Neuromusculoskeletal Medicine (OMT) Review Article

Tara Talebi-Talghian*, BS, Paulyna Schulz, MS and Teodor Huzij, DO

Neuropsychiatric considerations in treating anorexia nervosa patients with osteopathic manipulative medicine: a narrative review

https://doi.org/10.1515/jom-2023-0242
Received November 29, 2023; accepted June 28, 2024;
published online July 29, 2024

Abstract: Osteopathic manipulative medicine (OMM) has a growing recognition in serving as an effective treatment to promote adaptation and homeostasis of the body by addressing musculoskeletal, neural, vascular, and lymphatic structures to promote self-healing and regulation. OMM can treat the musculoskeletal tension and sympathetic hyperactivity resulting from the increased cortisol response and hypersensitivity found in varying psychiatric illnesses, including anorexia nervosa (AN). This paper addresses the considerations necessary for treating AN patients with OMM, emphasizing the need to evaluate their abnormal high-level neuronal processing of sensory information, including differences in touch perception compared to the general population. Current literature was gathered utilizing a combination of the following keywords: anorexia nervosa, perception of touch, and osteopathic manipulative medicine/treatment. No literature was found addressing the effects of OMM on treating AN patients. Eight studies addressed the change in perception of touch found in AN patients. Results of the literature review reveal that the perceptions of touch in AN patients are distorted and can lead to reduced perceived pleasantness encountered in social interactions and touch. Specific changes have been found in C-tactile (CT) afferents responsible for the positive effects of touch, thus influencing emotional regulation. The significance of addressing this topic is to provide insight into the pathophysiological processes of AN and to inform physicians of unconventional stimuli that may exacerbate AN symptoms and behaviors. Further study is required to elucidate the role and mechanism of OMM in patients with AN and whether manual therapy could worsen pathological behavior and thinking patterns seen in AN patients. Such studies could include, but are not limited to, examining biological factors such as cortisol levels in AN patients receiving OMM and collecting data about AN patients' thinking patterns and behavior during OMM treatment.

Keywords: anorexia nervosa; osteopathic manipulative medicine; osteopathic manipulative treatment; perception of touch

Osteopathic manipulative medicine (OMM) has a growing recognition in serving as an effective treatment to promote adaptation and homeostasis of the body [1]. Manipulative treatment targets musculoskeletal, neural, vascular, visceral, and lymphatic structures to promote self-healing and regulation [2]. The applicability of OMM is versatile and includes addressing the physical and emotional manifestations of psychiatric conditions [3]. OMM has been recognized as a useful treatment in managing somatic dysfunctions seen in psychiatric patients influenced by the psychosomatic pathway, as well as decreasing anxiety and depression symptoms [3–4]. Although current research lacks studies specifically evaluating the effects of OMM on the managements of anorexia nervosa (AN), literature has addressed utilizing OMM as an adjunct therapy in addressing pubertal pathological manifestations induced by malnutrition primarily by optimizing lymphatic flow to mitigate endocrine dysfunctions [5]. However, further investigation is warranted to determine its specific benefits for patients with AN [5].

Additionally, studies suggest that AN patients have an altered perception of touch that may influence pathogenesis and behavioral presentations [6–13]. This paper reviews existing research and discusses the potential considerations for treating AN patients with OMM, based on the current understanding of their pathophysiology and unique change in touch perception. The significance of addressing this topic is to provide insight into the pathophysiological processes of AN and inform physicians of unconventional stimuli that may

***Corresponding author: Tara Talebi-Talghian**, BS, College of Osteopathic Medicine, Rocky Vista University, 8401 S. Chambers Road, Englewood, CO 80112, USA, E-mail: tara.talebi-talghian@co.rvu.edu. https://orcid.org/0000-0002-7687-9790
Paulyna Schulz, MS, College of Osteopathic Medicine, Rocky Vista University, Englewood, CO, USA. https://orcid.org/0009-0008-0589-8557
Teodor Huzij, DO, Department of Osteopathic Principles and Practice, Idaho College of Osteopathic Medicine, Meridian, ID, USA

exacerbate AN symptoms and behaviors. To investigate this relationship, this review discusses the etiology and pathophysiology of AN, alterations in touch perception within AN, and the utilization of OMM in the treatment of AN patients.

Anorexia nervosa

AN is an eating disorder that impacts adults worldwide and can lead to various complications, including death, when not appropriately treated [14]. Unfortunately, due to the nature of the disorder and spectrum of presentations, AN patients experience delays in treatment and misdiagnosis. In females, the highest incidence of AN is around the age of 15 but appears to be increasing in 10–14 year olds [14]. The data of the peak incidence in males is conflicting and remains unclear, as some suggest it is 12–13 years old whereas other data suggest that it is 16 years old. The lifetime prevalence of AN is up to 4 % in females and up to 0.3 % in males [14].

AN is characterized by weight loss or difficulty maintaining the appropriate body weight for height, age, and stature (body mass index [BMI] < 18.5 kg/m^2). Per the DSM-5-TR, there are three primary diagnostic features of AN: (1) persistent caloric intake restriction; (2) intense fear of weight gain and/or persistent behavior that prevents weight gain; and (3) persistent lack of recognition of the severity of the low body weight [15]. Diagnosis of AN can be further specified as two subtypes: (1) restricting type; and (2) binge-eating/purging type. Restricting type involves weight loss primarily achieved through dieting, fasting, and/or excessive exercise. In contrast, the binge-eating/purging type involves recurrent episodes of binge-eating or purging behavior, such as vomiting or the abuse of laxatives, enemas, or diuretics [15].

Body image disturbances that present with AN appear similar to body dysmorphic disorder (BDD), thus it is important to delineate these two pathologies. As presented in the DSM-5-TR, AN is an eating disorder, while BDD is an obsessive-compulsive-related disorder [16]. BDD is defined as an excessive preoccupation with one or more perceived flaws or defects in appearance that are not observable or appear slight to others. This excessive preoccupation with a self-perceived physical anomaly leads to compulsive behaviors such as repetitive examination, hiding, or increased efforts to improve the perceived defect [16]. Examples of behaviors include repetitive mirror checking, continually comparing one's appearance to another, excessive grooming, or excessive reassurance seeking [17].

Despite differences, AN and BDD have comparable onset, with BDD typically preceding AN [17]. Several studies have observed considerable comorbidity between AN and BDD because they commonly co-occur with overlapping features [17]. An interview-based investigation of AN patients found that 25 % of female patients showed BDD symptoms before exhibiting signs of AN behavior. In contrast, no patients with bulimia nervosa showed comorbidity of prior BDD [17]. AN and BDD affect a wide range of populations but are most prevalent in females ages 10–25. Grant et al. [18] reported that 39 % of 41 AN patients had a comorbid lifetime diagnosis of BDD unrelated to body image appearance or weight. Another study found that symptoms of BDD were present in 25 % of AN patients [19]. Because the data show such a strong comorbid relationship between AN and BDD, both should be considered clinically and diagnostically.

Pathophysiology of anorexia nervosa

The hypothalamic-pituitary-adrenal (HPA) axis is the body's primary neurohormone system that contributes to homeostasis by regulating physiological processes, including metabolism, immune response, and the autonomic nervous system during stress [20]. Increased HPA axis activity has been shown to influence the onset and course of AN [20]. AN patients experience a wide variety of neurohormone changes; cortisol and dopamine appear to play the greatest role in AN pathophysiology [20, 21]. A review of multiple studies showed that increased salivary cortisol levels in AN patients are a potential consequence of chronic food restriction and an adaptation to starvation [20]. Specifically, a study conducted by Shibuya et al. [20] measuring salivary cortisol showed that the mean cortisol levels at every 2-hour interval from 9 am to 7 pm were significantly higher in AN subjects than those in the control group.

High cortisol levels affect the HPA axis by decreasing gonadotropin-releasing hormone (GnRH) and luteinizing hormone (LH) pulsation, disrupting the menstrual cycle in female AN patients [20]. Thus, there is an inverse relationship between cortisol levels and menstrual frequency, which often results in secondary amenorrhea from decreased estrogen levels. Additionally, the reduced estrogen leads to increased bone resorption and turnover, whereas the excess cortisol impairs calcium absorption from the gut, inhibits osteoblasts, and stimulates osteoclasts, further contributing to low bone density [20].

Dopamine-releasing neurons of the ventral tegmental area (VTA) are central in reward processing, motivational and goal-directed behaviors [21]. VTA dopamine is theorized to operate primarily through projections from the midbrain through the mesolimbic pathway into the ventral striatum. Increased dopamine in the mesolimbic reward pathway is significant in reinforcing and maintaining primary reward, development of addictive behavior, and habit formation. In AN patients, neuroendocrine studies have shown increased D2/D3 receptor binding in the ventral striatum [21]. Furthermore, due to caloric restriction, AN patients have increased cortisol levels and reduced leptin signaling in the VTA, contributing to elevated mesolimbic dopamine levels [21]. As a result, increased VTA dopamine is implicated in reinforcing the behaviors of AN patients.

Touch perception and osteopathic manipulative medicine in trauma patients

When investigating and understanding the perception of touch and its impact, it is important to consider other psychiatric populations who are considered touch-sensitive, such as trauma patients, and their responses to touch-based therapies. Research focusing on the effects of body therapy (moderate pressure massage) for posttraumatic stress disorder (PTSD) patients has been shown to increase the release of oxytocin, induce parasympathetic relaxation, and to reduce cortisol activity [22]. Furthermore, an integrative review of touch-based intervention for PTSD patients revealed that touch-based therapies can play an integral role in supporting emotional regulation and reducing PTSD-related symptoms [22].

Field et al. [23] studied the effects of massage therapy on women who experienced sexual abuse. Women who were given massage therapy reported an immediate decrease in depression, anxiety, and stress-related symptoms and had unchanged attitudes toward touch. In comparison, women who did not receive massage therapy had increased negative attitudes toward touch [23]. It is suspected that if the massage therapy was continued, women receiving massage therapy may have experienced decreased negative attitudes toward touch. This study revealed the impact that appropriate and positive touch can have in the healing process of sexual abuse victims [23].

OMM has been studied to be an effective approach in helping manage the psychological and physical symptoms of PTSD [24, 25]. OMM for PTSD patients focuses on the nervous and circulatory systems, spine, viscera, cranium, and diaphragms to restore homeostatic balance and normalize autonomic activity to optimize a patient's ability to adapt and respond to stressors appropriately [24]. Craniosacral therapy for veterans with PTSD and traumatic brain injury has been found to reduce the frequency of headaches and anxiety-related PTSD symptoms [25]. This specific treatment approach focuses on cranial manipulation, requiring a very light touch during treatment [25]. However, despite the improvements in headache and anxiety symptoms, data suggest a potential exacerbation of PTSD symptoms, as evidenced by an increase in mean PTSD scores post-intervention. The utilization of touch provided by OMM has been linked to opportunities for patients with PTSD to regain relaxation, normalize autonomic control mechanisms, and alleviate headache severity [24, 25]. Nevertheless, the effectiveness of touch-based therapy in improving PTSD symptoms remains uncertain.

Methods

Two targeted literature searches were conducted independently by two authors (TT and PS) utilizing published articles in English from 2000 to 2023 in Google Scholar. First, the authors investigated literature addressing altered tactile perception and pathophysiology in AN with the following search terms: "tactile," "perception," "touch," and "anorexia nervosa," which were included in the title and not included in citations. This yielded 83 publications. To narrow the results, the following exclusion criteria were applied: bulimia, binge, and orthorexia. This decreased the search results to 78 publications. A second literature investigation was conducted to find articles addressing the use of OMM in patients with AN. The following search terms were utilized: "anorexia nervosa," "osteopathic manipulative medicine," "OMM," and "OMT" (osteopathic manipulative treatment). This yielded 29 articles.

For both searches, abstracts were utilized to determine relevance, with frequent in-person discussions between authors to adjudge any disagreements if presented. A hand search for articles cited in the selected articles was also performed to ensure that relevant articles were not missed. Eight articles were identified that explored changes in tactile perception among AN patients. Only one article discussed the utility of OMM in treating adolescents with AN as a protocol study [26]. Thus, no data reveals the effects of OMM in AN patients.

Discussion

Touch perception in anorexia nervosa

Body image disturbances in AN and BDD patients can be linked to abnormal high-level neuronal processing of sensory information, including differences in perception of touch compared to the general population [10]. This change in perception has been investigated by studying the C-tactile (CT) afferents associated with affective touch [7–10]. These afferents are responsible for the positive effects of touch, thus influencing emotional regulation [10, 27, 28]. The specific pathway of CT afferents is not entirely understood. It is theorized that these unmyelinated primary afferents ascend in the lamina I-spinothalamic tract and target the contralateral dorsal posterior insular cortex [27]. The insular cortex has been recognized to be the gateway between sensory systems and emotional processing in the frontal lobe [28]. This explains the role of CT afferents in processing the pleasantness of touch and influencing emotional regulation [10, 27, 28]. It is further hypothesized that CT afferent information is additionally processed in the brainstem and diencephalic homeostatic regions, which may influence parasympathetic and neurohormonal processes of the body that contribute to pleasantness and safety [27]. Through these pathways, CT afferents may also contribute to interoceptive awareness about hunger and thirst [27, 28].

Studies involving two-point discrimination testing showed that AN patients overestimate distances between tactile stimuli in addition to visually overestimating images of their bodies [10, 12]. The perception of interpersonal affective touch and its social modulation was examined in AN patients because social difficulties in AN patients have been found to be associated with a lack of pleasant feelings during social interaction [9]. The study results suggested that AN patients have impaired CT-based affective touch systems that could reduce perceived pleasantness in social interactions and touch [9]. Tagini et al. [13] further investigated the role of affective touch in relationship to social anhedonia in AN patients and discovered that affective touch was preserved in their AN sample population. However, it was addressed that multiple factors contribute to the perceived pleasantness of affective touch in social interaction such as comorbid psychopathology and lack of affective touch exposure in infancy [13]. The impairment in CT afferents can remain after recovery, which could explain the prolonged effects of AN in decreased pleasantness of touch [6, 9]. More specifically, individual differences in the dysmorphic appearance of the body and emotional awareness might be associated with touch perceptions across body sites. Cazzato et al. [7] investigated the pleasantness rating of touch in AN patients across varying body sites, including the palms, forearm, face, and abdomen. The patients reported the lowest pleasant ratings for the abdomen [7].

To provide a more insightful understanding of neural dysfunction in AN patients, visuospatial and somatosensory cortical processing was explored via functional magnetic resonance imaging (fMRI) [11]. Compared to a control group of healthy females, underweight AN patients displayed increased activation of the left superior parietal cortex encompassing the primary somatosensory cortex, even without visual information [11]. The study claimed that this altered connectivity might indicate dysfunctional processing of somatosensory information regarding body size [11]. This affects current visual memories, leading to a failure to integrate visual and somatosensory perceptual information [11]. The disruption of brain connectivity and increased activation of the somatosensory cortex involved in visual perception, proprioception, and touch may lead to alterations in perceived touch and exacerbate body image disturbances in AN patients [11].

Osteopathic manipulative medicine in anorexia nervosa

A foundational component of osteopathic medicine is the diagnosis and treatment of somatic dysfunction: “impaired or altered functional states of the human body characterized by positional asymmetry, restrictions in motion, tissue texture changes and/or tenderness.” [2] This treatment approach allows osteopathic physicians to evaluate the complex viscero-visceral, somato-visceral, somato-psychological, and psycho-somatic relationships in a patient, which optimizes the ability to treat a patient holistically. Psycho-somatic disorders, or the disrupted interaction between the mind and body, are a group of disorders presenting with physical conditions that are affected by emotional states [29, 30]. AN and BDD are categorized as psychosomatic disorders [30]. OMM can treat musculoskeletal tension and sympathetic hyperactivity found in varying psychiatric illnesses such as schizophrenia, depression, anxiety, obsessive-compulsive disorder, PTSD, AN and BDD [3, 4, 24, 25].

Further review of the osteopathic literature suggests that OMM can influence endocrine pathways that may be disrupted in adolescents experiencing puberty and malnutrition [5]. In severe cases of AN, nutritional deficiency, anxiety, and other clinical manifestations can lead to endocrine dysfunction, such as amenorrhea and high cortisol levels [5, 20]. It is suggested that OMM can ease psychoemotional stress by normalizing somatic dysfunction in the

thoracic spine and ribcage, which will optimize lymphatic flow and potentially improve endocrine disruptions [5]. Although research suggests that OMM may benefit physiologic disruptions seen in AN, OMM has also been shown to increase dopamine levels [31]. This effect may be more of a concern than a benefit because of the theory of dopamine dysfunction in AN patients that reinforces pathological behaviors [21]. The dopamine pathways are altered to increase the sense of reward when patients participate in certain eating behaviors such as caloric restriction and overexercising [21]. The effect of increased dopamine by OMM could indirectly maintain or strengthen unhealthy eating and exercise habits in AN patients [21, 31].

Finally, literature discussing the influence of OMM on specific tactile afferents is limited, but it is hypothesized that the therapeutic effects of OMM rely on CT afferents the most [1]. No literature currently discusses OMM's impact on AN patients and their perceived pleasantness of being touched while receiving OMM despite evidence that touch is perceived differently in AN patients. As a result, it is unclear what negative effects, if any, may occur from providing treatment for somatic dysfunction that arise from psychosomatic disorders in patients with AN. Such negative effects could include worsening AN symptoms such as increasing caloric restriction or weight checking. In addition, it is unclear whether OMM could contribute to the negative perceptions of touch that AN patients can experience.

The demonstrated efficacy of touch-based therapies in touch-sensitive populations like trauma survivors, underscores the necessity to examine their potential benefits or drawbacks in individuals with AN. This emphasizes the importance of investigating the effectiveness of such therapies in AN patients to understand their relevance and effects on treatment outcomes. Future research to address these questions may include measurements to assess the perception of touch during OMM in this patient population to fully understand beneficial osteopathic treatment. Due to the positive correlation between cortisol levels and chronic starvation, salivary cortisol levels may be assessed before, during, or after OMM treatment on AN patients to determine OMM's impact on neurohormonal regulation [20]. The results of such future research could inform the determination of possible inclusion and exclusion criteria for OMM in patients with AN.

Limitations

This review reveals the lack of quantitative research on the use of OMM on patients with AN. Our literature review includes quantitative data assessing the perception of touch for patients with AN compared to healthy controls. However, this information cannot be generalized to the application of OMM on patients with AN [5]. The review reveals the need to study the effects of OMM on AN patients, specifically the benefits and their perception of touch in response to OMM.

Conclusions

This literature review suggests that a possible variance in the perceived pleasantness of being touched, specifically during OMM, should be assessed in the AN patient population. A review of the literature shows the involvement of impaired CT afferent pathways and increased dopamine release with the use of OMM, which could potentially reinforce the pathological behavior and thinking patterns seen in AN. Furthermore, activation of CT afferents has been found to specifically increase dopamine release in the nucleus accumbens [32]. The activation of CT afferents during OMM may be problematic due to the role that the nucleus accumbens has in the mesolimbic pathway that is found to have altered dopamine pathology in AN patients that play a role in restrictive eating behaviors and excessive dieting [21]. Additionally, AN patients report the highest ratings of decreased pleasantness with touch to the abdomen [7]. This finding may need to be more strongly considered when practicing OMM, because many techniques involve targeting structures in the abdominal and thoracic regions. Our discussions highlight the need for further empirical research to validate the potential impacts of OMM on patients with AN and to elucidate whether manual therapy could worsen the pathological behavior seen in these patients.

The presentation of AN is on a spectrum, can go undiagnosed, and patients can present in varying stages of symptoms, recovery, or remission. Considering these stages during OMM may be important because treatment may vary based on presentation and is another subject for further study. In the meantime, individual assessment of patient preferences regarding touch and manual therapy, including OMM, should be accomplished with all patients, especially those with AN. Such an evaluation can help clarify the direction of personalized osteopathic treatment plans for the underlying psychological manifestations of AN before considering OMM.

Research ethics: Not applicable.
Author contributions: The authors have accepted responsibility for the entire content of this manuscript and approved its submission.
Competing interests: None declared.

Research funding: None declared.
Data availability: Not applicable.

References

1. McGlone F, Cerritelli F, Walker S, Esteves J. The role of gentle touch in perinatal osteopathic manual therapy. Neurosci Biobehav Rev 2017;72: 1–9.
2. Seffinger MA. Glossary of osteopathic terminology. In: Foundations of osteopathic medicine: philosophy, science, clinical applications, and research, 4th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2018.
3. Bonilla L, Weleff J. Early osteopathic thought on serious mental illness and how osteopathic medicine fits into psychiatry today. *Am J Psychiatr Resid J* 2022;18:2–4.
4. Theodore B, Flaum DO, Ravi Chinsky OI, Sheldon C, Yao DO. Obsessive-compulsive disorder: diagnosis and management with an osteopathic component. Osteopath Family Phys 2020;12:18–24.
5. Chinsky R, Lilaporia S, Li T, Chan T. Puberty: an approach to diagnosis and management with an osteopathic component. Osteopath Family Phys 2021;13:21–30.
6. Bellard A, Trotter P, McGlone F, Cazzato V. Vicarious ratings of self vs. other-directed social touch in women with and recovered from Anorexia Nervosa. Sci Rep 2022;12:13429.
7. Cazzato V, Sacchetti S, Shin S, Makdani A, Trotter PD, McGlone F. Affective touch topography and body image. PLoS One 2021;16(11): e0243680.
8. Crucianelli L, Demartini B, Goeta D, Nisticò V, Saramandi A, Bertelli S, et al. The anticipation and perception of affective touch in women with and recovered from anorexia nervosa. Neuroscience 2021;464:143–55.
9. Crucianelli L, Cardi V, Treasure J, Jenkinson PM, Fotopoulou A. The perception of affective touch in anorexia nervosa. Psychiatr Res 2016; 239:72–8.
10. Davidovic M, Karjalainen L, Starck G, Wentz E, Björnsdotter M, Olausson H. Abnormal brain processing of gentle touch in anorexia nervosa. Psychiatr Res Neuroimaging 2018;281:53–60.
11. Favaro A, Santonastaso P, Manara R, Bosello R, Bommarito G, Tenconi E, et al. Disruption of visuospatial and somatosensory functional connectivity in anorexia nervosa. Biol Psychiatr 2012;72: 864–70.
12. Keizer A, Smeets MAM, Dijkerman HC, van den Hout M, Klugkist I, van Elburg A, et al. Tactile body image disturbance in anorexia nervosa. Psychiatr Res 2011;190:115–20.
13. Tagini S, Bastoni I, Villa V, Mendolicchio L, Castelnuovo G, Mauro A, et al. Affective touch in anorexia nervosa: exploring the role of social anhedonia and lifespan experiences. J Affect Disord 2023;324:607–15.
14. van Eeden AE, van Hoeken D, Hoek HW. Incidence, prevalence and mortality of anorexia nervosa and bulimia nervosa. Curr Opin Psychiatr 2021;34:515–24.
15. Feeding and eating disorders. In: American psychiatric association: diagnostic and statistical manual of mental disorders, Fifth Edition, Text Revision. Washington, DC: American Psychiatric Association; 2022: 371–97 pp.
16. Obsessive-compulsive and related disorders. In: American psychiatric association: diagnostic and statistical manual of mental disorders, Fifth Edition, Text Revision. Washington, DC: American Psychiatric Association Publishing; 2022:263–94 pp.
17. Hartmann AS, Greenberg JL, Wilhelm S. The relationship between anorexia nervosa and body dysmorphic disorder. Clin Psychol Rev 2013; 33:675–85.
18. Grant JE, Kim SW, Eckert ED. Body dysmorphic disorder in patients with anorexia nervosa: prevalence, clinical features, and delusionality of body image. Int J Eat Disord 2002;32:291–300.
19. Rabe-Jablonska Jolanta J, Sobow Tomasz M. The links between body dysmorphic disorder and eating disorders. Eur Psychiatr 2000;15:302–5.
20. Shibuya I, Nagamitsu S, Okamura H, Komatsu H, Ozono S, Yamashita Y, et al. Changes in salivary cortisol levels as a prognostic predictor in children with anorexia nervosa. Int J Psychophysiol 2011; 82:196–201.
21. Gorrell S, Collins AGE, Le Grange D, Yang TT. Dopaminergic activity and exercise behavior in anorexia nervosa. OBM Neurobiol 2020;4:10.
22. McGreevy S, Boland P. Touch: an integrative review of a somatosensory approach to the treatment of adults with symptoms of post-traumatic stress disorder. Eur J Integr Med 2022;54:102168.
23. Field T, Hernandez-Reif M, Hart S, Quintino O, Drose LA, Field T, et al. Effects of sexual abuse are lessened by massage therapy. J Bodyw Mov Ther 1997;1:65–9.
24. Collebrusco L, Fabri S, Furfaro A, Tanini I, Lombardini R, Rizza A, et al. Osteopathy and emergency: a model of osteopathic treatment aimed at managing the post-traumatic stress – Part 1. Health 2018;10: 998–1005.
25. Davis L, Hanson B, Gilliam S. Pilot study of the effects of mixed light touch manual therapies on active duty soldiers with chronic post-traumatic stress disorder and injury to the head. J Bodyw Mov Ther 2016;20:42–51.
26. Letranchant A, de MYK, Bigre CDL, Wagner A, Curt F, Silva J, et al. The ACAMTO study – impact of add-on osteopathic treatment on adolescent patients with anorexia nervosa: study protocol for a randomized controlled trial. Trials 2021;22:839.
27. Marshall AG, McGlone FP. Affective touch: the enigmatic spinal pathway of the C-tactile afferent. Neurosci Insights 2020;15: 2633105520925072.
28. Olausson H, Wessberg J, Morrison I, McGlone F, Vallbo Å, Vallbo Å. The neurophysiology of unmyelinated tactile afferents. Neurosci Biobehav Rev 2010;34:185–91.
29. Tatayeva R, Ossadchaya E, Sarculova S, Sembayeva Z, Koigeldinova S. Psychosomatic aspects of the development of comorbid pathology: a review. Med J Islam Repub Iran 2022;36:152.
30. Abbate-Daga G, Delsedime N, Nicotra B, Giovannone C, Marzola E, Amianto F, et al. Psychosomatic syndromes and anorexia nervosa. BMC Psychiatr 2013;13:14.
31. Vigotsky AD, Bruhns RP. The role of descending modulation in manual therapy and its analgesic implications: a narrative review. Pain Res Treat 2015;2015:292805.
32. Maruyama K, Shimoju R, Ohkubo M, Maruyama H, Kurosawa M. Tactile skin stimulation increases dopamine release in the nucleus accumbens in rats. J Physiol Sci 2012;62:259–66.