Osteopathic Manipulative Treatment for long-term postoperative sequelae in children operated for type III esophageal atresia: A series case

Andrea Manzotti1, Alati Alessia2, Matteo Galli3, Francesco Cerritelli1, Chiara Leva1, Adele Alberti1, Alessandro Stizzoli1, Sara Costanzo1, Luciano Maestri1 and Gloria Pelizzo1

1 RAISE Lab, Foundation COME Collaboration, Milan, Italy
2 Division of Neonatology, “V. Buzzi” Children’s Hospital, ASST-FBF-Sacco, Milan Italy
3 Research Department SOMA, Istituto Osteopatia Milano, Milan, Italy
4 UOC of Pediatric Surgery Unit, Children’s Hospital “V. Buzzi” ASST-FBF-Sacco Milan Italy

Abstract: Background and purpose of the study: Esophageal atresia (AE) is a congenital anomaly that affects the normal development of the esophagus in neonates. The timely surgical approach allows its resolution, but long-term morbidities in adolescents show neurological developmental abnormalities and musculoskeletal deformities. The goal in this preliminary study is to investigate the recovery of the range of the right upper limb movement and on the rise of the anthropometric parameters through the osteopathic manipulative treatment, which, by acting on the connective system has a trophotropic effect documented. Materials and Methods: 5 children with type III AE were included in the study. 6 OMTs were performed in 4 months. At each treatment, the following were assessed height, weight, BMI and ROM in elevation of the right upper limb. OMT has been applied to improve scar, larynx, rib cage, and sternum mobility. Results: in the statural growth there was an average change of 2.3 cm in 4 months and in the ROM of the upper limb there was an average increase of 8° in 4 months. There were no significant changes in weight and BMI. Conclusions: This preliminary study suggests that it is a viable option to be further researched. In addition, the study provides potentially valuable evidence that the osteopathic manipulative treatment could benefit the increase in anthropometric parameters and the mobility of the right upper limb of children operated on for AE. In light of the results, new studies to evaluate the effectiveness of OMT in post surgical treatment of congenital malformations of the thorax can be considered in the future.

Keywords: Esophageal atresia; OMT; Surgery; ROM; Pediatric.

1. Introduction

AE is represented by the congenital agenesis of a portion of the esophagus. It is considered a rare disease, with an incidence of 1 in 2,500 births [1]. Type C according to Gross classification (Esophageal atresia with a distal tracheoesophageal fistula) is the most frequent form, with an incidence of 85% [1,2]. Infants affected by this pathology usually undergo surgery during the early stages of life and the intervention may be performed through a thoracotomy or a thoracoscopy, depending on the surgeon’s choice.

Posterolateral thoracotomy is frequently used in pediatric thoracic surgery. It provides an adequate space to work in the thoracic cavity and access to the posterior mediastinum, allowing expansion of the surgical field as needed in cases of technical difficulties or complications [3–5]. Through this incision, the surgeon cuts at least one (often the latissimus dorsi) or several major thoracic muscles such as the anterior dentate, trapezius, and rhomboid muscles [4].

This type of surgery may lead to severe complications such as acute postoperative pain, disturbance to lung dynamics and also a reduction in the performance of the
shoulder girdle [3]. In the long term, this surgical approach can generate comorbidities affecting the musculoskeletal system, such as alteration of the scapulohumeral kinetics, morphological dysfunction of the spine such as thoracogenic, and alterations of the respiratory kinetics, such as costal fusions [4]. The cause of these sequelae could be attributable to post-surgical scar adhesions, which reduce the resilience of the tissue - including the fascial connective tissue – and its elastic return capacity if distorting forces are applied. Fascial tissue is connective tissue that surrounds blood vessels, nerves, viscera, meninges, bones, and muscles, dividing the body into various layers at different depths [6]. Surgery, as is the case with trauma or diabetes, can alter fascial tissue favoring fibrosis [7].

Osteopathy is a complementary alternative medicine (CAM) based on manual evaluation and treatment, in which "touch" has a fundamental role, both in the assessment of the patients [8] and for treating different parts of the body such as the fascial system. Several studies have shown how the Osteopathic Manipulative Treatment (OMT) could modulate the inflammatory cytokines leading to the regulation of fibroblast activity, and probably a large-scale relaxation of the connective tissue [9–11]. OMT can also improve the range of motion (ROM), demonstrated in different clinical contexts [6,12,13] by using different types of techniques including myofascial release, articular and visceral ones. Furthermore, osteopathy has been demonstrated efficacy and safety in the pediatric field and in management of esophageal atresia [14,15]. Other studies showed the efficacy in digestive pathologies treatment of the child such as infant colic, gastroesophageal reflux and constipation [16–18].

Moreover, a gentle approach to the musculoskeletal structure appears to be helpful to modulate the activity of ANS [19,20] showing an increase of the parasympathetic function by interacting with the interoceptive process at the brain level, specifically insular cortex, and its control on the whole body [21–23].

Reducing the signs of allostatic load in the children after a surgery is an important condition to prevent postural and neurodevelopmental issues allowing them to have normal breathing and feeding parameters [24–26]. In this study, we present 5 case studies of children operated on for type C esophageal atresia in neonatal age. The aim is to verify whether the OMT may have a possible effect on shoulder range of motion (ROM) and other biometric indicators such as BMI and weight and height.

2. Materials and Methods

Patient Information

Case 1

A 5-year-old boy, born at term by eutocic delivery underwent a right lateral thoracotomy on day 2 of life after a diagnosis of esophageal atresia with distal fistula. He needed two endoscopic dilatations following the intervention. The child often experienced reflux issues treated with specific medications. More than three times per year respiratory tract infections were reported. He sometimes experienced dysphagia for solid food. Parents reported no management problems in daily life activities.

Case 2

The second case that we present is a girl of about 5 years of age, born by cesarean delivery. Right lateral thoracotomy was performed two days after birth with a diagnosis of esophageal atresia with distal fistula. She also presented left superior vena cava draining into the left atrium and sacralization of the first coccygeal vertebra with the absence of the others. The girl often experienced gastroesophageal reflux, treated through specific drugs and modified postures for overnight rest. Respiratory infections, more than three times a year, were reported.

Case 3
A 3-year-old boy, preterm delivered, underwent right lateral thoracotomy 9 months after birth for EA type C. He underwent 3 endoscopic dilations after surgery for esophageal stenosis. The child rarely experienced gastroesophageal reflux and did not need any specific drugs. He reported a maximum of three episodes of respiratory infections per year and did not show any problems in eating.

Case 4

A 3-year-old child, born by vaginal delivery small for gestational age (SGA) with an Intrauterine Growth Restriction (IUGR). Esophageal atresia with tracheoesophageal fistula was diagnosed at birth and surgically treated through a right lateral thoracotomy, two days after. Respiratory failure occurred after surgery. A fundoplication was performed one year and 7 months after birth for gastro-oesophageal reflux not responding to medical treatment. He also underwent 8 endoscopic dilations during the routine follow-up. He had more than three episodes a year of respiratory infections, ate selected food, and often has symptoms of esophageal food blockage.

Case 5

A 7-year-old boy born from eutocic birth at 39 weeks. The lateral thoracotomy was performed the day after delivery with the diagnosis of esophageal atresia with tracheoesophageal fistula. He sometimes experienced reflux episodes treated with specific drugs. He manifested fewer than three episodes of respiratory tract infections per year.

Clinical Findings and Diagnostic Assessment

After obtaining parental consent, we organized 6 sessions of OMT carried out in 4 months. Two patients performed respectively only 3 and 4 treatments (Fig. 1)

Before each session, the following parameters were assessed: weight, height, body mass index (Weight/Height^2) and the mobility and range of motion (ROM) of the upper limb in elevation through a manual goniometer evaluation. Each child was investigated carefully, through osteopathic manual assessment by monitoring the relevance of the scar limitation at the level of the other areas of the body and assessing the presence of different regions of restriction on the hyoid, larynx, esophagus/sternum, ribs/diaphragm; elements involved both in the intervention and the malformation itself.

Timeline

![Timeline](image)

Figure 1. Timeline of osteopathic evaluations and treatments. Numbers indicate the session and arrows show the time between sessions in weeks. OMT=osteopathic manipulative treatment.

Therapeutic Intervention
Osteopathic manipulative treatment (OMT) is used to alleviate somatic dysfunction and thereby restore normal motion and function throughout the body [27]. In fact, the main focus of treatment is to restore a physiological ROM by increasing the movement of the ribs, sternum, vertebrae, superficial cervical fascia, hyoid, larynx, diaphragm and of the upper limb. The second goal of the study is to improve respiratory and swallowing capacity. These structures were frequently involved in all children musculoskeletal restrictions.

The right lateral posterior scars are the main restricted areas we have focused on during all treatments, improving the impairment of the child movement that scars left.

We used direct and indirect techniques that are well-known and described in the literature [6] to make the areas of restriction more compliant and free [28]. The manipulative osteopathic treatment supports the metabolic processes, promotes vascularization and improves ROM [6,13,29].

3. Results

Outcome

Treatment showed no adverse events in any of the cases treated. On one occasion, an episode of reflux occurred during the session of OMT, and was resolved by lifting the head of the treatment table. No other side effects occurred during treatments or reported by parents.

Regions with an impaired function in each case in pre and post treatment period are described in Table 1.

| Case 1 | Region restricted pre-treatment period | Region restricted post treatment period |
|--------|---------------------------------------|----------------------------------------|
|        | Right postero-lateral scar             | Dorsal region (T2-T9)                  |
|        | Left hypochondrial region              | Right iliac region                     |
|        | Dorsal region (T5-T9)                 | Hypomobility of diaphragm muscle.      |

| Case 2 | Region restricted pre-treatment period | Region restricted post treatment period |
|--------|---------------------------------------|----------------------------------------|
|        | Right postero-lateral scar             | Hypomobility of diaphragm muscle.      |
|        | Hypomobility of diaphragm muscle.      | Sternal hypomobility                   |
|        | Dorsal region (T5-T9)                 | Hyoid restriction                      |

| Case 3 | Region restricted pre-treatment period | Region restricted post treatment period |
|--------|---------------------------------------|----------------------------------------|
|        | Right postero-lateral scar             | Right hypochondrial region             |
|        | Hypomobility of diaphragm muscle       | Right sacro-iliac joint                |
|        | Dorsal region (T5-T9)                 | Sternal hypomobility                  |

| Case 4 | Region restricted pre-treatment period | Region restricted post treatment period |
|--------|---------------------------------------|----------------------------------------|
|        | Right postero-lateral scar             | Right iliac region                     |
|        |                                       | Upper cervical hypomobility            |
Table 2 shows pre-post-treatment biometric parameters values for all cases. Specifically,

Case 1 underwent 6 treatments in 70 days. During this period there was an increase in the height of 3.5 cm, going from 106 to 109.5; while the ROM of the upper limb increased from 165° to 171°. On the other hand, there was a reduction in body weight of one kilogram with a consequent decrease in BMI.

Case 2 received 6 treatments in 77 days. There was a height growth of 3 cm from 99 cm to 102 cm. The ROM of the upper limb remained at 158°. The weight remained constant at 14.7 kg, with a consequent reduction in the BMI.

Case 3 received 3 treatments in 62 days. There was no change in terms of weight and height, but there was a significant improvement in the ROM of the upper right limb from 137° to 158°.

Case 4 underwent 6 treatments in 85 days. He has grown from 90 to 93 cm, the weight increased by 800 grams, but the BMI was still reduced. The mobility of the upper limb in elevation raised from 164° to 167° without recording alterations in the normal functions of daily life.

Case 5 received 4 treatments in less than a month. He has grown by 2 cm in height from 115.5 to 117.5, and the upper limb has gone from an elevation of 150° to 160°. The weight remained constant.

Table 2. Synthesis of the biometric values for all the cases studied.

| Cases | Parameter            | Pre treatment | Last treatment and evaluation |
|-------|----------------------|---------------|------------------------------|
| Case 1| Height (cm)          | 106           | 109.5                        |
|       | Weight (Kg)          | 18            | 17                           |
|       | BMI                  | 16.02         | 14.31                        |
|       | Shoulder elevation   |               |                              |
|       | ROM                  | 165°          | 171°                         |
| Case 2| Height (cm)          | 99            | 102                          |
|       | Weight (Kg)          | 14.5          | 14.7                         |
|       | BMI                  | 14.75         | 13.46                        |
| Case   | Height (cm) | Weight (Kg) | BMI    | Shoulder elevation ROM |
|--------|-------------|-------------|--------|------------------------|
| 3      | 86          | 10.5        | 13.52  | 158°                   |
| 4      | 90          | 12          | 14.81  | 164°                   |
| 5      | 115.5       | 22.2        | 16.64  | 150°                   |

BMI=Body Mass Index; ROM=Range of Motion.

4. Discussion

The data collected among the cases underline an improvement of the arc of movement in elevation of the right upper limb and an increase in height, even if the treatment is performed years after surgery.

As the literature suggests, outcomes in pediatric surgery may have short- and long-term effects on the child and their family from both the pathophysiological and psychosocial points of view [30]. Considering the post-surgical sequelae on the musculoskeletal system, recent studies support that the less invasive the surgery is, the more anatomical alterations of the movement system are avoided [5,31]. In this case our results on ROM could suggest better management of these frequent side-effects.

In fact, the range of motion deficit of the upper right limb is strongly documented in the literature [3]. Many studies consider the onset of scoliosis, thoracic deformities, scapular elevations, and limitation on right shoulder ROM as a possible long-term postoperative risk [5,31,32]. In this way the increase in mobility in shoulder elevation of four out of five children suggests that more research into the possibility of intervening through manipulative osteopathic treatment on this deficit.

Several studies support the plausibility of increasing joint ROM with OMT in different contexts. Sposato & Bjerså [33] in their review investigated the effects of OMT applied to adults who underwent surgery, showing an increase of spinal ROM in flexion, extension, bilateral lateral side bending in patients with lumbar discectomy respect an exercise control group, and an increase in lateral flexion in patients with thoracotomy. Serra-Añó et al. [13] have shown an efficacy of myofascial relaxation on shoulder mobility, in accordance with our results.
Another finding is the increase in height after the treatment period. Birketvedt et al. [34] reported in their study that 15% of children undergoing surgery for OA were classified as stunted. In our study, we can identify an increase in the height parameters of three cases treated compared with the linear measures of growth: in the first case the child passes from near the 10th to near the 25th percentile; in the second case from -2SD to near 10th percentile; and in the fifth case varies from the 10th over the 25th percentile. These results, according to Frongillo et al. [35], suggest the important role of evaluating the effects of an intervention using linear measure of growth. Other studies are needed to confirm these preliminary effects on a larger sample size, focusing on this outcome in accordance with several other interventions.

Considering the constancy of the weight values compared to the change occurred in height of our sample we decided not to take into account the BMI due his inability to consider some parameters including fat mass and lean mass. As Weber et al. [36] shown in their study, body composition measurements can be useful to predict clinical outcomes and nutritional status.

Early surgery in the children is a significant stress factor in growth measurement not only from the physical point of view, but also from the cognitive, emotional and psychosocial ones [30]. For instance, height deficit can be related to an increase in the serum concentrations of proinflammatory cytokines and cortisol as a result of post surgery condition [37]. Thinking about these connections and correlating the musculoskeletal system - with all its subdivisions, that include the fascial system- we can suppose that small state growths may be linked to the presence of stress factors. Osteopathic treatment has demonstrated its efficacy in modulating autonomic nervous system function, favoring the enhancement of parasympathetic activity [29,38,39]. In 2019, a study demonstrated a reduction in allostatic biomarkers -evaluation of cortisol, diurnal catecholamines with urine tests, glycated hemoglobin, high-intensity lipoproteins, high reactive protein C sensitivity, blood pressure, BMI and hip-waist index- following osteopathic manipulative treatment [40]. Furthermore, it would be essential to introduce the evaluation of allostatic biomarkers to determine a real correlation between the results of the treatment and the principles with which these are related without at present an objective response.

It could be interesting to reduce the age of intervention on children to ensure that the identified malfunctions can be treated and resolved in the shortest possible time in order to avoid chronic effects.

Regarding limitations, the number of cases presented should be increased to determine absolute efficacy but certainly some food for thought. Furthermore, outcomes through photos of the subject on the frontal and sagittal plane and pictures related to the mobility of the skeletal structures could.

5. Conclusions

The present study supports the hypothesis that OMT may be useful to increase the ROM in children.

Others studies should be developed to indorse these preliminary findings in a larger sample size, including the presence of allostatic biomarkers to better investigate the possible effects on growth, and implementing a control group for comparison of results

Author Contributions: Andrea Manzotti: Conceptualization, Methodology, Investigation, Resources, Supervision, Project administration, Writing - review & editing. Alessia Alati: Conceptualization, Methodology, Data curation Investigation, Writing - original draft. Matteo Galli: Conceptualization, Methodology, Data curation, Writing - original draft. Francesco Cerritelli: Review & editing. Chiara Leva: review & editing, Adele Alberti: Review Alessando Stizzoli: Review. Sara Costanzo: Validation, Writing - review & editing, Resources, Supervision, Project administration. Luciano Maestri: Validation, Writing - Review & editing, Resources, Supervision, Project administration. Gloria Pelizzo: Validation, Writing - review & editing, Resources, Supervision, Project administration.
**Funding:** This research received no external funding.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patients to publish this paper.

**Acknowledgments:** The authors sincerely thank Dr Andy Otaqui, Tania Rota and Silvia Guarise for their invaluable help during the study.

**Conflicts of Interest:** The authors declare no conflict of interest.

**References**

1. Smith N. Oesophageal atresia and tracheo-oesophageal fistula. Early Hum Dev. 2014;90:947–50.

2. van Lennep M, Singendonk MMJ, Dall’Oglio L, Gottrand F, Krishnan U, Terheggen-Lagro SWJ, et al. Oesophageal atresia. Nat Rev Dis Primer. 2019;5:26.

3. Askarpour S, Peyvasteh M, Ashrafi A, Dehdashtian M, Malekian A, Aramesh M-R. MUSCLE-SPARING VERSUS STANDARD POSTEROLATERAL THORACOTOMY IN NEONATES WITH ESOPHAGEAL ATRESIA. ABCD Arq Bras Cir Dig São Paulo [Internet]. Colégio Brasileiro de Cirurgia Digestiva - CBCD; 2018 [cited 2021 Jan 7];31. Available from: http://www.scielo.br/scielo.php?script=sci_abstract&pid=S0102-67202018000200302&lng=en&nrm=iso&tlng=en

4. Bianchi A, Sowande O, Alizai NK, Rampersad B. Aesthetics and lateral thoracotomy in the neonate. J Pediatr Surg. 1998;33:1798–800.

5. Zhang J, Wu Q, Chen L, Wang Y, Cui X, Huang W, et al. Clinical analysis of surgery for type III esophageal atresia via thoracoscopy: a study of a Chinese single-center experience. J Cardiothorac Surg. 2020;15:55.

6. Parravicini G, Bergna A. Biological effects of direct and indirect manipulation of the fascial system. Narrative review. J Bodyw Mov Ther. 2017;21:435–45.

7. Pavan PG, Stecco A, Stern R, Stecco C. Painful connections: densification versus fibrosis of fascia. Curr Pain Headache Rep. 2014;18:441.

8. Manzotti A, Cerritelli F, Chiera M, Lombardi E, La Rocca S, Biasi P, et al. Neonatal Assessment Manual Score: Is There a Role of a Novel, Structured Touch-Based Evaluation in Neonatal Intensive Care Unit? Front Pediatr. 2020;8:432.

9. Degenhardt BF, Johnson JC, Fossum C, Andicochea CT, Stuart MK. Changes in Cytokines, Sensory Tests, and Self-reported Pain Levels After Manual Treatment of Low Back Pain. Clin Spine Surg Spine Publ. 2017;30:E690–701.

10. Licciardone JC, Kearns CM, Hodge LM, Bergamini MVW. Associations of Cytokine Concentrations With Key Osteopathic Lesions and Clinical Outcomes in Patients With Nonspecific Chronic Low Back Pain: Results From the OSTEOPATHIC Trial. J Am Osteopath Assoc. 2012;112:596.

11. Tozzi P. Selected fascial aspects of osteopathic practice. J Bodyw Mov Ther. 2012;16:503–19.

12. Chaitow L. What’s in a name: Myofascial Release or Myofascial Induction? J Bodyw Mov Ther. Elsevier; 2017;21:49–51.

13. Serra-Añó P, Inglés M, Bou-Catalá C, Iraola-Lliso A, Espi-López GV. Effectiveness of myofascial release after breast cancer surgery in women undergoing conservative surgery and radiotherapy: a randomized controlled trial. Support Care Cancer Off J Multinatl Assoc Support Care Cancer. 2019;27:2633–41.

14. Barni A, Zechillo D, Uberti S, Ratti S. Osteopathic Manipulative Treatment in a Paediatric Patient with Oesophageal Atresia and Tracheo-Oesophageal Fistula. Case Rep Gastroenterol. 2019;13:178–84.

15. Posadzki P, Lee MS, Ernst E. Osteopathic Manipulative Treatment for Pediatric Conditions: A Systematic Review. PEDIATRICS. 2013;132:140–52.

16. Bramati-Castellarin I, Patel VB, Drysdale IP. Repeat-measures longitudinal study evaluating behavioural and gastrointestinal symptoms in children with autism before, during and after visceral osteopathic technique (VOT). J Bodyw Mov Ther. 2016;20:461–70.

17. Eguaras N, Rodríguez-López ES, Lopez-Dicastillo O, Franco-Sierra MÁ, Ricard F, Oliva-Pascual-Vaca Á. Effects of Osteopathic Visceral Treatment in Patients with Gastroesophageal Reflux: A Randomized Controlled Trial. J Clin
18. Pizzolorusso G, Turi P, Barlafante G, Cerritelli F, Renzetti C, Cozzolino V, et al. Effect of osteopathic manipulative treatment on gastrointestinal function and length of stay of preterm infants: an exploratory study. Chiropr Man Ther. 2011;19:15.

19. D’Alessandro G, Cerritelli F, Cortelli P. Sensitization and Interoception as Key Neurological Concepts in Osteopathy and Other Manual Medicines. Front Neurosci. 2016;10:100.

20. Manzotti A, Cerritelli F, Lombardi E, La Rocca S, Chiera M, Galli M, et al. Effects of osteopathic treatment versus static touch on heart rate and oxygen saturation in premature babies: A randomized controlled trial. Complement Ther Clin Pract. 2020;39:101116.

21. Cerritelli F, Chiacchiarella P, Gambi F, Perrucci MG, Barassi G, Visciano C, et al. Effect of manual approaches with osteopathic modality on brain correlates of interoception: an fMRI study. Sci Rep. 2020;10:3214.

22. 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.

23. Cerritelli F, Chiacchiarella P, Gambi F, Saggini R, Perrucci MG, Ferretti A. Osteopathy modulates brain–heart interaction in chronic pain patients: an ASL study. Sci Rep. 2021;11:4556.

24. Grunau RE, Holsti L, Peters JWB. Long-term consequences of pain in human neonates. Semin Fetal Neonatal Med. 2006;11:268–75.

25. Tezza G, Paiola G, Zoccante L, Gandolfi M, Smania N, Ciceri ML, et al. Gut-Brain Axis Exploration: Stabilometric Platform Performances in Children Affected by Functional Gastrointestinal Disorders. J Pediatr Gastroenterol Nutr [Internet]. 2021 [cited 2021 Jan 10];Publish Ahead of Print. Available from: https://journals.lww.com/jpgn/Abstract/9000/Gut_Brain_Axis_Exploration__Stabilometric_Platform.95863.aspx

26. Walker K, Holland AJ, Winlaw D, Sherwood M, Badawi N. Neurodevelopmental outcomes and surgery in neonates. J Paediatr Child Health. 2006;42:749–51.

27. Lichiardone JC, Kearns CM, Hodge LM, Minotti DE. Osteopathic manual treatment in patients with diabetes mellitus and comorbid chronic low back pain: subgroup results from the OSTEOPATHIC Trial. J Am Osteopath Assoc. United States; 2013;113:468–78.

28. Pizzolorusso G, Cerritelli F, D’Orazio M, Cozzolino V, Turi P, Renzetti C, et al. Osteopathic evaluation of somatic dysfunction and craniosacral strain pattern among preterm and term newborns. J Am Osteopath Assoc. 2013;113:462–7.

29. Cerritelli F, Cardone D, Pirino A, Merla A, Scoppa F. Does Osteopathic Manipulative Treatment Induce Autonomic Changes in Healthy Participants? A Thermal Imaging Study. Front Neurosci. 2020;14:887.

30. Ben Ari A, Margalit D, Udassin R, Benarroch F. Traumatic Stress among School-Aged Pediatric Surgery Patients and Their Parents. Eur J Pediatr Surg Off J Austrian Assoc Pediatr Surg Al Z Kinderchir. 2019;29:437–42.

31. Bastard F, Bonnard A, Rousseau V, Gelas T, Michaud L, Irtan S, et al. Thoracic skeletal anomalies following surgical treatment of esophageal atresia. Lessons from a national cohort. J Pediatr Surg. 2018;53:605–9.

32. Okuyama H, Tazuke Y, Uenoa T, Yamanaka H, Takama Y, Saka R, et al. Long-term morbidity in adolescents and young adults with surgically treated esophageal atresia. Surg Today. 2017;47:872–6.

33. Sposato NS, Bjerså K. Osteopathic Manipulative Treatment in Surgical Care: Short Review of Research Publications in Osteopathic Journals During the Period 1990 to 2017. J Evid-Based Integr Med. 2018;23:2515690X18767671.

34. Frongillo EA, Leroy JL, Lapping K. Appropriate Use of Linear Growth Measures to Assess Impact of Interventions on Child Development and Catch-Up Growth. Adv Nutr. 2019;10:372–9.

35. Weber DR, Moore RH, Leonard MB, Zemel BS. Fat and lean BMI reference curves in children and adolescents and their utility in identifying excess adiposity compared with BMI and percentage body fat. Am J Clin Nutr. 2013;98:49–56.

36. Ruffini N, D’Alessandro G, Mariani N, Pollastrelli A, Cardinali L, Cerritelli F. Variations of high frequency parameter of heart rate variability following osteopathic manipulative treatment in healthy subjects compared to
control group and sham therapy: randomized controlled trial. Front Neurosci. 2015;9:272.

40. Nuño V, Siu A, Deol N, Juster R-P. Osteopathic Manipulative Treatment for Allostatic Load Lowering. J Am Osteopath Assoc. 2019;119:646–54.