

Interdisciplinary Therapeutic Approaches Based on the Relationship Between Dental Pain Perception and NiTi Archwires Types, Evaluated in the First Months of Orthodontic Treatment

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Pain is one of the most common reasons for patients scheduling or avoiding appointments in the dental office. This symptomatology which is commonly associated with fixed orthodontic treatment, may have a negative impact on the quality of life of the patient and may cause absences from periodic appointments. Interdisciplinary orthodontic treatment has a clear positive effect on psychological, functional, social health but also involves pain and discomfort, at least in the early stages or until the adaptability of the body occurs. The use of NiTi archwires during the first stages of treatment provides the development of physiological forces, but depending on each patient pain threshold, dental pain is perceived.

Keywords: dental pain, orthodontic treatment, NiTi archwire, interdisciplinarity

Pain is one of the most common reason for patients scheduling or avoiding appointments in the dental office. It is an unpleasant sensation that cannot be endured for a long time by the patient and which, in correlation with fear and anxiety, may exacerbate their symptoms. Symptomatology commonly associated with fixed orthodontic treatment, this may have a negative impact on the patient's quality of life and may result in discontinuation of treatment or absence from periodic appointments.

Orthodontic treatment is often an integral part of interdisciplinarity, creating through it the premises of a complex oral rehabilitation. One of its goals is to achieve the aesthetic aspect of the smile as well as a functional occlusion. Thus, besides the conventional stainless steel archwires, the Nickel-Titanium alloy (NiTi) archwires are used. Nitinol is the name for Nickel Titanium alloy which has two interesting properties: memory of forms and superelasticity. Due to its molecular structure, at low temperatures the alloy can be deformed and manipulated, known as martensitic state, but it returns to its form at high temperatures-known as austenitic state, as seen in figure 1 and figure 2. This property of returning to the original form is known as memory shape [1]. Nitinol memory shape is the ability to mechanically deform, subjected to a certain temperature, called *transition temperature*, and then to recover its original shape, non-deformed by heating over *transformation temperature*.

Along with its memory shape, Nitinol also has extraordinary elasticity, making it extremely useful for archwires. Superelasticity goes hand in hand with the

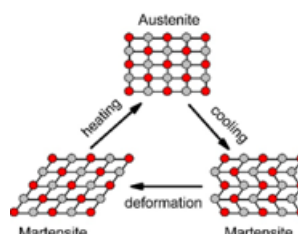


Fig 2. Nitinol superelastic molecular transformation due to temperature (CC BY-SA 3.0 Mmm-jun).

memory shape and, even if some criticism has been brought to its use in the medical field due to its nickel content, Nitinol proves to be very useful in applications involving movement and flexibility as is the orthodontic treatment. Among the properties of Nitinol that make it appreciated and preferred for medical use are: biocompatibility, torsional strength, physiological compatibility, shape memory, fatigue resistance, and imaging compatibility.

Experimental part

The aim of the study was to evaluate from the patient point of view, the perception of pain occurring after 0.14 NiTi and 0.16 NiTi archwire used at certain time moments after their insertion in the fixed appliance.

The study group consisted of a total of 39 patients with fixed orthodontic appliances who have given their consent freely to answer the questions. One group consisted of 11 patients with esthetic braces with NiTi coated esthetic archwires (8 female, 3 male), another group of 14 patients with metallic braces and NiTi archwires (8 female and 6 male), and last group of 14 patients with metallic braces and thermal NiTi archwires (9 female and 5 male).

Using the *0-10 Numeric Pain Rating Scale*, patients were asked to assess and quantify the appearance or persistence of the sensation of: tension, pressure, dental sensitivity, dental pain on a scale from 0 to 10, where 0 is no pain and 10 is the maximum intensity of pain / sensation experienced in: the first day after the archwire insertion (Z1), at the end of the first week (S1) and at the end of the fourth week (S4) from the archwire insertion.

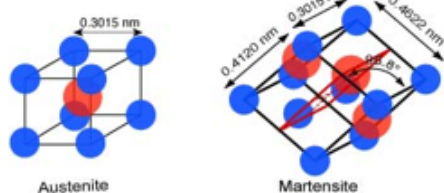


Fig 1. Nitinol's molecular structure (public domain Tom)

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Results and discussions

Percentage distribution by gender did not show significant differences depending on the type of archwires used ($p = 0.371$) (fig. 3).

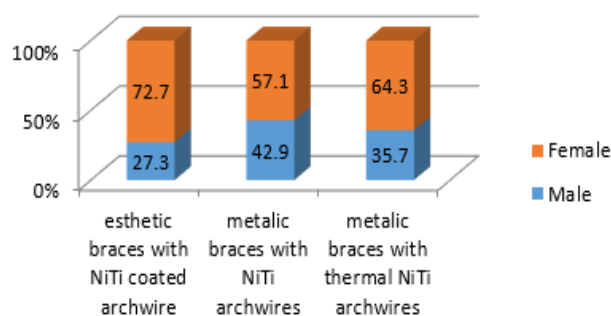


Fig.3. Structure of study groups by gender

After the use of 0.14 NiTi archwires (fig. 4) we noticed that the average level of sensation of tension at Z1 moment did not differ significantly depending on the type of archwire used ($p > 0.05$), while the in S1 ($p < 0.05$) and S4 ($p < 0.001$) moments, for the patients with thermal NiTi archwires the average level was significantly lower than the others used. For the sensation of tension there were decreases in the mean score in moments S1 and S4 as compared to day 1, but the differences were significant only in patients with thermal NiTi archwires.

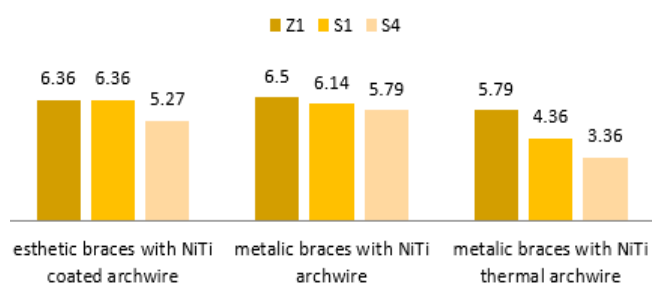


Fig 4. Tension perception assessment for 0.14 NiTi coated, NiTi and NiTi thermal archwires

In figure 5, we notice that the average level of pressure sensation at Z1 moment did not differ significantly depending on the type of archwire used ($p > 0.05$), while in weeks S1 ($p < 0.05$) and S4 ($p < 0.001$) for patients with the thermal ones the average level was significantly lower than the other types. For the sensation of pressure there were decreases in the average level during the study period, but the differences were significant only for the patients with thermal NiTi archwires.

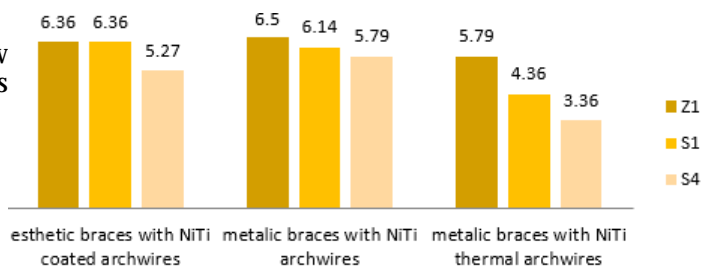


Fig 5. Pressure sensation assessment for archwires 0.14 NiTi coated, NiTi si NiTi thermal

The average levels of dental sensitivity (fig. 6) at moments Z1 and S4 did not differ significantly depending on the type of applied archwires ($p > 0.05$), while at week S1 the average level in patients with thermal NiTi archwires was significantly lower than the other types ($p < 0.05$). Dental sensitivity decreased from an average score of 6.27 (Z1) to 4.09 (S4) for patients with NiTi coated archwires ($p < 0.05$), from 6.71 (Z1) to 4.07 (S4) for patients with NiTi archwires ($p < 0.001$) and from 5.79 (Z1) to 2.93 (S4) for patients with thermal NiTi archwires ($p < 0.001$).

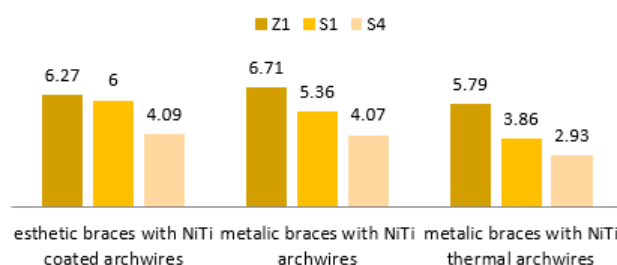


Fig 6. Dental sensitivity assessment for 0.14 coated NiTi, NiTi si NiTi thermal archwires

The average levels of dental pain (fig. 7) at moments Z1, S1 and did not differ significantly depending on the type of applied archwires ($p > 0.05$). Dental pain has decreased from an average score of 6.27 (Z1) to 4.09 (S4) for patients with NiTi coated archwires ($p < 0.05$), from 6.71 (Z1) to 4.07 (S4) for patients with NiTi archwires ($p < 0.001$) and from 5.79 (Z1) to 2.93 (S4) for patients with the thermal NiTi archwires ($p < 0.001$).

In the case of 0.14 NiTi and NiTi thermal archwires we can say that the sensation of tension, pressure, dental sensitivity and dental pain has a peak at Z1, then a slight decrease at S1, then at S4 the decrease is more importance. The NiTi thermal archwires have determined the lowest recordings due to the most likely lower and constant forces they exert on the teeth (table 1).

Table 1

AVERAGE PERCEPTION OF TENSION, PRESSURE, DENTAL SENSITIVITY, DENTAL PAIN DEPENDING ON THE TYPE OF NiTi 0.14 ARCHWIRE

perception	Braces with 0.14 NiTi archwires								
	NiTi coated archwires			NiTi archwires			NiTi thermal archwires		
	Z1	S1	S4	Z1	S1	S4	Z1	S1	S4
Average Tension \pm SD	6.36 \pm 1.91	6.36 \pm 1.91 ^{ns}	5.27 \pm 1.62 ^{ns/ns}	6.50 \pm 1.40	6.14 \pm 1.66 ^{ns}	5.79 \pm 1.67 ^{ns/ns}	5.79 \pm 1.48	4.36 \pm 1.87 ^b	3.36 \pm 1.65 ^{a/ns}
Average pressure \pm SD	6.36 \pm 1.91	6.36 \pm 1.91 ^{ns}	5.27 \pm 1.62 ^{ns/ns}	6.50 \pm 1.40	6.14 \pm 1.66 ^{ns}	5.79 \pm 1.67 ^{ns/ns}	5.79 \pm 1.48	4.36 \pm 1.87 ^b	3.36 \pm 1.65 ^{a/ns}
Average dental sensitivity \pm SD	6.27 \pm 1.95	6.00 \pm 2.05 ^{ns}	4.09 \pm 1.92 ^{b/b}	6.71 \pm 1.77	5.36 \pm 2.06 ^{ns}	4.07 \pm 1.64 ^{a/ns}	5.79 \pm 1.67	3.86 \pm 1.96 ^b	2.93 \pm 1.59 ^{a/ns}
Average dental pain \pm SD	6.27 \pm 1.95	5.73 \pm 2.05 ^{ns}	3.91 \pm 2.02 ^{b/b}	6.71 \pm 1.77	5.36 \pm 2.06 ^{ns}	4.07 \pm 1.64 ^{a/ns}	5.79 \pm 1.67	3.86 \pm 1.96 ^b	2.93 \pm 1.59 ^{a/ns}

a) $p < 0.001$

b) $p < 0.05$

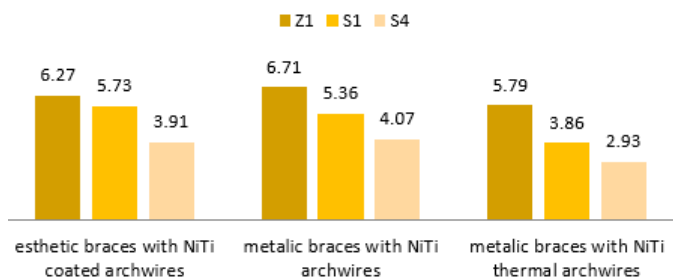


Fig 7. Dental pain assessment for 0.14 coated NiTi , NiTi and NiTi thermal archwires

Regarding patients responses following the application of 0.16 NiTi archwires, the following aspects were noticed.

The average levels of tension sensation (fig. 8) at moments Z1, S1 did not differ significantly depending on the type of archwires applied ($p > 0.05$), while at week S4 the average level in patients with thermal NiTi archwires was significantly lower than the other types ($p < 0.05$). For the tension sensation there were decreases in the average score from 6.45 (Z1) to 4.91 (S4) for patients with NiTi coated archwires ($p < 0.05$); from 6.57 (Z1) to 5.21 (S4) for patients with NiTi archwires ($p < 0.05$) and from 5.79 (Z1) to 3.36 (S4) for patients with thermal NiTi archwires ($p < 0.001$).

The average level of pressure sensation for the moments Z1, S1 did not differ significantly according to the type of archwires used ($p > 0.05$), while the average level in S4 week for the patients with thermal NiTi archwire was significantly lower than the other types ($p < 0.05$).

For pressure sensation there was a decrease in average score from 6.45 (Z1) to 4.91 (S4) for patients with NiTi esthetic archwires ($p < 0.05$); from 6.36 (Z1) to 4.43 (S4) for patients with NiTi archwires ($p < 0.001$) and from 5.79 (Z1) to 3.21 (S4) for the patients with thermal archwires ($p < 0.001$).

The average level of dental sensitivity (fig. 9) at moments Z1, S1 and S4 did not differ significantly depending on the type of archwires used ($p > 0.05$). Dental sensitivity

decreased from an average score of 5.45 (Z1) to 3.18 (S4) for patients with esthetic archwires ($p < 0.05$), from 5.57 (Z1) to 3.21 (S4) for patients with NiTi archwires ($p < 0.001$) and from 5.36 (Z1) to 2.79 (S4) for patients with thermal NiTi archwires ($p < 0.001$).

The average levels of dental pain at Z1, S1 did not differ significantly depending on the type of archwire applied ($p > 0.05$), while at week S4 the mean level in patients with thermal NiTi archwires was significant less than the other types ($p < 0.05$). Dental pain has decreased from an average score of 5.45 (Z1) to 3.18 (S4) for patients with esthetic archwires ($p < 0.05$); ($p < 0.001$) and from 4.79 (Z1) to 2.07 (S4) for patients with thermal NiTi archwires ($p < 0.001$).

As can be seen in table 2, in the case of the thermal 0.16 NiTi archwires and NiTi archwires, we can say that the sensation of tension, pressure, dental sensitivity and dental pain has a peak at Z1, then a slight decrease at S1, then at S4 the decrease is more important. Both 0.14 and 0.16 NiTi Thermal archwires have produced the smallest record due to better biocompatibility in terms of spring force expression.

Contemporary dentistry offers a wide range of biomaterials and techniques and modern technologies, which lead to substantial improvements in the treatment plans, both from the point of view of biocompatibility as well as from the biomechanical one, adding new possibilities of rebuilding morphology and affected stomatognathic system functions [2].

Aesthetic treatment is very important in the diagnosis and treatment plan. The aesthetic requirement must be understood and dosed in the context of a complete treatment solution with the importance of other factors: mechanical, functional, biological and psychic, all the subordinate concept of a complex oral rehabilitation [3].

For each and every case / situation, the physician must choose the best clinical and technological solution, while ensuring optimum results [4].

In the literature, there are a series of studies on pain assessment during orthodontic treatment. Although all

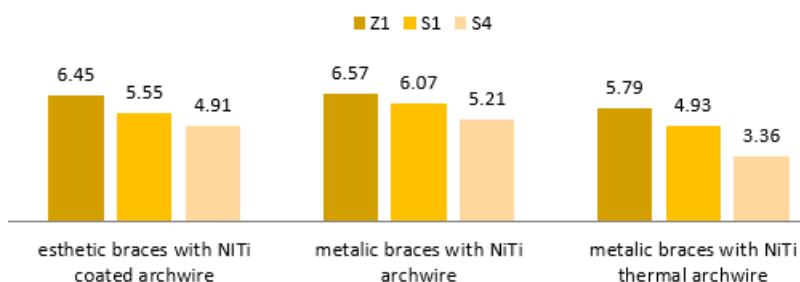


Fig 8. Tension perception assessment for 0.16 NiTi coated, NiTi and NiTi thermal archwires

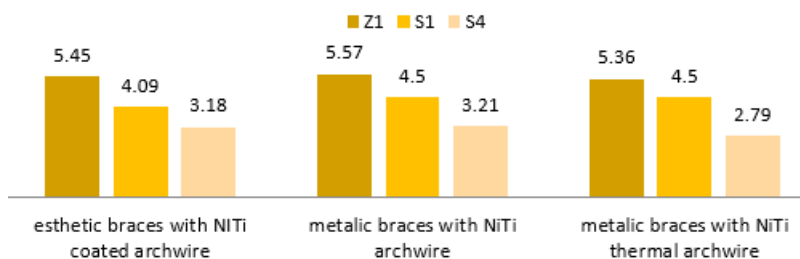


Fig 9. Dental sensitivity assessment for 0.16 coated NiTi , NiTi and NiTi thermal archwires

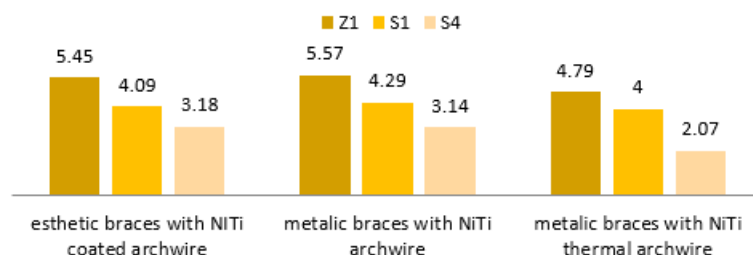


Fig 10. Dental pain assessment for archwires 0.16 NiTi coated, NiTi and NiTi thermal archwires

Table 2

AVERAGE PERCEPTION OF TENSION, PRESSURE, DENTAL SENSITIVITY, DENTAL PAIN DEPENDING ON THE TYPE OF NiTi 0.16 ARCHWIRE

perception	Braces with 0.16 NiTi archwires								
	Esthetic archwires			NiTi archwires			NiTi thermal archwires		
	Z1	S1	S4	Z1	S1	S4	Z1	S1	S4
Average Tension \pm SD	6.45 \pm 1.44	5.55 \pm 1.44 ^{ns)}	4.91 \pm 1.38 ^{b)ns)}	6.57 \pm 1.28	6.07 \pm 1.21 ^{ns)}	5.21 \pm 1.05 ^{b)ns)}	5.79 \pm 1.48	4.93 \pm 1.44 ^{ns)}	3.36 \pm 1.65 ^{a)b)}
Average pressure \pm SD	6.45 \pm 1.44	5.55 \pm 1.44 ^{ns)}	4.91 \pm 1.38 ^{b)ns)}	6.36 \pm 1.15	5.36 \pm 1.22 ^{b)}	4.43 \pm 1.02 ^{a)b)}	5.79 \pm 1.48	4.64 \pm 1.50 ^{ns)}	3.21 \pm 1.67 ^{a)b)}
Average dental sensitivity \pm SD	5.45 \pm 1.57	4.09 \pm 1.70 ^{ns)}	3.18 \pm 1.33 ^{b)ns)}	5.57 \pm 1.34	4.50 \pm 1.02 ^{b)}	3.21 \pm 0.70 ^{a)a)}	5.36 \pm 1.87	4.50 \pm 1.91 ^{ns)}	2.79 \pm 1.58 ^{a)b)}
Average dental pain \pm SD	5.45 \pm 1.57	4.09 \pm 1.70 ^{ns)}	3.18 \pm 1.33 ^{b)ns)}	5.57 \pm 1.34	4.29 \pm 0.91 ^{b)}	3.14 \pm 0.66 ^{a)a)}	4.79 \pm 1.85	4.00 \pm 1.66 ^{ns)}	2.07 \pm 1.64 ^{a)b)}

a) $p < 0.001$ b) $p < 0.05$

studies agree that pain occurs during orthodontic treatment, there are large variations between reported prevalence rates, intensity and duration of this type of pain [5-10].

It has been observed that pain and discomfort last longer than 4 weeks after the onset of fixed orthodontic treatment, which has led us to follow the perception of pain from the point of view of the patient when introducing two archwire sizes into the initial stages of treatment.

Factors influencing the pain sensitivity may be physiological or psychological. The physiological factors are represented by: age, sex, circadian rhythm, blood pressure variation, menstrual cycle, intensity of applied force, individual pain threshold. Psychological factors refer to anxiety, as its core or environment-induced, past or previous experiences [9].

As pain is generally a subjective symptom, it is also extremely difficult to quantify [5,7,8,10,12,13]. In the scale used by us the rate 0 indicates absence of pain, 1-3 is considered mild pain, 4-6 moderate, severe [7-10, 14,15].

In addition to alveolar pain caused by dental movements, and mucosal lesions on the internal face of the cheeks, on the edges of the tongue can cause pain. Most studies conclude that the maximum moment of pain may occur within the first 24 h of application of the appliance, [5,9,10,13,16-18] but may persist even after removal of the appliance [19], there are some authors who did not consider significant the pain of low intensity [16]. Changing eating habits in favor of softer foods is recommended to alleviate pain in the idea that many patients are accusing pain of hard or fibrous foods [12].

As a mechanism of production, the orthodontic pain is caused primarily by the compression made by the orthodontic forces on the periodontal ligament. The response occurs immediately after archwire placing and is characterized by ischemia and compression of the periodontal ligament. Age and periodontal status have influence in orthodontic response and also in pain. After the application of mechanical forces, the cells of the periodontal ligament produce some quantities of mediators that they are diffused into the gingival crevicular fluid and afterwards into the saliva [20]. Dental movement is effected through processes of bone resorption and apposition that occur subsequent to the existence of an inflammatory process localised at this level [21-23]. Delayed responses, especially hyperalgesia, begin some hours later. During this response, released prostaglandins may increase the sensitivity of pain receptors to harmful agents such as bradykinin, acetylcholine, substance P and histamine. This phase continues with neurogenic inflammation,

osteoblastic and osteoclastic activity, periodontal vasodilatation and pain [7, 24]. It is now widely accepted that lighter forces are less traumatic and painful and are considered to be ideal for orthodontic treatment [25].

Nowadays the orthodontic therapy is spreading both among young patients and aged patients due to increased esthetic and functional needs [26, 27]. Effective communication between the clinician and patient, warning the patient about the occurrence and existence of pain during orthodontic treatment and attention to the psychological well-being of the patient can improve pain tolerance and reduce pain perception [7, 8, 16].

For pain relief, non-steroidal anti-inflammatory and analgesic drugs may be used, but should not be exaggerated with administration because they would disrupt the dental movement due to prostaglandin antagonism [7,8].

Eating habits have an influence on the onset of dental pain during orthodontic treatment, so the fibrous or harsh foods can aggravate the pain, while a softer, more protective diet will significantly reduce this unpleasant aspect. This finding was consistent with the results of other authors [19] and suggests that patients should change their diet to provide comfort [7,8,28]. It is generally recommended that harder foods be cut into pieces for easier chewing, however, patients tend to underestimate or ignore advice on dietary changes.

Conclusions

Discomfort and pain caused in the initial stage of fixed orthodontic treatment may be moderate to severe and may last for a long time. Tooth brushing can also cause discomfort and eating soft foods can minimize pain. Effective communication between the clinician and patient, warning the patient about the occurrence and existence of pain during orthodontic treatment and attention to a good quality of life of the patient can improve pain tolerance and reduce the pain perception during orthodontic treatment. Initially recorded pain decreases in intensity during the advancement of treatment, the use of NiTi thermal archwires has a positive effect, being associated with a lower intensity of pain during orthodontic treatment.

References

- GHERGHESCU, I.A., JICMON, G.L., COTRUT, C., BRANZEI, M., BERBECARU, A.C., PREDESCU, A.M., CIUCA, S., Rev. Chim. (Bucharest), **67**, no. 9, 2016, p. 1734
- ANTOHE, M.E., DASCALU, C., SAVIN, C., FORNA, N.C., BALAN, A, Mat. Plast., **53**, no. 4, 2016, p. 767

3. ANTOHE, M.E., AGOP FORNA, D., DASCALU, C.G., FORNA, N.C., , International Journal of education and information technologies , Vol.: 10, 2016, p. 199
4. ANTOHE, M.E., FORNA AGOP D., ANDRONACHE, M., FEIER, R., FORNA, N.C. , Romanian Journal of Oral Rehabilitation, **8**(2), 2016, p.16
5. BERGIUS, M., KILIARIDIS, S., BERGGREN, U., J. Orofac. Orthop. **61** (2), 2000, p. 125
6. JONES, M.L., Eur. J. Orthod. **6** (1), 1984, p.48
7. KRISHNAN, V., Eur. J. Orthod. **29** (2), 2007, p.170
8. KRUKEMEYER, A.M., ARRUDA, A.O., INGLEHART, M.R., Angle Orthod. **79** (6), 2009, p.1175
9. SCOTT, P., SHERRIFF, M., DIBIASE, A.T., COBOURNE, M.T., Eur. J. Orthod. **30** (3), 2008, p.227
10. TECCO, S., D'ATTILIO, M., TETE, S., FESTA, F., Eur. J. Orthod. **31** (4), 2009, p. 380
11. MACOVEI, G., BOLOS, A., Buletin de psihiatrie integrativa, **53** (2), 2012, p.40
12. RAKHSHAN, H., RAKHSHAN, V. The Saudi Dental Journal **27**, 2015,p.81
- 13.. XIAOTING, L., YIN, T., YANGXI, C. Angle Orthod. **80** (5), 2010 p. 925
- 14.. *** Numeric Pain Rating Scale Instructions.pdf
15. MCCAFFREY, M., PASERO, C. Pain: Clinical manual (2nd edition) by C. V. Mosby, St Louis. ISBN 0 8051 5609 X; 1999, p.16
16. ERDINC, A.M., DINCER, B., Eur. J. Orthod. **26** (1), 2004, p.79
17. JONES, M., CHAN, C., Am. J. Orthod. Dentofacial Orthop. **102** (4), 1992, p.373
18. NGAN, P., KESS, B., WILSON, S., Am. J. Orthod. Dentofacial Orthop. **96** (1), 1989, p.47
19. MIYAWAKI, S., YASUHARA, M., KOH, Y., Am. J. Orthod. Dentofacial Orthop. **115** (1), 1999, p. 83
20. LUCHIAN, I., MARTU, I., GORIUC, A., VATA, I., HURJUI, L., MATEL M.N., MARTU, S., Rev. Chim. (Bucharest), **67**, no. 10, 2016, p.2119
21. LUCHIAN I., MARTU, I., IOANID, N., GORIUC, A., VATA, I.,MARTU STEFANACHE, A., HURJUI, L., TATARCIUC, M., MATEL M.N., MARTU, S., Rev. Chim. (Bucharest), **67**, no. 12, 2016, p.2479
22. NICOLAICIUC, O., MIHAI, C., SUFARU, IG., MARTU, I. SOLOMON, SM., TATARCIUC, D., BUDACU, C., MARTU, S, Rev. Chim. (Bucharest), **68**, no. 3, 2017, p. 619
23. URSARESCU, IG., PAVAL, D., SOLOMON, SM., PASARIN, L., BOATCA, M., NICOLAICIUC, O., NITESCU, DC., MARTU, S. Romanian Journal of Oral Rehabilitation, **8**(1), 2016, p.97-103
24. SUFARU, IG., SOLOMON, SM., PASARIN, L., MARTU-STEFANACHE, MA., OANTA, AC., MARTU, L., CIOCAN PENDEFUNDA, A., MARTU, S. Romanian Journal of Oral Rehabilitation, **8**(4), 2016, p.42-46.
- 25.. LUCHIAN, I, VATA, I, MARTU, I, STIRBU, C., SIUSTIS I, TATARCIUC, M., MARTU, S. Romanian Journal of Oral Rehabilitation, **8**(2), 2016, p.51-55
26. MACOVEI, G., ANDRIAN, S., IOVAN, G., GHEORGHE, A., NICA, I., TOPOLICEANU, C., BOLAT, M., TOFAN, N., STOLERIU, S., PANCU, G., Romanian Journal of Oral Rehabilitation, **8**(4), 2016, p.57.
- 27.LUCHIAN, I, VATA, I, MARTU, I, TATARCIUC, M., PENDEFUNDA V, MARTU, S. Romanian Journal of Oral Rehabilitation, **8**(1), 2016, p. 80-83.
28. SCHEURER, P.A., FIRESTONE, A.R., BURGIN, W.B., Eur.J. Orthod. **18** (4), 1996, p. 349

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