered active if both the local and the referred pain evoked by manual palpation reproduced total or partial pattern of the headache (Simons et al., 1999).

Muscle TrPs were searched in each muscle with a 1-min interval between two consecutive points. After TrP

examination on each point, patients were asked to draw the distribution of referred pain (if it was elicited during examination) on an anatomical map. The referred pain area of muscle TrPs was calculated with a digitizer (ACECAD D9000, Taiwan).

Statistical analysis

Data was analyzed with SPSS® version 14.0 (SPSS Inc, Chicago, IL) Results are expressed as mean and 95% confidence interval in the text. The Kolmogorov–Smirnov test showed a normal distribution of quantitative data ($p > 0.05$). The differences in the number of active TrPs between both sides were assessed with the non-parametric Wilcoxon Signed-Rank test. The chi square (χ^2) test was used to assess the differences in the size of the distribution of active TrPs within each muscle on each side. A two-way ANOVA was used to detect the differences in referred pain area (cm^2) between muscles and sides. The Bonferroni test was conducted as post hoc analysis. The Pearson (r) test was used for the correlation analysis between referred pain areas and clinical variables relating to headache (intensity, frequency, duration, history). The statistical analysis was conducted at a 95% confidence level. A p value-less than 0.05 was considered statistically significant.

Results

Clinical features of the sample

In this CTTH sample, mean duration of the headache history was 11.5 years (95% CI 7.2–15.8 years). The mean headache period per day was 7.2 h (95% CI 5.8–8.5 h), the mean intensity per episode was 4.8 (95% CI 4.4–5.2), and the number of days per week with headache was 4.5 (95% CI 4.1–5.0 days/week). The day of the examination mean headache intensity was 2.3 (95% CI 2.0–2.6). Headache intensity was positively associated with the headache duration of individual attacks ($r = 0.65$; $p = 0.02$): the greater the intensity, the longer the duration of the headache. The mean head pain area reported by the patients during their attacks was 4.1 cm^2 (95% CI 2.6–5.6) in the frontal region, 5.9 cm^2 (95% CI 4.7–7.2) in the occipital region (including the posterior part of the neck region), 3.3 cm^2 (95% CI 2.5–4.1) in the left side of the head, and 2.8 cm^2 (95% CI 1.9–3.8) in the right side of the head (Figure 2). No correlation

between head pain areas and pain clinical parameters (intensity, duration or frequency) were found.

Muscle TrPs in CTTH: number, location and referred pain areas

The mean number of active TrPs within each CTTH patient was 7 (95% CI 6.2–8.0). A greater number ($T = 2.79$; $p = 0.016$) of active TrPs was found on the right side (4.2 ± 1.5) when compared to the left side (2.9 ± 1.0).

TrPs in the suboccipital muscles were most prevalent ($n = 12$; 92%), followed by the superior oblique muscle ($n = 11$ [85%]/ $n = 9$ [69%] right/left side), the upper trapezius muscle ($n = 11$ [85%]/ $n = 6$ [46%]) and the masseter muscle ($n = 9$ [69%]/ $n = 7$ [54%]). The distribution of active muscle TrPs was significantly different between sides for the upper trapezius ($\chi^2 = 4.792$; $p = 0.045$), the sternocleidomastoid ($\chi^2 = 4.524$; $p = 0.045$) and the levator scapulae muscles ($\chi^2 = 5.406$; $p = 0.0354$). In such a way, active TrPs were mostly located in the right side in both upper trapezius and sternocleidomastoid muscles, whereas levator scapulae TrPs were mostly located in the left side. The distribution of active TrPs in the analyzed muscles is shown in Table 1, and referred pain areas of particular muscles in Table 2.

The ANOVA showed significant differences in referred pain areas between muscles ($F = 4.7$, $p = 0.001$), but not between sides ($F = 1.1$; $p = 0.3$). Based on a Bonferroni post hoc analysis, the referred pain area elicited from levator scapulae TrPs was significantly greater than the referred pain from the sternocleidomastoid ($p = 0.02$), the masseter ($p = 0.003$) and the superior oblique ($p = 0.001$) muscles. Referred pain areas of upper trapezius, splenius capitis, suboccipital, and levator scapulae were not significantly different ($p > 0.3$).

Discussion

This study showed the existence of multiple active TrPs in different head, neck and shoulder muscles in patients with CTTH. Both the local and referred pain elicited by active TrPs reproduced the headache pattern in all the patients. The presence of bilateral active TrPs in trigemino-cervical muscles provides a plausible explanation for the symmetrical bilateral distribution of pain observed in patients with CTTH.

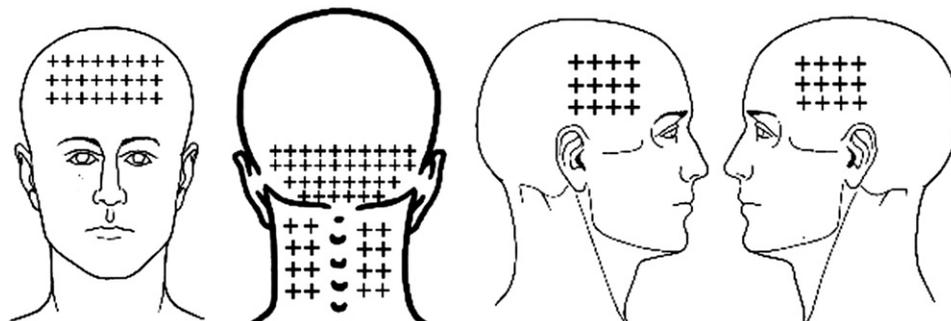


Figure 2 Symptom area of the patients with chronic tension type headache included in the current study.

Table 1 Number of patients with chronic tension type headache (*n*) with active trigger points (TrPs) located in each muscle.

	Upper trapezius muscle		Sternocleidomastoid muscle		Masseter muscle	
	Left side	Right side	Left side	Right side	Left side	Right side
Active TrPs (<i>n</i>)	6	11	2	6	7	9
No TrPs (<i>n</i>)	7	2	11	7	6	4
	Splenius capitis muscle		Levator scapulae muscle		Superior oblique muscle	
	Left side	Right side	Left side	Right side	Left side	Right side
Active TrPs (<i>n</i>)	4	4	8	4	9	11
No TrPs (<i>n</i>)	9	9	5	9	4	2

We found up to seven active muscle TrPs within each headache patient, supporting the assumption of spatial summation of TrP activity in CTTH, as we have previously suggested (Fernández-de-las-Peñas et al., 2007a,b,d). Our results underscore the importance of searching for multiple active TrPs in different muscles in patients with CTTH. This finding increases the relevance of multiple TrPs because active TrPs constitute an important source of peripheral nociception since higher concentrations of chemical mediators (bradykinin, calcitonin gene-related peptide, substance P, and serotonin) may be present in active muscle TrPs (Shah et al., 2005). This hypothesis would be related to previous assumptions that peripheral nociception and sensitization mechanisms would play a crucial role in the evolution from episodic to chronic tension type headache (Bendtsen and Schoenen, 2006). Therefore, clinicians should search and treat active muscle TrPs in the musculature which receives a trigemino-cervical innervation in patients with CTTH and try to treat those which referred pain TrP reproduced the headache attack.

We also calculated the referred pain areas elicited by active TrPs and found that referred pain areas of suboccipital and levator scapulae muscle TrPs were the commonest ones. It is interesting to note that neck (suboccipital, levator scapulae or splenius capitis), instead of head muscles (masseter or superior oblique), showed the greatest referred pain areas. These findings claim for the relevance of neck muscles in pain perception in CTTH.

Previously we assessed referred pain areas from the upper trapezius (Fernández-de-las-Peñas et al., 2007b) and temporalis (Fernández-de-las-Peñas et al., 2007c) muscles, but not from the remaining muscles included in the current study. The current study increases the number of muscle TrPs which referred pain is contributing to headache pain pattern in CTTH. Additionally, we also showed that the referred pain areas of the analyzed muscles covered the extension of the entire headache pain pattern of the patients, although we should consider that the referred pain areas of some muscle TrPs, e.g. suboccipital, splenius capitis, and upper trapezius, are located in the same region of the head (frontal or lateral side of the head or neck). In addition, we should take into account that the referred pain pattern of the levator scapulae muscle did not reach the head. Nevertheless, since all CTTH patients reported neck pain symptoms, active TrPs in this muscle are related to the neck pain pattern present in CTTH. Finally, the referred pain patterns elicited by active TrPs in the current study were very similar to those previously reported by Simons et al. (1999) and by Beat de Jung (2006). Nevertheless, some slight differences may be observed, probably due to the pathology of the patients included, or due to the sensitization state in which the patients were explored.

An interesting finding was that active TrPs in the upper trapezius and sternocleidomastoid muscles were mostly located in the right side, whereas levator scapulae TrPs were mostly located in the left side. These results are

Table 2 Referred pain areas of active trigger points on each muscles in patients with chronic tension type headache.

Patients with chronic tension type headache		
Upper trapezius	Right side (<i>n</i> = 11)	3.4 ± 1.2 (2.5–4.2)
	Left side (<i>n</i> = 6)	2.9 ± 1.2 (1.7–4.2)
Sternocleidomastoid	Right side (<i>n</i> = 6)	2.5 ± 0.7 (1.8–3.2)
	Left side (<i>n</i> = 2)	1.8 ± 0.4 (1.4–2.6)
Masseter	Right side (<i>n</i> = 9)	2.2 ± 0.5 (1.8–2.6)
	Left side (<i>n</i> = 7)	2.8 ± 1.0 (1.9–3.8)
Splenius capitis	Right side (<i>n</i> = 4)	3.8 ± 0.5 (3.1–4.6)
	Left side (<i>n</i> = 4)	3.1 ± 1.5 (1.0–4.4)
Levator scapulae	Right side (<i>n</i> = 4)	4.9 ± 1.1 (3.1–6.6)
	Left side (<i>n</i> = 8)	4.1 ± 2.0 (2.4–5.8)
Superior oblique	Right side (<i>n</i> = 11)	2.5 ± 1.1 (1.7–3.2)
	Left side (<i>n</i> = 9)	2.7 ± 1.6 (1.5–4.0)
Suboccipital	<i>n</i> = 12	4.5 ± 1.3 (3.7–5.4)

Referred pain areas (cm²) are expressed as means ± standard deviation (95% confidence interval).

similar to those found in a previous study (Fernández-de-las-Peñas et al., 2007b) in which TrPs in the upper trapezius muscle were also located in the dominant side. A greater prevalence of TrPs in the right side may be related to the fact that all patients were right-hand dominant. Bernard (1997) found that highly repetitive work and forceful arm or hand movements cause neck and shoulder pain. Repetitive use of the muscle in the dominant side may be a factor to the development of TrPs (Simons, 2004). Nevertheless, this hypothesis does not explain why active TrPs in the levator scapulae were more prevalent on the non-dominant side. Future studies should investigate this topic.

We should recognize some limitations of the study. Firstly, we only included women with CTTH; therefore our results cannot be extrapolated to men with CTTH. Future studies should include men with CTTH for a more generalization of the results of the current study. Secondly, we included a small sample size, so future studies with a greater number of patients is recommended. Thirdly, since active TrPs are not found often in healthy controls we only included patients, in the current study. The reason was that we wanted to investigate referred pain areas in active TrPs in a patient population.

Conclusions

The present study showed the existence of multiple active TrPs in different head, neck and shoulder muscles in women CTTH. Both the local and referred pain elicited by active TrPs reproduced the headache pattern in patients. The referred pain areas of TrPs located in neck muscles were greater than the referred pain areas of head muscles. Spatial summation of nociceptive inputs from multiple active TrPs may contribute to both peripheral and central sensitization in CTTH.

References

- De Jung, B., 2006. *Triggerpunkt-therapie*, second ed. Verlag Hans Huber, Bern.
- Bendtsen, L., Jensen, R., 2006. Tension type headache: the most common, but also the most neglected headache disorder. *Curr. Opin. Neurol* 19, 305–309.
- Bendtsen, L., Jensen, R., 2009. Epidemiology of tension-type headache, migraine and cervicogenic headache. In: Fernández-de-las-Peñas, C., Arendt-Nielsen, L., Gerwin, R. (Eds.), *Tension Type and Cervicogenic Headache: Patho-physiology, Diagnosis and Treatment*. Jones & Bartlett Publishers, Baltimore, pp. 7–13.
- Bendtsen, L., Schoenen, J., 2006. Synthesis of tension type headache mechanisms. In: Olesen, J., Goasby, P., Ramdan, N.M., Tfelt-Hansen, P., Welch, K.M.A., 2006. *The Headaches*, third ed. Lippincott Williams & Wilkins, Philadelphia, 2006.
- Bernard, B., 1997. *Musculoskeletal Disorders and Workplace Factors: a Critical Review of Epidemiologic Evidence for Work-related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back*, second ed. US Department of Health and Human Services, NIOSH, Cincinnati, OH, pp. I-C-59.
- Fernández-de-las-Peñas, C., Cuadrado, M.L., Gerwin, R.D., Pareja, J.A., 2005. Referred pain from the trochlear region in tension-type headache: a myofascial trigger point from the superior oblique muscle. *Headache* 45, 731–737.
- Fernández-de-las-Peñas, C., Alonso-Blanco, C., Cuadrado, M.L., Gerwin, R.D., Pareja, J.A., 2006a. Trigger points in the sub-occipital muscles and forward head posture in tension type headache. *Headache* 46, 454–460.
- Fernández-de-las-Peñas, C., Alonso-Blanco, C., Cuadrado, M.L., Gerwin, R.D., Pareja, J.A., 2006b. Myofascial trigger points and their relationship with headache clinical parameters in chronic tension type headache. *Headache* 46, 1264–1272.
- Fernández-de-las-Peñas, C., Ge, H.Y., Arendt-Nielsen, L., Cuadrado, M.L., Pareja, J.A., 2007a. Referred pain from trapezius muscle trigger point shares similar characteristics with chronic tension type headache. *Eur. J. Pain* 11, 475–482.
- Fernández-de-las-Peñas, C., Ge, H.Y., Arendt-Nielsen, L., Cuadrado, M.L., Pareja, J.A., 2007b. The local and referred pain from myofascial trigger points in the temporalis muscle contributes to pain profile in chronic tension-type headache. *Clin. J. Pain* 23, 786–792.
- Fernández-de-las-Peñas, C., Simons, D.G., Cuadrado, M.L., Pareja, J.A., 2007c. The role of myofascial trigger points in musculoskeletal pain syndromes of the head and neck. *Curr. Pain Headache Rep* 11, 365–372.
- Fernández-de-las-Peñas, C., Cuadrado, M.L., Arendt-Nielsen, L., Simons, D.G., Pareja, J.A., 2007d. Myofascial trigger points and sensitisation: an updated pain model for tension type headache. *Cephalalgia* 27, 383–393.
- Fernández-de-las-Peñas, C., Cuadrado, M.L., Gerwin, R.D., Pareja, J.A., 2009. Referred pain from the lateral rectus muscle in subjects with chronic tension type headache. *Pain Med* 10, 43–48.
- Fumal, A., Schoenen, J., 2008. Tension-type headache: current research and clinical management. *Lancet Neurol* 7, 70–83.
- IHS. 2004. *Headache Classification Subcommittee of the International Headache Society: The International Classification of Headache Disorders*, second ed. *Cephalalgia* 24(Suppl. 1), 9-160
- Jensen, M.P., Turner, J.A., Romano, J.M., Fisher, L., 1999. Comparative reliability and validity of chronic pain intensity measures. *Pain* 83, 157–162.
- Lyngberg, A.C., Rasmussen, B.K., Jorgensen, T., Jensen, R., 2005. Has the prevalence of migraine and tension-type headache changed over a 12-year period? A Danish population survey. *Eur. J. Neurol* 20, 243–249.
- Phillip, D., Lyngberg, A.C., Jensen, R., 2007. Assessment of headache diagnosis: a comparative population study of a clinical interview with a diagnostic headache diary. *Cephalalgia* 27, 1–8.
- Schwartz, B.S., Stewart, W.F., Simon, D., Lipton, R.B., 1998. Epidemiology of tension type headache. *JAMA* 279, 381–383.
- Shah, J.P., Phillips, T.M., Danoff, J.V., Gerber, L.H., 2005. An in vitro microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. *J. Appl. Physiol* 99, 1977–1984.
- Simons, D.G., 2004. Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction. *J. Electromyogr. Kinesiol* 14, 95–107.
- Simons, D.G., Travell, J., Simons, L.S., 1999. *Travell and Simons' Myofascial Pain and Dysfunction: the Trigger Point Manual*, second ed., Vol. 1. Williams & Wilkins, Baltimore.
- Stovner, L., Hagen, K., Jensen, R., et al., 2007. The global burden of headache: a documentation of headache prevalence and disability worldwide. *Cephalalgia* 27, 193–210.