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APPLICATION OF THE CEPHALOMETRIC ANALYSIS IN ASSESSING THE EXTRACTION THERAPY IN INDIVIDUALS WITH DIFFERENT TYPE OF GROWTH

ПРИМЕНА НА КЕФАЛОМЕТРИСКАТА АНАЛИЗА ВО ОДРЕДУВАЊЕ НА ЕКСТРАКЦИОНАТА ТЕРАПИЈА КАЈ ИНДИВИДУИ СО РАЗЛИЧЕН ТИП НА РАСТ

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Abstract

All dental, skeletal and muscle components of the orofacial region are in interrelation and connection. Disturbances of the growth and development of the orofacial region often lead to occurrence of different types of facial deformities and different orthodontic anomalies in sagittal, transversal or vertical direction. The assessment of the plan of orthodontic treatment of those irregularities encompasses overall and extensive analysis of several parameters starting with the age of the person, extra-oral and intraoral characteristics of the individuals, analysis of roentgenograms and cephalograms, and gnatomeric analysis as well. All this confirms the status and importance of facial aesthetics in planning and determining the orthodontic treatment. Analyses based on the values of the craniomandibular angle (SN/MP) determine the type of growth which could be vertical or hyperdivergent and horizontal or hypodivergent. Each entity has its own skeletal, dental and soft tissue characteristics. Cephalometric analysis is an essential part of these analysis, and is of great value in assessing the plan of orthodontic treatment confirming or rejecting the decisions or dilemmas in conducting the treatment with or without extraction of teeth, which mostly depends on the degree of crowding in the mandibular front , the assessment of position of the incisors and the aesthetic line, the maxillary crowding, and the size of the horizontal incisive step overjet, as well the periodontal health and overall health of the oro-dental complex. **Key words:** cephalometric analysis, growth pattern, tooth extraction.

Апстракт

Сите дентални, скелетни и мускулни компоненти на орофацијалната регија се во меѓусебна поврзаност и интеракција. Отстапувањето во растот и развојот на орофацијалниот систем честопати води кон појава на различни типови на фацијални деформитети и различни ортодонтски неправилности во сагитален, трансверзален или вертикален правец. Одредувањето на планот на третман на истите, подразбира севкупна и опсежна анализа на повеќе параметри почнувајќи од возраста, екстраоралните и интраоралните карактеристики на индивидуата, анализа на рентгенграфски и кефалометриски снимки, гнатометриска анализа. Сето ова го потврдува значењето на фацијалната естетика при планирањето и утврдувањето на ортодонтски третман. Анализата заснована врз вредностите на кранио-мадибуларниот агол (SN / MP) го одредува видот на раст кој може да биде вертикален или хипердивергентен и хоризонтален или хиподивергентен. Секој ентитет има своја карактеристика на скелетните, денталните и орофацијаланите мекоткивни структури. Кефалометриската анализа како дел од овие анализи, е од огромно значење во одредување на планот на ортодонтскиот третман и истата ја потврдува или отфрла одлуката и дилемата за спроведување на третман со или без примена екстракција, кој во голема мера зависи од типот на раст, од степенот на збиеност во мандибуларниот фронт, естетската линија, максиларната збиеност и големината на хоризонталната инцизивна стапалка, периодонталното здравје. Сето ова го потврдува значењето и важноста на фацијалната естетика во планирањето и одредувањето на ортодонтскиот третман. **Клучни зборови:** кефалометриска анализа, тип на раст, екстракција на заби.

Introduction

Growth and development of the craniofacial system is an individual and genetic induced process, which presents in different variations in the size and form of these structures. Morphological and clinical characteristics of these changes are in correlation with the individual growth potential. As a result of different growth patterns and combinations of anteroposterior and vertical dimensions during that period, different facial characteristics evolve. Teeth, muscles, and bones are in interrelation and interconnection during growth and they tend to emphasize or

camouflage initial deformities. Their disproportions and malposition often lead to development of malocclusion and certain facial abnormalities.

One of the prime and primary tasks of orthodontics is to direct the growth and development of the orofacial region and establish a balance between all parts of that system, and with that, create a proper occlusion, function and esthetics. There are several diagnostic methods for gaining a proper and correct diagnosis of skeletal disharmonies. Profile cephalometric is among the most important and it allows us to estimate the individual growth and development, to estimate the dimensions of the facial skeleton, the interrelation of bone and soft tissues, and the characteristics of the bases of jaws and dentoalveolar relations. That's why in orthodontics, proper diagnosis is of primary importance and according to it, an adequate implementation of the orthodontic treatment.

Therefore, it is of utmost importance in orthodontics to determine the correct diagnosis and an adequate implementation of the treatment plan.

Estimation of growth reveals that postnatal growth of the face occurs mostly in depth, then in height, and at least in width. Even in the same anatomical structure like the mandible; ramus and corpus of the lower jaw enrich their dimensions with different intensity in different periods. Nanda came to conclusion that the upper and lower facial components of the anterior facial height, don't grow alike. In that manner, the importance of cephalometry in the estimation and assessment of the growth potential of every individual is bigger. The roentgen cephalometry technique was introduced by Hofrath and Broadbent who enabled the application of X-rays for assessment of longitudinal growth of individuals. In its beginnings, cephalometry developed as means to study growth and development, but later its purpose was expanded on prediction of the growth and development, for diagnosis and planning of the treatment, and estimation of the progress of the treatment as well. Steiner emphasizes that analysis is not complete until it is personalized for each patient. Several orthodontist clinicians made some improvements and supplemented the current cephalometric such as Sassoni, Tweed, Steiner, Shwartz, Ricketss, Solow[1-4].

The cephalometric analysis consists of series of measurements designed to measure different geometric parameters, which precisely determine these anatomy-morphological facial structures based on four basic parameters: size, form, position and orientation. With this analysis, we gain directions for the orthodontic diagnosis and treatment plan. The decision to reduce the number of teeth in orthodontic practice always encounters a big dilemma. Orthodontists traditionally follow a specific diagnostic procedure, which allows them to be confident in making proper decisions regarding the plan of the treatment. The cephalometric analysis helps them to estimate the proper plan individually, and decisions for extraction are easier when it's a clear case, not a "limited "one[5,6].

There are several parameters which are of great help in making that decision. Some of them are focused on the estimation of the anterior vertical growth of the face, as the axis of the mandible (Y- axis) according to Downs. This angle is in correlation with the parameter of sagittal length of the mandible, namely, a bigger antero-posterior dimension of the corpus of the mandible correlates with increased vertical growth, which is followed by increased anterior facial height and greater opportunity for development of irregularities in the vertical dimension and an open bite, thus reflecting on soft tissues and extraoral appearance of the individual. (convex or concave profile with increased anterior facial height, especially in the lower anterior region). The craniomandibular angle SN/MP is considered to be a more stable parameter which is independent of the change in the sagittal dimension of the mandible, and therefore it is also used for defining individuals with different types of vertical growth, like individuals with vertical or hyper divergent types of growth where the values of this angle are greater than 32˚, and hypo divergent growth - where the angle SN/MP is less than 32˚. In determining the direction of mandibular growth and rotation, there is also the angle that makes the Frankfurt's horizontal and mandibular plane of Tweed (FMA angle), the ratio of the posterior and anterior face height or the so-called Jarabak ratio, as well as the Vert Index of Ricketts[7], which are complementary to the overall analysis.

Guo Y. and ass.[8] conducted an analysis of the impact of the morphological characteristics of malocclusion class II grade 1 on the decision to carry out treatment with a reduction in the number of teeth, studied in 4 groups where different extraction therapies were performed. Namely, in one of the groups, two maxillary first premolars were extracted; in the second - two maxillary first premolars and one mandibular incisor; in the third – the first premolars in the upper and lower jaws, and in the fourth group - two maxillary first premolars and two mandibular second premolars. Their examinations proved that the statistically significant factors responsible for a different extraction protocol were as follows: the crowding in the mandibular frontal segment, the molar correlation, the type of growth, the size of the horizontal incisal step, and the protrusion of the lower lip.

Kim[9-11] uses a specific model of determining the so-called extraction index by applying several parameters ODI - pointer of a vertical maxilla-mandibular correlation, which is an indicator of the size of the vertical incisal step (the sum of the angles AB/MP and SpPl/FH); APDI – indicator of the anteroposterior dysplasia of the maxilla-

mandibular correlation (sum of the angles FH/NPg, NPg/AB and SpPl/FH; CF - balance indicator for horizontal and vertical orofacial skeletal components -Σ (ODI + APDI) and EI -extraction index - which determines whether there is a need for extraction or not, {Σ of CF + IIA (interincisal angle) + value of protrusion or retraction of the lips} - and is in correlation with the horizontal and vertical components, the inter-incisal angle and the position of the lips, which directly affect the appearance of the face and its aesthetics. In order to determine the type of face, the position of the lips and the characteristics of the soft tissue profile, Merrifield used an angle (Z) made by the Frankfurt horizontal and the aesthetic line (E-line). According to Ricketts[13], one of the important variables in determining the need for extraction is the distance of the lower lip from the E-line (which touches the tip of the nose and the tip of the chin). Namely, when the lips have an inadequate projection, it's difficult for the orthodontist to decide on extraction, as opposed to the position when the lips pass the E-line, when the extraction decision is easier to be made. This, in fact, confirms the importance of facial aesthetics in planning and determining the orthodontic treatment[14-20].

Many authors have conducted analyses of the need to carry out an extraction therapy in orthodontics.

According to Konstantonis et al.[21], the decision on the need to carry out the extraction therapy, depends on several changeable variables such as: the degree of crowding in the mandibular front, the aesthetic line, the maxillary density, and the size of the horizontal incisal step.

The crowding of the teeth in the maxilla, along with the size of the horizontal incisal step in individuals with class I malocclusion, is an indicator of the projection of the teeth and the soft tissue structures, which plays an important role in balanced dental and facial aesthetics. Excessive overjet is usually observed in cases with dentoalveolar bi-maxillary protrusion which are routinely addressed and treated by removing the four first premolars.

Often, in individuals with malocclusion class I, increased overjet occurs when mandible crowding is present.

According to Sivakumar[22], there is a disagreement about the effect of extractions of premolars on the dentofacial vertical dimension. It is thought that the orthodontic movement of posterior teeth towards the front or the medial line, after the extraction of the first premolars, leads to a reduction in the vertical dimension.

Shearn[23] and Woods[24] have come to the conclusion that the type of growth has a major influence on the decision to extract mandibular premolars in subjects with class II grade 1 malocclusion, as well as the size of the horizontal incisal step.

According to Guo et al.[8] while examining subjects with malocclusion class II grade 1, the extraction of maxillary premolars is indicated in patients with a horizontal type of growth, while bi-maxillary extraction of premolars is conducive to individuals with normal or vertical type of growth.

Other studies have suggested such an approach to extraction therapy in individuals with hyper-divergent or vertical type of growth, while treatment without extraction is indicated in individuals with meso-divergent (normal) type of growth[25].

Schudy 26 also points out that teeth extraction leads to "closing the bite". This philosophical approach is also represented by Sassouni and Nanda[27].

Regarding the treatment of class III malocclusion, Beltrao[28], starting from the cephalometric analysis of Kim and assessing the need for extraction with it, comes to a conclusion that these subjects give good and stable results in terms of aesthetics and function, and are obtained by applying a camouflage orthodontic treatment. This is especially true for individuals with open bite and hyperdivergent type of growth, and is a solid alternative to the surgical approach to this malocclusion.

Discussion

In orthodontics, extractions are often subject of discussion, and their percentage has significant variations over the years depending on the trend of treatment and other various factors.

In the treatment of class I malocclusion in modern orthodontics, there are two main therapeutic approaches: extraction and treatment without tooth extraction. Extractions are routinely used to address the crowding of teeth, and to reduce dental intrusion, as well as soft tissue protrusion above them. Alternative treatment is performed by widening (expansion) the dental arches. The rate of extraction in orthodontics shows strong variations depending on the decade and socioeconomic factors.

In diagnosing and planning treatment, the orthodontist examines a series of variables and parameters that give way to the final decision. These variables are measurements of cephalometric records and model analysis, taking into account both the age and gender of the patient. Other factors, such as periodontal condition, restorations and congenitally absent or extracted teeth, are also affecting the decision to extract. After taking in consideration all of the above factors, the treatment plan is determined and whether the need for extraction is justified or not[6,7].

The study of Konstantinos et al.[21] shows that the rate of extractions in subjects with class I malocclusion, is 26.8%, and is in relative consensus with the findings of

other authors. They implement the so-called discriminatory analysis, according to which the study of the ratio of 4 variables in Class I determines the need for the implementation of an extraction therapy. These are the degree of crowding in the mandibular front, the aesthetic line, the maxillary crowding, and the value of the horizontal incisal step.

According to a study conducted by Proffit[29] at the University of North Carolina in the 1950s, only 10% of cases were treated with the extraction of four first premolars. In the next decade, the percentage reaches its peak by 50% and remains at that level until the 1980's, when it begins to gradually decrease. Reducing the rate of extraction is due to the lack of evidence in literature on the stability of treatment after extraction, as well as the unproven theory that extraction is associated with TMJ dysfunction. Numerous studies suggest that more recent findings in orthodontics, along with the tendency for more protruded lips, brings the extraction rate up to 30%, and thus it reaches the level of the early 1990s.[30-32].

According to the regression formula, the decision for extraction in subjects with malocclusion Class II division 1 depends largely on three variables: anterior mandibular crowding, molar correlation and the type of facial growth. These are also the findings of Nelson[33], who came to the conclusion that the correction of malocclusion Class II division 1, is largely manifested by dental, and then by vertical changes.

The study of Al-Nimri[34] also concludes that the decision to extract the first or second premolars in the mandible is a result of crowding in the mandibular dental arch, the inclination of the maxilla-mandibular angle, and the relation between the anterior and posterior facial height.

The horizontal incisal step is also an important factor determining the need for extraction. In a certain group of patients with malocclusion class II grade 1 with increased overjet, the extraction of maxillary premolars is often carried out as an alternative to orthogonal surgery[35,36]. In cases with a large horizontal incisal step and a good or potentially good mandibular dental arch, extractions may only be limited to the upper dental arch[37].

Starting from the aesthetic point of view, there are opposed opinions on the position and the shape of the lower lip, which according to some, is largely determined by the position of mandible incisors[38,39], while others suggest that the horizontal position of the lower lip is a result of the position of mandible incisors, while its vertical position is primarily determined by the incisal edge of the maxillary incisors[40].

The treatment of malocclusion Class III mainly involves the use of fixed appliances, in combination with extraction, and is one of the options for non-surgical approach in the treatment of skeletal anomalies. The application of the arc technique with a greater number of curves, or the so called multi loop edgewise archwire –MEAW, is used for the treatment of more severe forms of Class III malocclusion. The extraction index in this technique will depend on the vertical incisal step indicator, the anteroposterior dysplasia indicator, as well the aesthetic line, the inter-incisal angle, and the position of the lips. Mandibular third molars are often extracted when using this technique.

Lin and Gu[41] concluded in their study that more severe forms of Class III malocclusion in permanent dentition can be successfully treated by extraction of mandibular second molars, especially in people with vertical type of growth. This allows greater inclination and movement of the teeth distally, as well as noticeable changes in the soft tissue profile.

Conclusion

Today, facial beauty is an important physical attribute in modern society. Therefore, in orthodontics, the attainment of facial harmony and aesthetics becomes the main imperative. Changes in the dento-alveolar structures, from the aspect of movement of the teeth, the formation of remodeling processes in the alveolar ridges, changes in the dimensions of the dental arches, also affect the change in soft tissue structures and perioral tissues, which significantly change the patient's apparent appearance.

The standards in orthodontic diagnosis and planning of orthodontic treatment aim to determine the type of skeletal malformation and its correction. Assessing the type of skeletal irregularity includes analyzing multiple craniofacial parameters that define the facial type, the placement of the jaw bases relative to the cranial base, as well as the ratio of the dento-alveolar structures. In every diagnostic system, it is quite challenging to set the normative values, and in order to determine the presence and extent of the disorder, basic signs of irregularity must be known.

Establishing the need for an extraction therapy in persons with different vertical type of growth must be performed only with an individual assessment of multiple parameters and in accordance with the goals of orthodontic treatment.

In malocclusion Class II division 1, theextraction of two maxillary premolars is suggested in cases with expressed distal molar correlation, horizontal type of growth, mild crowding in the mandibular anterior region, and large overjet-larger than 7 mm. Extractions of four first premolars would be performed in individu-

als with pronounced crowding in the mandibular front, an intermediate expression of distal molar correlation, vertical type of growth, and noticeable protrusion of the lower lip. The meso-divergent type of growth requires the extraction of first maxillary premolars and a second mandibular at moderate compression in the mandibular front and not that much pronounced distal molar correlation and less noticeable lower lip.

As for the treatment of malocclusion Class III, camouflaging treatment usually involves the proclination of the maxillary incisors and the retroclination of mandible incisors to correct the opposite, i.e. negative horizontal incisal step. The need for extraction stems from the size of the "negative" overjet and is carried out in the mandibular dental arch.

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