

ORIGINAL RESEARCH ARTICLES

Prevalence and Anatomical Localization of Muscle Referred Pain from Active Trigger Points in Head and Neck Musculature in Adults and Children with Chronic Tension-Type Headache

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Abstract

Objective. To compare differences in the prevalence and the anatomical localization of the referred pain areas of active trigger points (TrPs) in head and neck musculature between adults and children with chronic tension-type headache (CTTH).

Design. A cross-sectional study.

Setting. Some studies had found that referred pain from active TrPs reproduce the head pain pattern in adults. No study has compared clinical differences between referred pain patterns elicited by active TrPs between adults and children with CTTH.

Patients. Twenty adults (10 men, 10 women, mean age: 41 ± 11 years) and 20 children (10 boys, 10 girls, mean age: 8 ± 2 years) with CTTH were included.

Outcome Measures. Bilateral temporalis, sternocleidomastoid, upper trapezius, and suboccipital muscles were examined for TrPs. TrPs were identified by palpation and considered active when local and referred pains reproduce the headache pain attacks. The referred pain areas were drawn on anatomical maps, digitalized, and also measured. An analysis technique based on a center of gravity (COG) method was used to provide a quantitative estimate of the localization of the TrP referred pain areas.

Results. Adults with CTTH exhibited a greater years with headache, higher intensity, and longer headache duration ($P < 0.05$) compared with children. The COG coordinates of the spontaneous pain on the dominant side were located more anterior (higher X-value), and spontaneous pain in the frontal and posterior areas was located more inferior (lower Y-value) in adults than in children. The number of active muscle TrPs was significantly higher ($P = 0.001$) in adults with CTTH (mean \pm standard

deviation [SD]: 4 ± 0.8) as compared with children (mean \pm SD: 3 ± 0.7). Children with CTTH had larger referred pain areas than adults for upper trapezius, sternocleidomastoid, and temporalis ($P < 0.001$) muscles. The COG coordinates of the referred pain areas of temporalis and sternocleidomastoid muscle TrPs were more inferior (lower Y-values) in adults than in children with CTTH.

Conclusions. This study showed that the referred pain elicited from active TrPs shared similar pain patterns as spontaneous CTTH in adults and children. Differences in TrP prevalence and location of the referred pain areas can be observed between adults and children with CTTH.

Key Words. Tension-Type Headache; Trigger Points; Referred Pain; Pain Assessment

Introduction

Tension-type headache is the most common form of headache in both adults [1] and adolescents [2]. Different studies have reported an overall prevalence rate for tension-type headache ranging from 38.3% for the episodic form, and 2.2% for the chronic form in adults [3], and from 5.5% to 26% in children between 6–12 years old [4–6]. In addition, the 1-year prevalence of tension-type headache has increased from 79% to 87% in the last 12-years in the Western world [7].

Although there has been an increasing interest in the need to understand the underlying mechanisms of this type of headache, the pathophysiology is not completely understood [8]. It has been proposed that tension-type headache may originate, at least to some extent, from referred pain from muscle trigger points (TrPs) located in head, neck, and shoulder muscles [9,10]. TrPs are defined as hypersensitive spots in a taut band of a skeletal muscle that elicit a referred distant pain [11]. Active TrPs are those spots where local and referred pains reproduce the clinical pain symptom experienced by the patient (i.e., in tension-type headache active TrPs should reproduce headache pain symptoms).

Different studies have demonstrated the relevance of the referred pain elicited by TrPs in temporalis [12], suboccipital [13] upper trapezius [14], and sternocleidomastoid [15] muscles in adults with chronic tension-type headache (CTTH). These studies found that CTTH is reproduced by the referred pain elicited by active TrPs. A study has recently demonstrated that the referred pain elicited from active TrPs in head, neck, and shoulder also shared similar pain pattern as spontaneous CTTH in children [16].

Nevertheless, these studies did not provide a quantitative estimate of the localization of the TrP referred pain areas. Two previous studies have used a new analysis technique based on a center of gravity (COG) method to estimate the localization of the referred pain areas elicited by injection of hypertonic saline injection into head and neck muscles

in healthy subjects [17,18]. With this technique, it would be possible to estimate the anatomical localization of the referred pain elicited by active TrPs in pain populations.

To the best of the authors' knowledge, no previous study has investigated the differences in the prevalence of active muscle TrPs and the anatomical localization of the referred pain areas between adults and children with CTTH. Therefore, the aims of the current study were to compare the differences in the prevalence and the anatomical localization of referred pain areas of active TrPs in head and neck musculature between adults and children with CTTH. We hypothesized that adults with CTTH would exhibit a greater number of active TrPs and larger referred pain areas as compared with children with CTTH.

Materials and Methods

Subjects

Consecutive patients diagnosed with CTTH by an experienced neuropsychiatrist and neurologists presented to the Neurology Department of Hospital Quirón were screened for eligibility criteria. In all participants, headache features, temporal profile, and family history were assessed. To be included, participants had to describe all the characteristics of CTTH (International Classification for Headache Disorders-II [ICHD-II]) [19]: bilateral location, pressing or tightening pain, mild/moderate intensity (≤ 6 on a numerical pain rate scale), and no aggravation of headache during physical activity. Vomiting or evident nausea during pain attacks was not permitted. Other primary headaches and medication-overuse headache were excluded according to ICHD-II criteria [19]. No secondary headache was permitted. No participant was taken prophylactic drugs at the time of the study. Informed consent was obtained from all participants including parents in the case of children. All procedures were conducted according to the Declaration of Helsinki. Ethical approval was granted by Local Ethics Committee (FHA 043).

Self-Reported Measures

Participants completed a headache diary for 4 weeks in order to complement the diagnosis [20]. Children received the help of their parents for the headache diary. An 11-point numerical pain rate scale [21] (NPRS; range: 0: no pain, 10: maximum pain) 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 the 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).

In addition, participants were asked to draw the distribution of their spontaneous pain pattern during headache attacks in an anatomical map including lateral, frontal, and occipital projections of the face (dimensions: 65 × 80 mm,

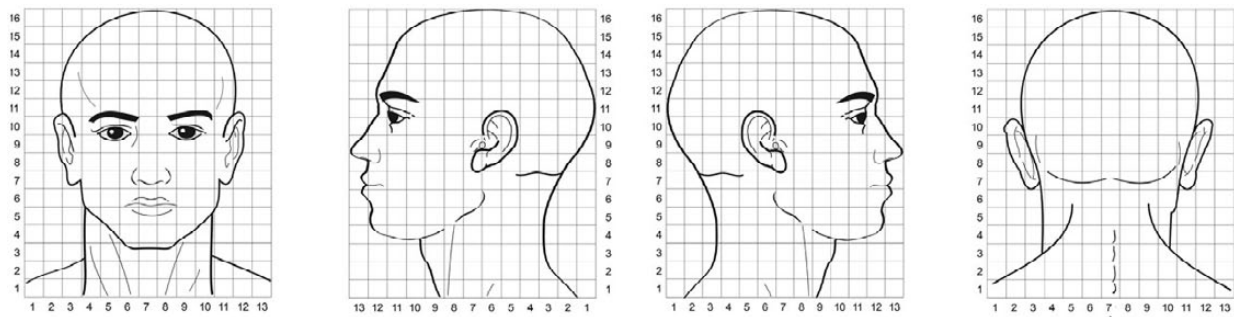


Figure 1 Schematic presentation of the center of gravity (COG) technique. The X- and Y-coordinates of the COG were calculated in a 13 × 16 grid system (see Methods).

Figure 1). The Beck Depression Inventory (BDI-II), a 21-item self-report measure assessing affective, cognitive, and somatic symptoms of depression, was used to exclude those participants with depressive symptoms (BDI-II >8 points) [22]. The BDI-II has shown good internal consistency ($\alpha = 0.86$) with higher scores indicating higher levels of depressive symptoms [23,24].

Muscle TrP Examination

Muscle TrPs were bilaterally explored within the upper trapezius, temporalis, and sternocleidomastoid muscles by an examiner with more than 10 years' experience in TrP examination. TrP diagnosis in these muscles was done following the criteria as described by Simons et al. [11]: 1) presence of a palpable taut band in a skeletal muscle; 2) presence of a hyperirritable sensitive spot within the taut band; 3) local twitch response elicited by the snapping palpation of the taut band; and 4) presence of referred pain in response to TrP compression (approximately 20 N force for 5 seconds). Gerwin et al. found that these criteria, when applied by an experienced examiner exhibit good inter-examiner reliability (kappa) ranging from 0.84 to 0.88 [25].

TrP diagnosis within the suboccipital muscles was made when there was local tenderness in the suboccipital region, referred pain with maintained pressure for 10 seconds and increased referred pain with active extension of the upper cervical spine [13].

TrPs were considered active when both the local and the referred pain evoked by the compression reproduced the spontaneous pain symptoms, and the elicited pain was familiar for the participant [11]. For that purpose, after TrP assessment on each muscle, participants were asked: "When I pressed this muscle, did you feel any pain or discomfort locally, and in other area (referred pain). Please tell me whether the pain that you felt in the other area reproduced any symptoms that you suffer from." The order of TrP evaluation was randomized between participants.

Assessment of Referred Pain Area and COG

Local pain was defined as pain located around the compression site, and referred pain was defined as the pain

located at least 1 cm outside the local pain area evoked by TrP palpation. Participants were asked to draw the distribution of the referred pain after palpation of each muscle TrP on the same anatomical map including lateral, frontal, and occipital projections of the face/neck (dimensions: 65 × 80 mm) (Figure 1). Specific information on possible referral patterns was avoided in order not to induce bias [26]. The spontaneous pain area and the TrPs referred pain areas were measured with a digitizer (ACECAD, model D9000+ digitizer, Taipei, Taiwan) to calculate the area of perceived pain expressed in arbitrary units (au).

In order to obtain a quantitative estimate of the localization of the perceived pain areas, either spontaneous pain symptoms or referred pain areas elicited by active TrPs, the COG was calculated according to previous studies [17,18]: a grid outline with 5-mm resolutions (i.e., a total of 13 × 16 = 208 grids) was superimposed on lateral, frontal, and occipital pain maps (Figure 1). Each grid in the coordinate system was assigned a value on a dichotomous basis (0: no pain, 1: pain). Therefore, the COG coordinates (X: anterior–posterior, Y: inferior–superior) in au were calculated according to the following formula:

$$x = \frac{\sum_{i=0}^{12} \sum_{j=0}^{16} (x_i \times \text{gridvalue}_{i,j})}{\sum_{i=0}^{12} \sum_{j=0}^{16} \text{gridvalue}_{i,j}}$$

$$y = \frac{\sum_{i=0}^{12} \sum_{j=0}^{16} (y_i \times \text{gridvalue}_{i,j})}{\sum_{i=0}^{12} \sum_{j=0}^{16} \text{gridvalue}_{i,j}}$$

Statistical Analysis

Data were analyzed with the SPSS statistical package (17.0 Version; SPSS Inc., Chicago, IL, USA). Results are expressed as mean, standard deviation (SD), and 95% confidence interval (95% CI). The Kolmogorov–Smirnov test was used to analyze the normal distribution of the variables ($P > 0.05$). Quantitative data without a normal distribution (i.e., pain history, headache intensity, headache frequency, headache duration, and number of active muscle TrPs) were analyzed with non-parametric tests, and data with a normal distribution (referred pain areas and X- and Y-coordinates) were analyzed with parametric tests. Differences in headache clinical parameters between groups were assessed with the non-parametric

Table 1 Headache clinical pain parameters between adults (N = 20) and children (N = 20) with chronic tension-type headache (mean \pm SD [95% CI])

	Adults with CTTH	Children with CTTH	Significance
Pain history (years)	8.6 \pm 6.5 (5.5–11.6)	1.6 \pm 0.8 (1.3–2.0)	$z = -4.929$; $P < 0.001$
Headache intensity (NPRS, 0–10)	5.9 \pm 1.1 (5.4–6.4)	5.0 \pm 1.2 (4.5–5.6)	$z = -2.382$; $P = 0.026$
Headache duration (hours/days)	7.3 \pm 2.3 (6.2–8.4)	4.8 \pm 2.6 (3.6–6.0)	$z = -2.993$; $P = 0.001$
Headache frequency (days/week)	4.3 \pm 0.6 (3.6–5.2)	4.0 \pm 0.9 (3.6–5.2)	$z = -0.554$; $P = 0.602$

SD = standard deviation; CI = confidence interval; CTTH = chronic tension-type headache; NPRS = numerical pain rating scale.

Mann–Whitney *U*-test. A two-way analysis of variance (ANOVA) with area (frontal, non-dominant dominant, posterior) as within-subjects variable and group (adults, children) as between-subjects variable was used to assess differences in spontaneous symptomatic pain areas between groups. Differences in X- and Y-coordinates of spontaneous pain areas between groups were assessed with the unpaired Student's *t*-test. Differences in the number of active TrPs between groups were assessed with the non-parametric Mann–Whitney *U*-test. The chi-square (χ^2) test was used to assess differences in the distribution of TrPs for each muscle on either side within both groups. A three-way ANOVA was used to compare referred pain areas (au) between sides (dominant/nondominant) and muscles (i.e., temporalis, upper trapezius, and sternocleidomastoid) as the within-subject factors and group (adults, children) as between-subject factor. A similar two-way ANOVA was used for the referred pain area from the suboccipital muscles but without side as factor. The Bonferroni test was used for post hoc analyses. Differences in X- and Y-coordinates of TrP referred pain areas between groups were assessed with the unpaired Student's *t*-test. Finally, the Spearman's rho (r_s) test was used to analyze the association between the number of TrPs, the referred pain areas, and clinical variables of the headache. The statistical analysis was conducted at 95% CI. A *P* value less than 0.05 was considered statistically significant.

Results

Demographic and Clinical Data of the Sample

One hundred (N = 100) consecutive patients, 60 adults and 40 children, presenting with headache between June 2009 and July 2010 were screened. Forty (66%) adults (concomitant migraine (N = 25), fibromyalgia syndrome (N = 7), previous whiplash (N = 8) and 20 (50%) children (hemi-cranial headache [N = 12], high levels of depression [N = 8]) were excluded. Finally, a total of 20 children, 10 boys and 10 girls, aged 6–12 years old (mean: 8 ± 2 years) and 20 adults, 10 men and 10 women, aged 18–47 years (mean: 41 ± 11 years) satisfied all the inclusion criteria and agreed to participate. In our sample, adults with CTTH exhibited greater years with headache from the onset, higher intensity, and longer headache duration

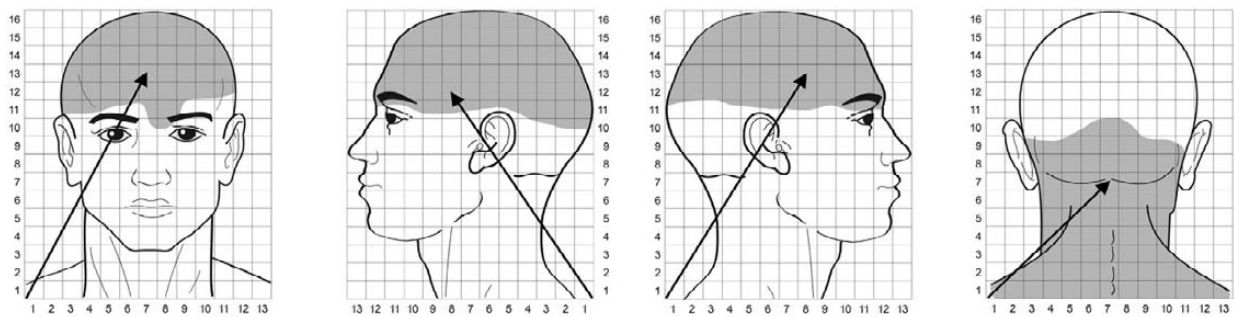
($P < 0.05$) compared with children with CTTH. No significant differences in headache frequency ($P > 0.60$) between adults and children with CTTH were found. Table 1 summarizes clinical and demographic data of the two groups.

Spontaneous Pain Areas

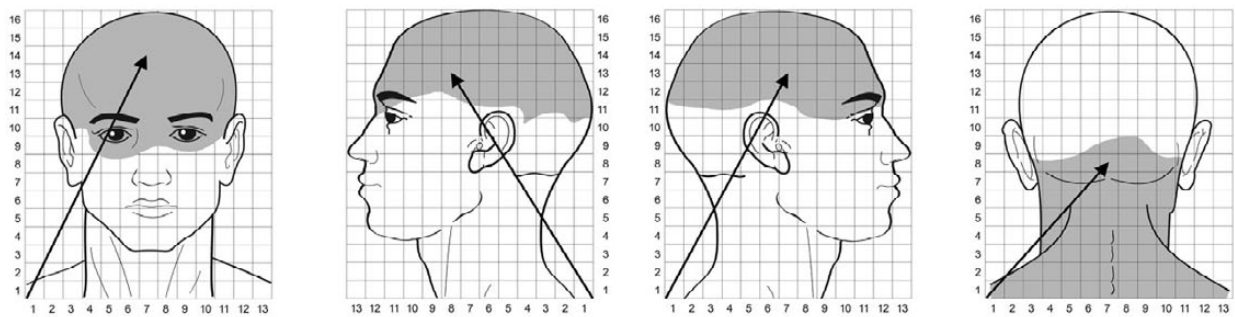
The mean spontaneous pain area in adults with CTTH was 48.6 au (95% CI 34.9–62.3) in the frontal region (N = 20, 100%), 84.5 au (95% CI 70.8–98.3) in the occipital region (N = 20, 100%) including the posterior part of the neck, 33.5 au (95% CI 19.8–47.2) on the dominant side of the head (N = 20, 100%), and 29.2 au (95% CI 15.4–42.8) in the non-dominant of the face (N = 20, 100%). Children with CTTH reported a mean spontaneous pain area of 59.1 au (95% CI 44.6–73.6) in the frontal region (N = 18, 90%), 59.9 au (95% CI 40.4–79.3) in the occipital region (N = 11, 55%) including the posterior part of the neck, 33.9 au (95% CI 16.2–51.6) on the dominant side of the head (N = 10, 50%), and 29.4 au (95% CI 10.9–47.9) on the non-dominant side of the face (N = 12, 60%).

The ANOVA indicated a significant difference between regions ($F = 11.443$; $P < 0.001$) but not between group ($F = 0.364$; $P = 0.548$) for spontaneous pain area. The post hoc analysis revealed that the pain area in the posterior region of the head was significantly larger ($P < 0.01$) than the other pain areas and that the frontal pain area was significantly larger than the dominant ($P < 0.05$) and non-dominant ($P = 0.009$) areas. No significant associations between headache intensity, frequency, or duration and spontaneous pain areas in either group were found ($P > 0.289$).

Additionally, significant differences between the location of the X-coordinate on the dominant side ($t = -2.155$; $P = 0.040$), Y-coordinate in the frontal ($t = -2.853$; $P = 0.007$), and posterior ($t = -2.822$; $P = 0.011$) areas: the pain areas in adults with CTTH were located more inferior (lower Y-value) and anterior (higher X-value) than in children with CTTH. No significant differences for the remaining coordinates of the COG between children and adults with CTTH were found ($P > 0.258$, Figure 2). Table 2 shows the mean values of X- and Y-coordinates of the COG for adults and children with CTTH.



Spontaneous pain in adults with CTTH



Spontaneous pain in children with CTTH

Figure 2 Center of gravity (COG) and areas of the spontaneous pain symptoms in adults (top) and children (bottom) with CTTH. The length of the pain vector (arrow) is computed in arbitrary units. CTTH = chronic tension-type headache.

Prevalence of Muscle TrPs

The mean \pm SD number of active muscle TrPs of each adult with CTTH was 4 ± 0.8 , whereas each child with CTTH shows 3 ± 0.7 active TrPs: the number of active TrPs was significantly higher in adults with CTTH as compared with children with CTTH ($z = -3.242$; $P = 0.001$). No

significant association between the number of active TrPs and any clinical headache parameter was found in either adults or children with CTTH.

The distribution of active muscle TrPs between adults and children with CTTH was significantly different for the dominant upper trapezius (both sides: $\chi^2 = 16.942$, $P < 0.001$),

Table 2 Center-of-gravity (COG) measurements of spontaneous pain drawing in adults ($N = 20$) and children ($N = 20$) with chronic tension-type headache (CTTH) (mean \pm SD [95% CI])

	Front Projection		Posterior Projection		Dominant (Right) Side		Non-Dominant (Left) Side	
	X	Y*	X	Y*	X*	Y	X	Y
Adults	7.0 ± 0.6 (6.7–7.2)	13.0 ± 1.0 (12.5–13.5)	6.9 ± 0.2 (6.8–7.0)	6.6 ± 1.8 (5.7–7.6)	8.2 ± 1.4 (7.4–8.9)	13.0 ± 2.0 (12.0–14.0)	8.3 ± 1.5 (7.5–8.2)	12.6 ± 1.6 (11.8–13.4)
Children	6.7 ± 0.6 (6.4–7.0)	13.7 ± 0.5 (13.5–14.0)	7.0 ± 0.1 (7.0–7.1)	8.4 ± 3.0 (6.2–10.5)	7.0 ± 1.7 (6.0–8.0)	13.1 ± 2.6 (11.5–14.6)	7.7 ± 1.2 (6.9–8.5)	13.2 ± 1.2 (12.4–14.0)

* Significant differences between adults and children with CTTH (Student's t -test, $P < 0.05$).
SD = standard deviation; CI = confidence interval.

Table 3 Number of adults and children with chronic tension-type headache (N) with active muscle trigger points (TrPs) in head and neck shoulder muscles

Adults with Chronic Tension-Type Headache (N = 20)							
	Upper trapezius muscle		Sternocleidomastoid muscle		Temporalis muscle		Suboccipital muscles
	Right side	Left side	Right side	Left side	Right side	Left side	Bilateral
Active TrPs (N)	16	7	6	8	13	11	20
No TrPs (N)	4	13	14	12	7	9	0

Children with Chronic Tension-Type Headache (N = 20)							
	Upper trapezius muscle		Sternocleidomastoid muscle		Temporalis muscle		Suboccipital muscles
	Right side	Left side	Right side	Left side	Right side	Left side	Bilateral
Active TrPs (N)	3	4	5	2	15	14	16
No TrPs (N)	17	16	15	18	5	6	4

and non-dominant sternocleidomastoid ($\chi^2 = 4.800$, $P = 0.032$): a greater number of adults exhibited active TrPs in these muscles compared with children with CTTH. No significant differences in the distribution of both temporalis (dominant: $\chi^2 = 0.476$, $P = 0.731$; non-dominant: $\chi^2 = 0.960$, $P = 0.514$), non-dominant upper trapezius ($\chi^2 = 1.129$, $P = 0.480$), dominant sternocleidomastoid ($\chi^2 = 0.125$, $P = 0.946$), and suboccipital ($\chi^2 = 2.500$, $P = 0.106$) muscles were found between groups. Table 3 details the distribution of TrPs in both adults and children with CTTH.

TrP Referred Pain Areas

A three-way ANOVA showed significant differences in referred pain areas between groups ($F = 17.412$, $P < 0.001$) and muscles ($F = 29.462$, $P < 0.001$) but not between sides ($F = 1.382$; $P = 0.241$). No significant interactions between group \times muscle ($F = 0.347$, $P = 0.708$), group \times side ($F = 0.155$, $P = 0.694$), side \times muscle ($F = 1.426$, $P = 0.237$), or group \times muscle \times side ($F = 0.087$,

$P = 0.917$) were found. The two-way ANOVA for the suboccipital musculature revealed significant differences between muscles ($F = 26.729$, $P < 0.001$) but not between groups ($F = 1.688$, $P = 0.122$). Children with CTTH showed larger referred pain areas as compared with adults with CTTH for upper trapezius, sternocleidomastoid, and temporalis ($P < 0.001$) but not for the suboccipital muscles ($P = 0.233$). The Bonferroni post hoc analyses revealed that the referred pain areas elicited by suboccipital TrPs was significantly larger than the referred pain elicited from all other muscles ($P < 0.001$). Furthermore, the referred pain area from upper trapezius TrPs was significantly larger than the referred pain areas from sternocleidomastoid and temporalis muscle TrPs in adults ($P < 0.05$) but not in children ($P > 0.347$) with CTTH. Table 4 details the size of the referred pain areas in the examined muscles in adults and children with CTTH.

Furthermore, significant differences between Y-coordinates in the sternocleidomastoid muscles on both sides (dominant: $t = -13.801$, $P < 0.001$; non-dominant:

Table 4 Referred pain areas (au) of active trigger points (TrPs) in head and neck-shoulder muscles in adults and children with chronic tension-type headache (CTTH)

	Adults with Chronic Tension-Type Headache		Children with Chronic Tension-Type Headache	
Upper Trapezius*	Right side (N = 16)	16.0 \pm 24.7 (4.4–27.5)	Right side (N = 5)	32.3 \pm 10.0 (20.1–44.6)
	Left side (N = 7)	37.8 \pm 26.1 (25.6–50.0)	Left side (N = 2)	46.0 \pm 9.9 (43.3–135.3)
Sternocleidomastoid*	Right side (N = 6)	6.3 \pm 11.6 (0.8–11.6)	Right side (N = 5)	27.8 \pm 4.2 (22.5–33.1)
	Left side (N = 8)	6.8 \pm 14.4 (0.0–13.6)	Left side (N = 3)	26.3 \pm 2.8 (19.4–33.3)
Temporalis*	Right side (N = 13)	9.6 \pm 10.7 (4.6–14.7)	Right side (N = 15)	29.0 \pm 14.5 (20.9–37.0)
	Left side (N = 11)	10.7 \pm 12.0 (5.1–16.3)	Left side (N = 14)	31.1 \pm 21.5 (18.7–43.5)
Suboccipital	Bilateral (N = 20)	52.2 \pm 27.0 (39.5–55.4)	Bilateral (N = 16)	68.6 \pm 31.5 (51.9–85.4)

* Significant differences between adults and children with CTTH (a three-way mixed ANOVA, $P < 0.01$). ANOVA = analysis of variance.

$t = -4.198$, $P = 0.004$) and in the temporalis muscles on both sides (dominant: $t = -2.439$, $P = 0.022$; non-dominant: $t = -4.440$, $P = 0.005$) were found: the TrP referred pain areas in adults (Figure 3) with CTTH were located more inferior (lower Y-values) than in children (Figure 4). No significant differences for the remaining coordinates of TrP-referred pain COG between children and adults with CTTH were found ($P > 0.217$). Table 5 summarizes mean values of X- and Y-coordinates of the COG of TrP referred pain areas for adults and children with CTTH.

Finally, no significant correlation between the size of the TrP referred pain area and clinical headache pain parameters was found in either adults or children with CTTH.

Discussion

This study showed that the referred pain elicited from active TrPs reproduced the headache pattern in both adults and children with CTTH. Additionally, some differences in TrP prevalence and location of the referred pain areas was observed between adults and children with CTTH, as adults had more active TrPs in the upper trapezius and in the left sternocleidomastoid muscles, whereas children exhibited larger referred pain areas than adults with CTTH. Furthermore, the location of the referred pain areas of sternocleidomastoid and temporalis muscle TrPs was located more inferior in adults than in children with CTTH.

We found that adults exhibited a longer duration since headache onset, higher intensity, and longer headache duration as compared with children with CTTH. It would be expected that adults suffered from headache from a longer period of time than children; however, the present results suggest that headache is also rated more severe in adults. Another difference was that spontaneous pain on the dominant side was more anterior (higher X-value) whereas spontaneous pain in the frontal and posterior areas were more inferior (lower Y-value) in adults with CTTH than in children with CTTH. These findings suggest that the perceived pain area can change over time.

The present study supports previous findings that active TrPs are involved in the pathophysiology and manifestation of CTTH, in a similar way, in adults and children with CTTH [10,16]. In fact, an important finding was that subjects were explored on a headache-free day. Nevertheless, some clinical differences and similarities between adults and children with CTTH need to be discussed. First, both adults and children with CTTH showed a very similar pattern of spontaneous pain areas, which can be related to the diagnosis of the pain condition and furthermore suggests that mapping pain areas on body diagrams is a reliable method to localize the patient's symptoms [27]. Our results support that the spontaneous pain pattern of CTTH is consistent as both groups exhibited very similar locations. Second, adults with CTTH showed a greater number of active TrPs than children with CTTH, which may be expected because adults had an almost four times

greater longer duration since onset of the headache than children with CTTH. It is possible that a greater number of active muscle TrPs will develop over time. From the present findings, we can speculate that there will be a continuum of TrP development in CTTH if pain is not properly managed. Longitudinal studies are required to further elucidate the evolution of active TrPs with time in CTTH. Third, the presence of upper trapezius TrPs was significantly higher in adults than children with CTTH, particularly within the dominant side, which may be related to the use of the repetitive use of the muscle on the dominant side in adults [28]. In such a way, a greater prevalence of active TrPs in the upper trapezius muscle may be a clinical and work-related difference between adults and children with CTTH. The relevance of the current finding should be explored in randomized clinical trials.

One surprising finding was that children with CTTH exhibited larger referred pain areas than adults with CTTH, which suggests that sensitization mechanisms involved in TrP referred pain may be more pronounced in children than in adults with CTTH. Another possible explanation could be that children are more hyper-vigilant than adults, although there is no prior research to support this claim. Finally, it could be argued that children with CTTH do not accurately draw their pain areas on the maps, although there is no evidence to suggest this. Future studies are needed to elucidate the differences in sensitization mechanisms between adults and children with CTTH.

Independently of the demonstrated clinical differences between adults and children with CTTH, the present results support the role of active TrPs in CTTH. Fernández-de-las-Peñas et al. formulated a pain model for adults with CTTH involving peripheral sensitization from active TrPs and central sensitization: active TrPs in the muscles innervated by C1–C3 segments or the trigeminal nerve would be responsible for the peripheral input creating a continuous and prolonged nociceptive afferent barrage into the trigemino-cervical nucleus caudalis, which would lead to sensitization of the central nervous system [10]. It is possible that this pain model can also be applied to children with CTTH. However, we recognize that we cannot establish a cause-and-effect relationship between TrPs and CTTH as the design of the current study was not longitudinal. Future trials investigating the effects of TrP treatment in adults and children with CTTH are needed to further elucidate the etiologic role of active TrPs in CTTH.

Conclusion

This study showed that the referred pain elicited from active TrPs reproduced a familiar headache pattern in both adults and children with CTTH. Adults with CTTH had more active TrPs in upper trapezius and left sternocleidomastoid muscles than children with CTTH. Children with CTTH exhibited larger TrP referred pain areas than adult. The current findings suggest that there are some differences in TrP prevalence and location of the referred pain areas between adults and children with CTTH.

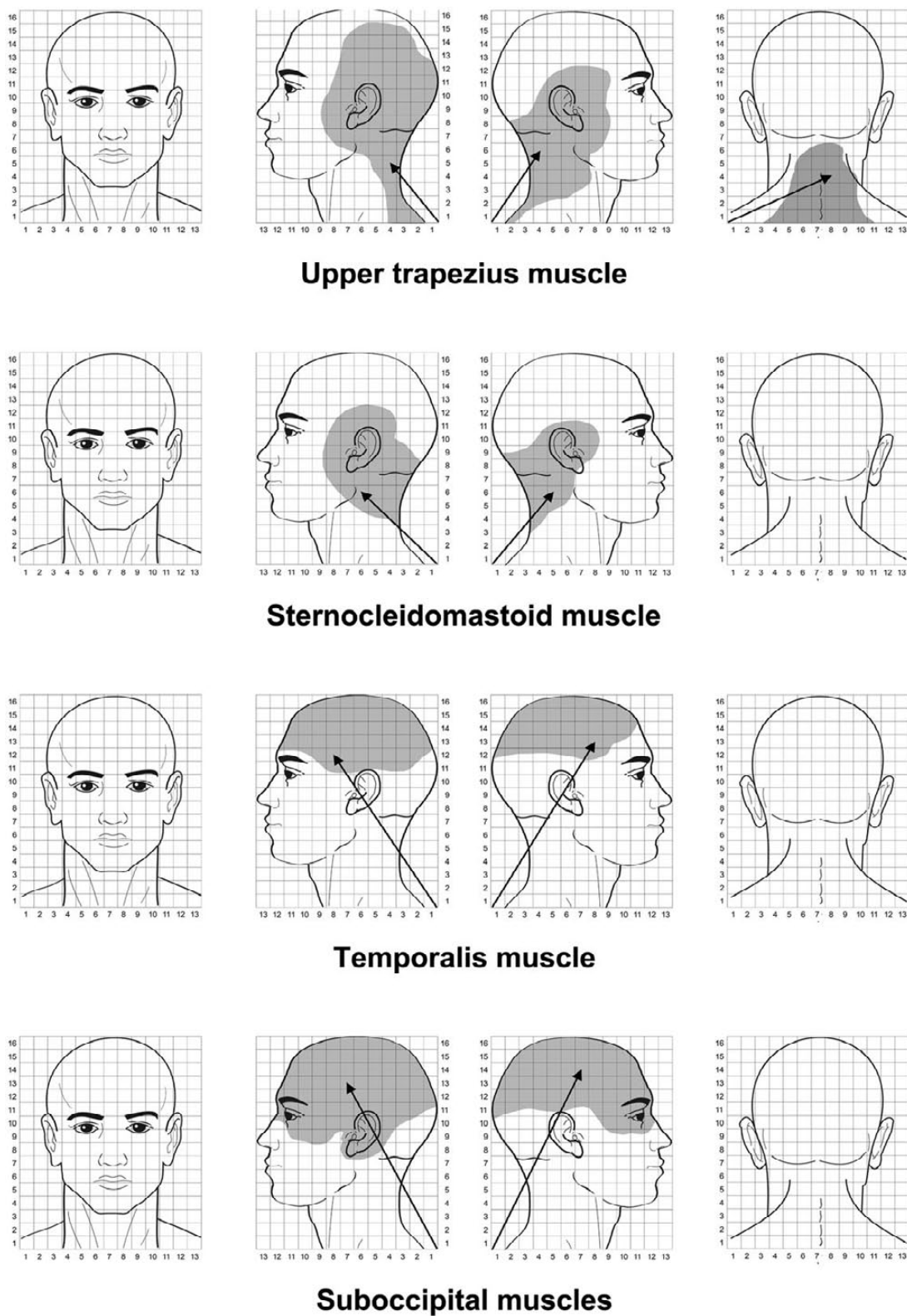


Figure 3 Center of gravity (COG) and areas of the referred pain elicited by active trigger points in adults with CTTH. The length of the pain vector (arrow) is computed in arbitrary units. CTTH = chronic tension-type headache.

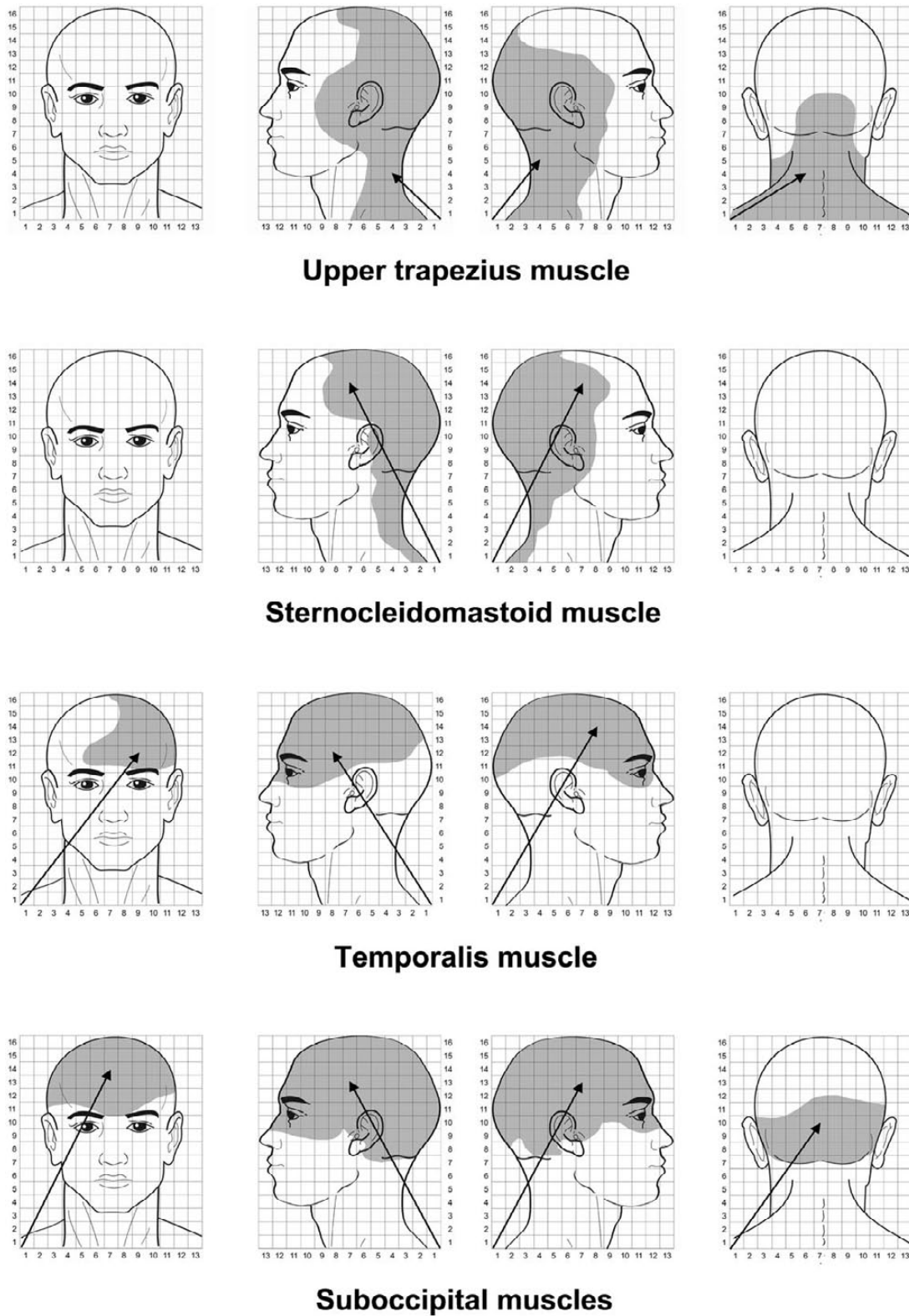


Figure 4 Center of gravity (COG) and areas of the referred pain elicited by active trigger points in children with CTTH. The length of the pain vector (arrow) is computed in arbitrary units. CTTH = chronic tension-type headache.

Table 5 Center of gravity (COG) measurements of referred pain drawing in adults and children with chronic tension-type headache (CTTH) (mean \pm SD [95% CI])

	Front Projection		Occipital Projection		Dominant (Right) Side		Non-Dominant (Left) Side	
	X	Y	X	Y	X	Y	X	Y
Upper trapezius muscle								
Adults	NA	NA	8.2 \pm 2.3 (6.4–10.0)	4.0 \pm 1.2 (3.2–5.0)	4.2 \pm 0.8 (3.7–4.6)	6.0 \pm 1.3 (5.4–6.8)	3.8 \pm 0.7 (2.9–4.7)	4.9 \pm 2.3 (2.1–7.7)
Children	NA	NA	6.3 \pm 2.6 (2.1–10.4)	4.0 \pm 0.9 (2.5–5.5)	3.9 \pm 0.2 (3.4–4.4)	5.4 \pm 0.2 (5.0–5.7)	3.6 \pm 0.5 (2.5–4.8)	3.9 \pm 1.1 (1.2–6.6)
Sternocleidomastoid muscle								
Adults	NA	NA	NA	NA	5.4 \pm 1.5 (1.7–9.2)	5.8 \pm 0.7* (4.1–7.5)	5.5 \pm 1.0 (4.5–6.5)	5.8 \pm 3.2* (2.4–9.1)
Children	NA	NA	NA	NA	7.1 \pm 1.1 (5.8–8.5)	13.8 \pm 0.8 (12.8–14.8)	6.7 \pm 0.2 (6.1–7.2)	14.0 \pm 1.0 (11.5–16.5)
Suboccipital muscles								
Adults	NA	NA	NA	NA	6.9 \pm 0.6 (6.6–7.2)	13.6 \pm 0.6 (13.2–14.0)	6.8 \pm 1.0 (6.3–7.4)	13.0 \pm 0.7 (12.6–13.4)
Children	6.7 \pm 0.3 (6.5–6.9)	13.9 \pm 0.5 (13.5–14.3)	7.1 \pm 0.3 (6.8–7.4)	9.71 \pm 2.8 (7.1–12.2)	7.0 \pm 0.3 (6.5–7.4)	14.3 \pm 1.3 (12.2–16.3)	6.9 \pm 0.5 (6.0–7.6)	14.3 \pm 0.5 (13.4–15.0)
Temporalis muscle								
Adults	NA	NA	NA	NA	7.6 \pm 0.7 (7.2–8.1)	12.8 \pm 0.9* (12.3–13.4)	7.8 \pm 1.1 (7.1–8.5)	12.4 \pm 0.8* (11.7–12.9)
Children	8.8 \pm 3.6 (3.1–14.4)	12.0 \pm 3.4 (6.6–17.4)	NA	NA	7.8 \pm 1.2 (7.1–8.5)	13.6 \pm 0.7 (13.2–14.0)	7.8 \pm 1.3 (7.0–8.5)	13.6 \pm 0.6 (13.3–14.0)

* Significant differences between adults and children with CTTH (Student's *t*-test, $P < 0.05$).

NA = not applicable (there was no referred pain to this area of the head); SD = standard deviation; CI = confidence interval.

Conflict of Interest/Competing Interests

None to declare.

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