STUDIA UBB EDUCATIO ARTIS GYMN., LXV, 4, 2020, pp. 5 – 20
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.65(4).27

POSTURE EVALUATION AND PHYSICAL THERAPY INTERVENTION USING ISOFREE MEDICAL EQUIPMENT, ADAPTED TO DENTISTS – CASE STUDY

POP NICOLAE HORAȚIU[1,*], MOHOLEA ADINA[1], VĂIDĂHĂZAN REMUS[2]

ABSTRACT. Introduction: Dentistry is considered a profession with a high risk of developing musculoskeletal disorders, as a consequence of specific operations involving a high degree of concentration and precision, the whole organism being solicited in a multidirectional manner (Gopinadh et al., 2013). The **objectives** of the study are to evaluate the dentist's posture with the help of IsoFree medical equipment and to develop an intervention program specific to postural disorders, most present in dentistry **Methods:** The research started on the 16th of November 2019 and ended on the 18th of May 2020 and included a case study of one subject. The protocol consisted of ten sessions of evaluation and intervention. The head, cervical and lumbar spine and foot were initially and finally evaluated using photometric measurements and the IsoFree equipment. The physical therapeutic intervention consisted of 19 exercises for each segment evaluated. **Results:** In the cervical spine, the CVA presents an improvement of 5^0 and the cranial angle (CA), has undergone an improvement from 26° to 23°, a decrease of 3^0. In regard to the real time feedback evaluation with the IsoFree, a 5^0 improvement from the initial value of 5^0 was noted after physical therapeutic intervention. In the lumbar spine, the final evaluation on IsoFree reveals a 3^0 progress of the trunk, the final value being -1^0. Using the standardized FPI evaluation, an initial score of +6 has been obtained as well as a final score of +4. In the initial bipodal evaluation with IsoFree, the average CoP X value is 1.88 mm and CoP Y value is 22.47 mm, while in the final evaluation the CoP values on the xOy axis are: 0,53 mm, respectively 13,74 mm. An increase in the values for both parameters of the stabilometry can be observedfrom the initial value of the ellipse surface area of 52.83 mm^2 to 123.55 mm^2, the final value. The perimeter has changed from 311.34 to 525.93 mm^2. **Conclusions:** The evaluation using the IsoFree technology shows significant benefits while being in accordance with other methods of evaluation. The proposed physical therapeutic intervention has determined positive outcomes on the subject's posture.

Keywords: *Posture, Physical Therapy, Technology, IsoFree, Dentistry.*

[1] *Babeș-Bolyai University, Faculty of Physical Education and Sport, Cluj-Napoca, Romania*
[2] *Babeș-Bolyai University, Faculty of Psychology and Science of Education, Cluj-Napoca, Romania*
** Corresponding Author: nicolaehoratiupop@gmail.com*

REZUMAT. ***Evaluarea posturii și intervenția prin mijloace kinetoterapeutice, adaptată medicului stomatolog cu ajutorul echipamentului medical ISOFREE – studiu de caz.*** **Introducere:** Stomatologia este considerată o profesie cu risc crescut de dezvoltare a leziunilor la nivel musculoscheletal, profesie care solicită multidirecțional întreg organismul, rezultând in adoptarea unor posturi incomode (Gopinadh et al., 2013). **Obiectivele** studiului sunt: să evalueze postura medicului stomatolog cu ajutorul aparaturii medicale IsoFree și să dezvolte un program de intervenție specific deficienţelor posturale, cel mai des întâlnite în cadrul profesiei de stomatolog. **Metode:** Prezentul studiu de caz s-a desfăşurat pe perioada 16.11.2019 – 18.05.2020. Intervenția a presupus 10 şedinţe de evaluare şi intervenţie. Poziția capului, a regiunii cervicale şi lombare a coloanei şi poziția piciorului au fost evaluate inițial şi final, folosind măsurători fotometrice şi echipamentul IsoFree. Protocolul de intervenție kinetoterapeutică a inclus 19 exerciții ce au vizat fiecare dintre regiunile evaluate. **Rezultate:** La nivelul coloanei cervicale, CVA (unghiul craniovertebral) prezintă o îmbunătățire de 5^0 iar unghiul cranian (CA), prezintă o îmbunătățire de la 26° la 23°. În ceea ce privește evaluarea feedback-ului în timp real cu IsoFree, se observă o îmbunătățire de 5^0 după intervenția kinetoterapeutică. La nivelul coloanei lombare, evaluarea finală pe IsoFree relevă un progres de 3^0 al trunchiului. Folosind instrumentul FPI de evaluare a piciorului, a fost obținut un scor inițial de +6, iar scorul final de +4. În evaluarea inițială bipodală cu IsoFree, valoarea medie CoP X este de 1,88 mm și valoarea CoP Y este de 22,47 mm, în timp ce în evaluarea finală valorile CoP pe axa xOy sunt: 0,53 mm, respectiv 13,74 mm. O creştere a valorilor pentru ambii parametri ai stabilometriei poate fi observat. **Concluzii:** Evaluarea cu ajutorul tehnologiei reprezentate de echipamentul IsoFree, prezintă beneficii însemnate și în același timp se află în concordanță cu alte metode observative de evaluare. Intervenția kinetoterapeutică propusă a determinat modificări pozitive în postura subiectului inclus în studiu.

Cuvinte cheie: *Postură, Kinetoterapie, Tehnologie, IsoFree, Stomatologie.*

Introduction

Dentistry is considered a profession with a high risk of developing musculoskeletal disorders, as a consequence of specific operations involving a high degree of concentration and precision, the whole organism being solicited in a multidirectional manner (Gopinadh et al., 2013).

Incorrect postures, most often found during working hours, whether standing or sitting, include a considerable cervical flexion accompanied by lateral flexions and rotations, arm abductions and repetitive movements of the wrist defined by force and precision (Bhandari, Bhandari, Uppal, & Grover, 2013).

When it comes to the lower limbs, often lack of complete ground contact leads to a defective support base. To all of these, the characteristics of static posture are added (Kierklo, Kobus, Jaworska, & Botuliński, 2011).

According to Ruivo et al. (2016, p. 76) „posture can be defined as the relative position of different body parts in space and it is an essential element of normal balance and an important indicator of health".

A variety of methods have been used over time for the posture evaluation: simple or complex, with or without radiations exposure, whether or not specific to an anatomic region. Out of these we mention: goniometry, photography, photogrammetry, radiography or the evaluation using specific medical equipment (Singla, Veqar, & Hussain, 2017).

Objectives

The objectives of the study are:

1. To evaluate the dentist's posture with the help of IsoFree medical equipment
2. To develop an intervention program specific for postural disorders, most present in dentistry

Materials

IsoFree

Fig. 1. IsoFree medical equipment (Tecnobody SRL, 2015)

IsoFree is a medical equipment for evaluation part of the TecnoBody – Functional Line (see Figure 1), for postural and functional training. It has been created for the attainment of physical exercises, whether for recovery or training purposes, with maximum control over one's posture. It contains four main components: stabilometric posture, 3D camera, touch screen and a specialized software, having the aim of analyzing the movement and postural control, giving feedback in real time (Tecnobody SRL, 2015).

Postural control – Stabilometry

According to Horak (2006), the ability of standing vertically, of going or doing different daily activities in a safely manner depends on the interaction of multiple physiological mechanisms resulting in a person's ability of maintaining one's balance. This is accomplished through postural control (Hébert-Losier & Murray, 2020).

The standard examination of postural control is stabilometric testing, which implies the recording of the Centre of Pressure (CoP) in standing position with the help of a pressure platform, i.e. stabilometric platform (Horak, 2006; Ruhe, Fejer, & Walker, 2011).

The stabilometric evaluation using IsoFree is represented by the following parameters: the ellipse surface area and perimeter. The ellipse surface area is determined by the projection of oscillations of CoP on the support base as a result of the postural control process. The perimeter represents the sum of the projected oscillation within the ellipse (Ruhe et al., 2011; Tecnobody SRL, 2015).

Foot alignment

The physiology and anatomic architecture of the foot are known for having an important role, influencing the postural control and the overall posture of the upper structures (Ghasemi, Koohpayehzadeh, Kadkhodaei, & Ehsani, 2016; Wright, Ivanenko, & Gurfinkel, 2012).

Flat foot and cavus foot represent two pathological conditions often found at the level of the foot, which can be a causative factor for different overuse injuries of the inferior limb such as: plantar fasciitis, tibial stress syndrome etc. (Okamura et al., 2020).

FPI-6 (Foot Posture Index - 6 items) is a validated evaluation method of the foot alignment. It has been created as an instrument serving for a comprehensive evaluation of the foot with various uses in clinical practice (Redmond, Crosbie, & Ouvrier, 2006).

Sagittal alignment of the spine

Sagittal alignment implies a harmonious relationship between cervical lordosis, thoracic kyphosis, lumbar lordosis, and pelvic anatomy (Kim & Menger, 2020; Le Huec, Saddiki, Franke, Rigal, & Aunoble, 2011).

Postural deviations of the spine are generated by alteration of regional or global alignment, which implies that any change in a region will result in compensations in adjacent regions. This mechanism, although it is not the most ergonomic, takes place for maintaining the CoP inside the support base (Le Huec et al., 2011).

Hasegawa et al. (2017) proposed a set of average values for the evaluation of spine alignment and the lower limbs in relation to a vertical line through the center of acoustic meati (CAM), on the ground.

At the level of the cervical region, two of the most used photographic measurements with a low degree of error are: the craniovertebral angle (CVA) and the cranial angle (CA) (Sheikhhoseini, Shahrbanian, Sayyadi, & O'Sullivan, 2018). With the help of these measurements the forward head posture (FHP) can be identified. FHP is defined as the excessive sagittal forward positioning of the head andneck in relation to the trunk (Harman, Hubley-Kozey, & Butler, 2005; Sheikhhoseini et al., 2018).

Methods

The research started on the 16th of November 2019 and ended on the 18th of May 2020. The protocol consisted of ten sessions of evaluation and intervention. These took place in the Medical Center Kinetoteam, Cluj-Napoca. The subject included in the study signed an informed consent and the collaboration with the Medical Center Kinetoteam was also realized through aconsent.

The physical therapeutic intervention program was split into four parts:

1. Warm up – fully realized with the continuous feedback on the posture by the IsoFree equipment.
2. Exercises for the cervical region (see table 1)
   (Diab & Moustafa, 2012; Harman et al., 2005; Ruivo et al., 2016; Ruivo, Pezarat-Correia, & Carita, 2017)
3. Exercises for the lumbar region (see table 2)
   (Lewis, Khuu, & Marinko, 2015; Moraes et al., 2009; Slater & Hart, 2017; Yoon, Kang, Kim, & Oh, 2018)
4. Exercises for the foot (see table 3)
   (Kulig, Burnfield, Requejo, Sperry, & Terk, 2004; Mulligan & Cook, 2013; Okamura et al., 2020)

Table 1. Exercises for the cervical region

Exercise	Targeted muscles	Objective
Chin tuck	Deep cervical flexors (Longus colli, Longus capitis)	Strengthening
Standing shoulder pullback	Shoulder retractors (Rhomboids, Middle trapezius)	Strengthening
Prone horizontal abduction with external rotation	Middle and Lower trapezius, Rhomboids, Infraspinatus, Teres minor	Strengthening
Y to I exercise	Middle and Lower trapezius, Serratus anterior	Strengthening
Side lying external rotation	Teres minor, Infraspinatus	Strengthening
Pectoral stretching	Pectoralis muscle	Stretching
Chin drop	Cervical extensors	Stretching
Static SCM stretch	Sternocleidomastoid	Stretching
Static levator scapulae stretch	Levator scapulae	Stretching

Table 2. Exercises for the lumbar region

Exercise	Targeted muscles	Objective
Bridge exercise	Gluteus maximus	Strengthening
Crunch	Rectus abdominis	Strengthening
Plank	Rectus and transversus abdominis, Internal and external oblique	Strengthening
Squat	Gluteus maximus, Quadriceps	Strengthening
Single leg dead lift	Gluteus maximus, Hamstrings	Strengthening
Erector spinae stretching	Erector spinae	Stretching
Gluteal muscles stretching	Gluteus maximus	Stretching

Table 3. Exercises for the foot

Exercise	Targeted muscles	Objective
Short foot	Plantar intrinsic foot muscle	Strengthening
Closed chain resisted foot adduction	Tibialis posterior	Strengthening
Gastrocnemius stretching	Gastrocnemius muscle	Stretching

The data collection within the initial and final evaluation was made using the data registration sheet.

For the evaluation of the head and cervical spine alignment, two standardized measurements have been used: CVA and CA (Ruivo et al., 2016). For the evaluation of the whole sagittal alignment the following have been used: plumb line evaluation (Hasegawa et al., 2017) and the evaluation using the IsoFree medical equipment (Tecnobody SRL, 2015) (see figures 2 and 3). For the foot alignment evaluation the standardized FPI-6 instrument has been used (Okamura et al., 2020).

The physical therapeutic intervention has been conducted for every region according to the recommendations offered by studies with positive results (Lewis & Sahrmann, 2015; Mulligan & Cook, 2013; Okamura et al., 2020; Ruivo et al., 2017; Sheikhhoseini et al., 2018).

Fig. 2 and 3. Evaluation using IsoFree (left) and the screen of IsoFree (right)

Results:

1. The evaluation of the head and cervical spine alignment (see table 4 and chart 1):

Table 4. The results of the CVA and CA evaluation

	Initial evaluation	*Final evaluation*
Craniovertebral angle	51 ^{0}	56 ^{0}
Cranial angle	26 ^{0}	23 ^{0}

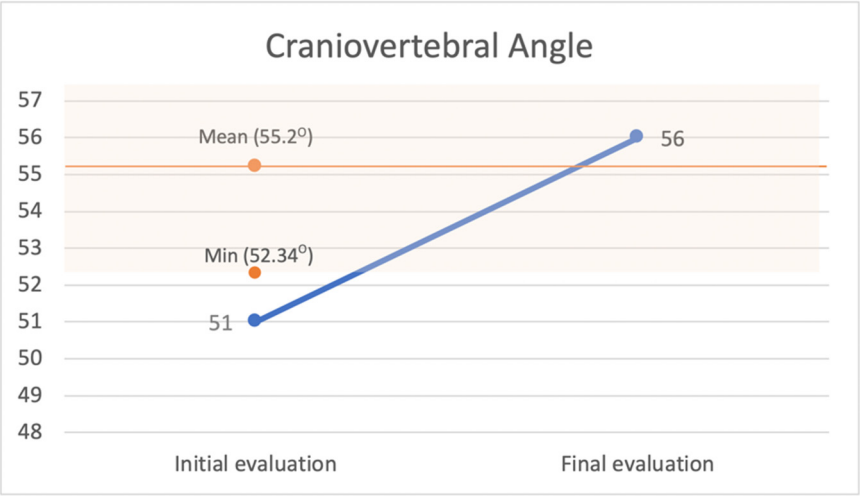


Chart 1. Craniovertebral Angle

2. The evaluation of the sagittal alignment:

Initial observation (see figure 4):

- The acromion is situated behind the vertical line through the center of acoustic meati (CAM), on the ground.
- All the vertebrae remain behind the vertical line through CAM.
- The great trochanter can be observed in the back of the vertical line through CAM.
- The knee and ankle landmarks are situated at the correct side – posterior to the vertical line through CAM, although at a relatively great distance from it.

Final observation:

- The vertebral alignment in relation to the vertical line through CAM can be noticed to distribute on both sides (anteroposterior).
- The great trochanter can be observed in the back of the vertical line through CAM.
- A decreased distance between the vertical line through CAM and the external malleoli can be noticed.
- The distance between landmarks of the lower limb (knee and ankle) and the vertical line through CAM has been diminished, especially in the external malleoli.

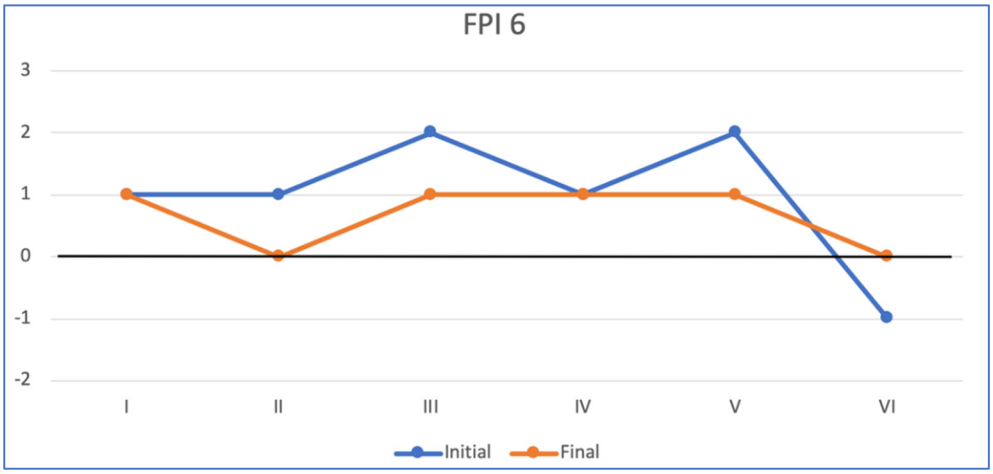
Fig. 4. Initial sagittal alignment using plumb line evaluation
(Photo made by authors)

3. The foot evaluation (see table 5 and chart 2):

Table 5. FPI evaluation results

Items	***Initial inițială***	***Final***
Talar Head Palpation	+1	+1
Supra and infra lateral malleolar curvature	+1	0
Calcaneal frontal plane position	+2	+1
Bulging in the region of talonavicular joint	+1	+1
Height and congruence of the medial longitudinal arch	+2	+1
Abduction/adduction of the forefoot on the rearfoot	-1	0
TOTAL FPI:	**+6**	**+4**

Chart 2. Foot Posture Index 6 items



4. The evaluation with IsoFree (see Table 6 and 7):

Table 6. The results of evaluation using IsoFree– Bipodal evaluation

	Initial evaluation	***Final evaluation***
Ellipse area (mm^2)	52,83	123,55
Perimeter (mm)	311,34	525,93
Average CoP X (mm)	1,88	0,53
Average CoP Y (mm)	22,47	13,74

Table 7. The results of the evaluation using IsoFree – Real time feedback

	Inițial	***Final***
The angle of flexion/ extension of the head	5^0	0^0
The angle of flexion/ extension of the trunk	-4^0	-1^0

Discussions

Cervical spine alignment

In the cervical spine, the CVA presents an improvement of 5^0, from the initial value of 51^0 to the final value of 56^0. CVA offers data on the head position in relation to the neck. Ruivo et al. (2016) and Sheikhhoseini et al. (2018) propose an average CVA value of 55.02° ± 2.86°, and as an inclusion criteria of a patient with forward head posture (FHP) a CVA greater or equal than 50° is suggested. Thus, the patient does not present deviant alignment of FHP, however, it is situated slightly above the inclusion criteria.

The cranial angle (CA), which offers information on the upper cervical vertebrae position, has undergone an improvement from 26° to 23°, a decrease of 3^0. An average value has not been stated, however Mulet, Decker, Look, Lenton, & Schiffman (2007) conclude that a decrease of the CA value represents an improvement, respectively an increase of the value represents a worsening of the condition.

The evaluation of the sagittal alignment with the help of the plumb line, even though it is an accessible method often used, does not offer quantitative data. Kendall, McCreary & Kendall (1983) affirms that CAM must be situated on the same vertical line on the ground, with the external malleoli, although in practice the average distance between the vertical line through CAM and external malleoli, in healthy subjects, is -4,8 cm ± 0,2 cm (the malleoli situated posteriorly) (Hasegawa et al., 2017).

In the case of this study's subject, it can be observed from the sagittal alignment evaluation through the plumb line method, that the external malleoli is situated posteriorly to the vertical line through CAM. The same goes for the acromion. Positive changes of these parameters have been noted after the intervention of physical therapy, however these changes cannot be objectively quantified.

In regard to the real time feedback evaluation with the IsoFree, a 5^0 improvement from the initial value of 5^0, has been noted after physical therapeutic intervention.

The three types of cervical alignment evaluation are in concordance and standardized photometric measurements respectively. CVA and CA, in the initial evaluation show a slightly forward head attitude, but still insufficient for it to be included in the pathologic FHP. In addition, IsoFree confers a relative small initial value of head flexion (5^0), however significant and through sagittal evaluation with plumb line, all of these results can be confirmed according to the criteria offered by Kendall et al. (1983). This concordance among the measurements is also found in the final evaluation.

The alignment of the lumbar spine and the pelvis

In the sagittal evaluation, the alignment has been initially characterized by the retroversion of the pelvis and the swayed back alignment of the trunk, more exactly it can be observed that the pelvis landmark, the great trochanter, is positioned slightly behind the vertical through CAM, which has been modified due to the 5^0 flexion of the head. However, the pelvis landmark must always be in front of the vertical line through CAM (Hasegawa et al., 2017).

The trunk, on the other hand, is situated far more posteriorly to the vertical line through CAM. The entire spine, including the lumbar region, in the case of the studied patient is considerably behind the vertical line, in contrast to the results of Hasegawa et al. (2017), in which the lumbar spine is located in front of the vertical line. The subject's posterior position has been confirmed by the evaluation using IsoFree, which present a value of -4^0 at the trunk, equivalent to 4^0 of extension.

After the intervention of physical therapy, the following improvements in the sagittal evaluation have been noticed: the pelvis is located on the vertical line through CAM, yet this time the line is situated more posteriorly because of the cervical correction. Furthermore, the spine alignment has been improved, while a harmonious anteroposterior distribution of the spine, in relation to the vertical line through CAM was recorded.

The final evaluation on IsoFree reveals a 3^0 progress of the trunk, the final value being -1^0.

The results offered by the IsoFree equipment have also been reflected in the sagittal evaluation, a concordance existing in both the initial and final evaluation.

Foot alignment and Stabilometric evaluation

Using the standardized FPI evaluation, an initial score of +6 has been obtained as well as a final score of +4. The interpretation grid of the obtained results offers the following information: between 0 and 5+, the score represents a neutral foot position; from 6+ to 9+ the foot is in a slight pronation, and from +10 to +12 a pronounced pronation. The negative values represent a slight foot supination, between -1 and -4, and pronounced foot supination from -5 to -12 (Oleksy, Mika, Lukomska-Gorny, & Marchewka, 2010). Therefore, in the initial evaluation, the foot posture is located at the lower bound of slightly supinated posture.

After the physical therapy program, improvements were noticed in four aspects of the FPI evaluation, respectively at the infra- and supra- lateral malleolar curvature, at the calcaneal frontal plane position, at the height of the medial longitudinal arch and the forefoot position.

In the initial bipodal evaluation with IsoFree, the average CoP X value is 1.88 mm, which shows a mediolateral deviation towards the right side. This indicates a slight shift of the weight projection to the right inferior limb. On the Oy axis, the average value is of 22.47 mm. This indicates the anterior projection of the CoP.

After the physical therapy program, an improvement of both directions of the xOy axis is noticed, especially in the anteroposterior plane. During the final evaluation, the average value of the CoP Y is 13,74 mm.

An increase in the values for both parameters of the stabilometry can be observed. From the initial value of the ellipse surface area of 52.83 mm^2 to 123.55 mm^2, the final value. The perimeter has changed from 311.34 to 525.93 mm^2.

These changes, which denote a decrease in the motor control quality and a regress of the stabilometry parameters, have been explained by Ghai, Ghai, & Effenberg (2017), in a meta-analysis on postural stability. They claim that focusing on modifying the spatial positioning of the body, process which is normally automatic, the performance of the motor control can be, temporarily affected.

Conclusions

In the cervical region, three evaluation methods have been used: evaluation using IsoFree, standardized photometric measurements (CVA and CA) and sagittal alignment evaluation using the plumb line. It was noticed that the results of all these methods are in concordance with one another.

The results of the initial cervical alignment evaluation present a slightly forward head position. After the physical therapy, positive results during the final evaluation were obtained.

The alignment of the lumbar spine was evaluated using IsoFree and the plumb line. A deficient extension of the trunk was highlighted, which is ameliorated through intervention.

The foot evaluation with the FPI-6 test was included in this study due to the importance of the ground contact in the superior structure alignment. After the intervention through physical therapy, the slightly supinated position was improved.

Bipodal evaluation using IsoFree reveals improvements of the CoP projection on the support surface following the physical therapeutic intervention. Moreover, the stabilometric evaluation offers indications on the postural control through the following parameters: ellipse surface area and perimeter.

The necessity of including balance and stability exercises in the postural intervention program is suggested by the final results of the stabilometry parameters, which are negatively affected by the conscious focus in an otherwise automated process.

The use of the IsoFree medical equipment brings a number of significant benefits both in evaluation and in intervention. Firstly, it raises awareness on spatial positioning of different segments of the body, giving real time, objective feedback. In addition, it leads to a better understanding of the requirements of the physical therapist as well as the suggested objectives. Another benefit is given by technology in the process of evaluation and rehabilitation which could offer objective, quantifiable and additional data.

The obvious limitations of the study include the small number of subjects which have participated in this program. It is recommended that the protocol be applied to a greater number of subjects in the future.

The evaluation using the IsoFree technology shows significant benefits while being in accordance to other methods of evaluation.

The proposed physical therapeutic intervention has determined positive outcomes on the subject's posture.

REFERENCES

1. Bhandari, S.B., Bhandari, R., Uppal, R., & Grover, D. (2013). Musculoskeletal Disorders in clinical dentistry and their Prevention. *Journal of Orofacial Research*, 106-114.
2. Diab, A.A., & Moustafa, I.M. (2012). The efficacy of forward head correction on nerve root function and pain in cervical spondylotic radiculopathy: A randomized trial. *Clinical Rehabilitation*, *26*(4), 351-361. https://doi.org/10.1177/0269215511419536
3. Ghai, S., Ghai, I., & Effenberg, A.O. (2017, martie 23). Effects of dual tasks and dual-task training on postural stability: A systematic review and meta-analysis. *Clinical Interventions in Aging*, Vol. 12, pp. 557-577. https://doi.org/10.2147/CIA.S125201
4. Ghasemi, M.S., Koohpayehzadeh, J., Kadkhodaei, H., & Ehsani, A.A. (2016). The effect of foot hyperpronation on spine alignment in standing position. *Medical Journal of the Islamic Republic of Iran*, *30*(1), 466.
5. Gopinadh, A., Devi, K.N.N., Chiramana, S., Manne, P., Sampath, A., & Babu, M.S. (2013). Ergonomics and Musculoskeletal Disorder: As an Occupational Hazard in Dentistry. *The Journal of Contemporary Dental Practice*, *14*(2), 299-303. https://doi.org/10.5005/jp-journals-10024-1317
6. Harman, K., Hubley-Kozey, C.L., & Butler, H. (2005). Effectiveness of an exercise program to improve forward head posture in normal adults: A randomized, controlled 10-week trial. *Journal of Manual and Manipulative Therapy*, *13*(3), 163-176. https://doi.org/10.1179/106698105790824888

7. Hasegawa, K., Okamoto, M., Hatsushikano, S., Shimoda, H., Ono, M., Homma, T., & Watanabe, K. (2017). Standing sagittal alignment of the whole axial skeleton with reference to the gravity line in humans. *Journal of Anatomy*, *230*(5), 619-630. https://doi.org/10.1111/joa.12586
8. Hébert-Losier, K., & Murray, L. (2020). Reliability of centre of pressure, plantar pressure, and plantar-flexion isometric strength measures: A systematic review. *Gait and Posture*, *75*(May 2019), 46-62. https://doi.org/10.1016/j.gaitpost.2019.09.027
9. Horak, F. B. (2006). MECHANISTIC AND PHYSIOLOGICAL ASPECTS Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? *Age and Ageing*, 7-11. https://doi.org/10.1093/ageing/afl077
10. Kendall, F., McCreary, E., & Kendall, H. (1983). *Muscles, testing and function: testing and function. 3rd edition*. Baltimore: Williams and Wilkins.
11. Kierklo, A., Kobus, A., Jaworska, M., & Botuliński, B. (2011). Work-related musculoskeletal disorders among dentists - a questionnaire survey. *Annals of agricultural and environmental medicine : AAEM*, *18*(1), 79-84. Preluat în din http://www.ncbi.nlm.nih.gov/pubmed/21736272
12. Kim, D., & Menger, R.P. (2020). Spine Sagittal Balance. În *StatPearls*. Preluat în din http://www.ncbi.nlm.nih.gov/pubmed/30521279
13. Kulig, K., Burnfield, J.M., Requejo, S.M., Sperry, M., & Terk, M. (2004). Selective Activation of Tibialis Posterior: Evaluation by Magnetic Resonance Imaging. *Medicine and Science in Sports and Exercise*, *36*(5), 862-867. https://doi.org/10.1249/01.MSS.0000126385.12402.2E
14. Le Huec, J. C., Saddiki, R., Franke, J., Rigal, J., & Aunoble, S. (2011). Equilibrium of the human body and the gravity line: the basics. *European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society*, *20*(5), 558-563. https://doi.org/10.1007/s00586-011-1939-7
15. Lewis, C.L., Khuu, A., & Marinko, L.N. (2015). Postural correction reduces hip pain in adult with acetabular dysplasia: A case report. *Manual Therapy*, *20*(3), 508-512. https://doi.org/10.1016/j.math.2015.01.014
16. Lewis, C.L., & Sahrmann, S.A. (2015). Effect of posture on hip angles and moments during gait. *Manual Therapy*, *20*(1), 176-182. https://doi.org/10.1016/j.math.2014.08.007
17. Moraes, A.C., Pinto, R.S., Valamatos, M.J., Valamatos, M.J., Pezarat-Correia, P.L., Okano, A.H., ... Cabri, J.M. (2009). EMG activation of abdominal muscles in the crunch exercise performed with different external loads. *Physical Therapy in Sport*, *10*(2), 57-62. https://doi.org/10.1016/j.ptsp.2009.01.001
18. Mulet, M., Decker, K.L., Look, J.O., Lenton, P.A., & Schiffman, E.L. (2007). A randomized clinical trial assessing the efficacy of adding 6 x 6 exercises to self-care for the treatment of masticatory myofascial pain. *Journal of Orofacial Pain*, *21*(4), 318-328.
19. Mulligan, E.P., & Cook, P.G. (2013). Effect of plantar intrinsic muscle training on medial longitudinal arch morphology and dynamic function. *Manual Therapy*, *18*(5), 425-430. https://doi.org/10.1016/j.math.2013.02.007

20. Okamura, K., Fukuda, K., Oki, S., Ono, T., Tanaka, S., & Kanai, S. (2020). Effects of plantar intrinsic foot muscle strengthening exercise on static and dynamic foot kinematics: A pilot randomized controlled single-blind trial in individuals with pes planus. *Gait and Posture*, *75*(September 2019), 40-45. https://doi.org/10.1016/j.gaitpost.2019.09.030
21. Oleksy, L., Mika, A., Lukomska-Gorny, A., & Marchewka, A. (2010). Intrarater reliability of the Foot Posture Index (FPI-6) applied as a tool in foot assessment in children and adolescents. *Medical Rehabilitation*, *14*(4), 10-20.
22. Redmond, A.C., Crosbie, J., & Ouvrier, R.A. (2006). Development and validation of a novel rating system for scoring standing foot posture: The Foot Posture Index. *Clinical Biomechanics*, *21*(1), 89-98. https://doi.org/10.1016/j.clinbiomech.2005.08.002
23. Ruhe, A., Fejer, R., & Walker, B. (2011). Center of pressure excursion as a measure of balance performance in patients with non-specific low back pain compared to healthy controls: a systematic review of the literature. *European Spine Journal*, *20*, 358-368. https://doi.org/10.1007/s00586-010-1543-2
24. Ruivo, R.M., Carita, A.I., & Pezarat-Correia, P. (2016). The effects of training and detraining after an 8 month resistance and stretching training program on forward head and protracted shoulder postures in adolescents: Randomised controlled study. *Manual Therapy*, *21*, 76-82. https://doi.org/10.1016/j.math.2015.05.001
25. Ruivo, R.M., Pezarat-Correia, P., & Carita, A.I. (2017). Effects of a Resistance and Stretching Training Program on Forward Head and Protracted Shoulder Posture in Adolescents. *Journal of Manipulative and Physiological Therapeutics*, *40*(1), 1-10. https://doi.org/10.1016/j.jmpt.2016.10.005
26. Sheikhhoseini, R., Shahrbanian, S., Sayyadi, P., & O'Sullivan, K. (2018). Effectiveness of Therapeutic Exercise on Forward Head Posture: A Systematic Review and Meta-analysis. *Journal of Manipulative and Physiological Therapeutics*, *41*(6), 530-539. https://doi.org/10.1016/j.jmpt.2018.02.002
27. Singla, D., Veqar, Z., & Hussain, M.E. (2017, iunie 1). Photogrammetric Assessment of Upper Body Posture Using Postural Angles: A Literature Review. *Journal of Chiropractic Medicine*, Vol. 16, pp. 131-138. https://doi.org/10.1016/j.jcm.2017.01.005
28. Slater, L.V., & Hart, J.M. (2017). Muscle Activation Patterns during Different Squat Techniques. *Journal of Strength and Conditioning Research*, *31*(3), 667-676. https://doi.org/10.1519/JSC.0000000000001323
29. Tecnobody SRL. (2015). *Iso-Free / Iso-Lift / Iso-Shift - Clinical Manual*.
30. Wright, W.G., Ivanenko, Y.P., & Gurfinkel, V.S. (2012). Foot anatomy specialization for postural sensation and control. *Journal of Neurophysiology*, *107*(5), 1513-1521. https://doi.org/10.1152/jn.00256.2011
31. Yoon, J.O., Kang, M.H., Kim, J.S., & Oh, J.S. (2018). Effect of modified bridge exercise on trunk muscle activity in healthy adults: a cross sectional study. *Brazilian Journal of Physical Therapy*, *22*(2), 161-167. https://doi.org/10.1016/j.bjpt.2017.09.005