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OPTIMIZATION OF SURGICAL-ORTHODONTIC TREATMENT TACTICS IN PATIENTS WITH IMPACTED TEETH

Pavlo I. Tkachenko, Maryna I. Dmytrenko, Mykola O. Cholovskyi
UKRAINIAN MEDICAL STOMATOLOGICAL ACADEMY, POLTAVA, UKRAINE

ABSTRACT

Introduction: Impacted teeth is complex anomaly of teeth eruption that requires a balanced approach not only in the differential diagnosis of its forms, but choice of rational methods of treatment.

The aim: Optimization of the tactics of orthodontic-surgical treatment of patients with impacted teeth based on the development and implementation of computed tomographic indices (KT) and photometric indices (FM) of opening of surgical access (OSA) to crowns of impacted teeth

Materials and methods: The results of treatment of 48 patients with delay of permanent teeth eruption have been analyzed. For an objective assessment of treatment results, a group of 24 (aged from 9 to 19 years old) was formed. All 24 patients had typical clinical situation.

Results: Orthodontic correction of patients envisaged, first of all, the elimination of obstacles in the way of teeth eruption, if necessary to provide space in dental arch and simultaneous treatment of associated bite malocclusions. Surgical exposure of impacted tooth crown was carried out and at the same time a triangular shaped guiding channel was formed, base of channel was at the impacted tooth and its angle finished into the dental arch. Precise dimensions and depth of the channel were preliminary planed on computed tomography slices with 3D reconstruction.

Mean values of CT width (7,13±0,54mm), and length (6,42±0,78mm) of OSA and CT index (130,79±8,19%) of OSA to impacted teeth crowns were determined.

Conclusion: To improve the quality of diagnosis and optimization of methodological approaches to treatment of patients with teeth impaction, we have proposed CT and FM OSA indices to the crowns of impacted teeth. The developed indices serve as specific reference points for optimization of diagnostic process, for reducing of probability of repeated surgical interventions and choosing the optimal path for instrumental orthodontic treatment of patients with impacted teeth

KEY WORDS: impacted teeth, orthodontic treatment, opening of surgical access to the crowns of impacted teeth

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INTRODUCTION

Impacted teeth is anomaly of teeth eruption, when a formed tooth within two years after the period of physiological eruption failed to appear and remains in a jaw [1]. Canines (48%), central (24%) and lateral incisors (15%) are more often impacted, less often premolars and molars (13%) [2]. Impacted teeth is a complex anomaly of dentition that requires a balanced approach not only in the differential diagnosis of its forms, but choice of rational methods of treatment [3,4].

Main reasons of complete permanent teeth impaction in patients with partial impaction are: early extraction of temporary teeth – 41,28%, delay of temporary teeth in dental arch – 28,44%; discrepancy between teeth size and jaws – 22,02%; anomalies of teeth formation – 16,51% and supernumerary teeth – 15,6%. Whereas in patients with multiple impaction (more than three teeth), syndromal pathology constitutes 41,67%; the presence of large number of supernumerary teeth – 27,76%, as well as abnormalities of teeth formation (13,89%) [2]. The choice of treatment scheme is based on etiologic factor and depends on age of a patient, the depth of tooth location, the presence of space for it in dentition, degree of tooth root formation.

Provision of complex orthodontic treatment in such cases involves combination of surgical, instrumental, protective, and functional (physiotherapeutic) methods [4, 5].

A known method of impacted teeth treatment involves staged orthodontic treatment of creating space by instrumental method, surgical opening of access to a crown of impacted tooth, followed by fixing on it of engaging elements (hooks, loops etc.) for traction of impacted tooth to dental arch by means of removable or unremovable constructions [6,7]. An essential drawback of this approach is its long term treatment, an average duration of treatment is 21,6 ± 8,7 months [7, 8, 9].

That is why a search of ways to reduce time of orthodontic appliances in presence of impacted teeth and related orthodontic pathology is a matter of high priority. And optimization of techniques for surgical uncovering of access to crowns of impacted teeth in a complex rehabilitation of such patients is a topical question of modern orthodontics.

THE AIM

Aim of study is to optimize the surgical-orthodontic treatment of patients with impacted teeth based on the development and introduction of computer tomography

and photometric indices for the surgical opening of access to crowns of impacted teeth.

MATERIALS AND METHODS

The results of treatment of 48 patients with delay of permanent teeth eruption have been analyzed. For an objective assessment of our work results, a group of 24 patients was formed. Clinical situation of these patients was typical according to the following criteria: they were born from the first pregnancy; living conditions were the same; they had average family incomes; somatic diseases and genetic pathology were not observed in the patients; satisfactory hygienic condition of oral cavity, there were no gingiva diseases and mucous membrane of oral cavity diseases , presence of no more than three impacted teeth buried in different parts of dental arch. The data showed that there were 12 patients with maxillary canines impaction , 6 patients with maxillary central incisors impaction, 2 patients with impaction of mandibular second molars, 2 patients with mandibular canines impaction and 2 patients with impaction of maxillary premolars. Females (58,33%) (n = 14) prevailed in the study, males were 41,67% (n = 10), the age of patients ranged from 9 to 19 years.

Clinical examination was performed according to the standard technique: history taking, external and internal oral examination, additional methods (photometric examination of face, study of diagnostic jaw models and orthopantomograms, 3D computed tomography). Presence of systemic diseases and teeth impaction of patient's close relatives were finding out while taking patients history data.

Angles of inclination of impacted teeth were marked on the orthopantomogram (OPG) using a modified method of Yu.I. Zhigurta [10]. Tomographic study according to indications made it possible confidently to carry out surgical and orthodontic procedures in complex treatment of patients with impaction of teeth and to achieve positive results. Cone-beam computed tomography (CBCT) allowed to determine accurately the state of crown and roots of impacted and adjacent teeth, to get clear and detailed idea of the position of impacted tooth, what enabled to plan optimal treatment strategy. Clinical and radiological data were carefully analyzed to decide the question of surgical access to impacted tooth, located in the alveolar process.

Surgical exposure of impacted tooth crown was carried out and at the same time a triangular shaped guiding channel was formed, base of channel was at the impacted tooth and its angle finished into the dental arch. Precise dimensions and depth of the channel were preliminary planed on computed tomography sections with 3D reconstruction.

Determination of etiological aspects of dental impaction plays an important role in choosing of an effective treatment method that is specific for each patient. According to etiological criteria, we identified three forms of teeth impaction. The first form of tooth impaction is hereditary one or that is due to the action of unfavorable embryonic factors, the presence of supernumerary teeth, the improper placement of the dental follicle in the jaw. The second form of dental impaction is formed under the influence of common factors, such as endocrine disorders, infectious diseases, general somatic diseases, inflammatory processes and jaw injury. The third form is impaction of teeth is caused by the action of unfavorable local factors – early

Table. I. CT and FM indices of OSA to crowns of impacted teeth.

Index	CT	FM	Index of statistic sagnificance, p
OSA Width, mm	7,13±0,54	6,92±0,58	>0,05
OSA index, %	6,42±0,78	6,50±0,74	>0,05
OSA index, %	130,79±8,19	128,71±9,98	>0,05

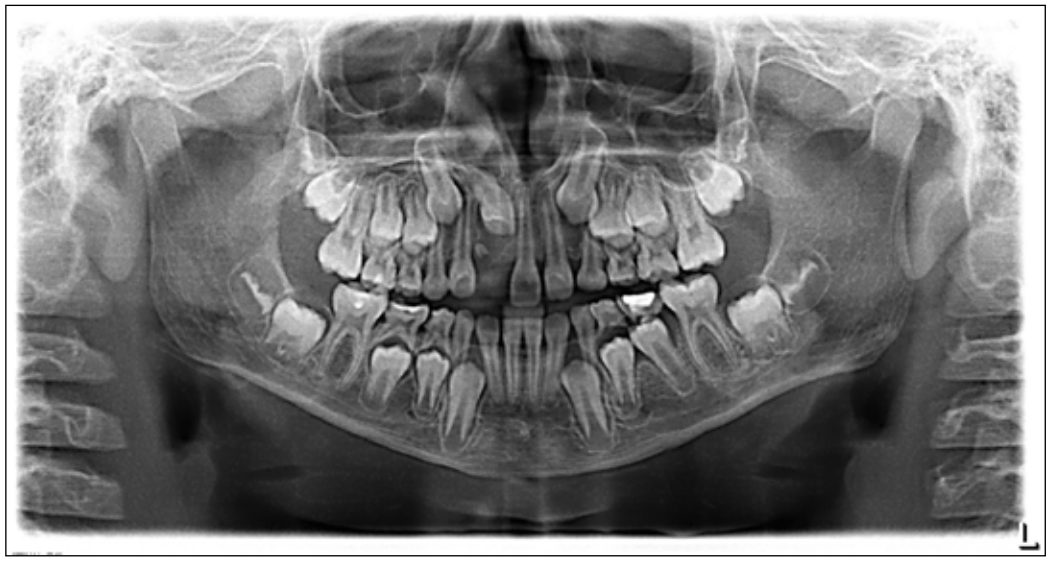

Fig. 1. Patient X, 9 years. Orthopantomogram Impacted 11 tooth.

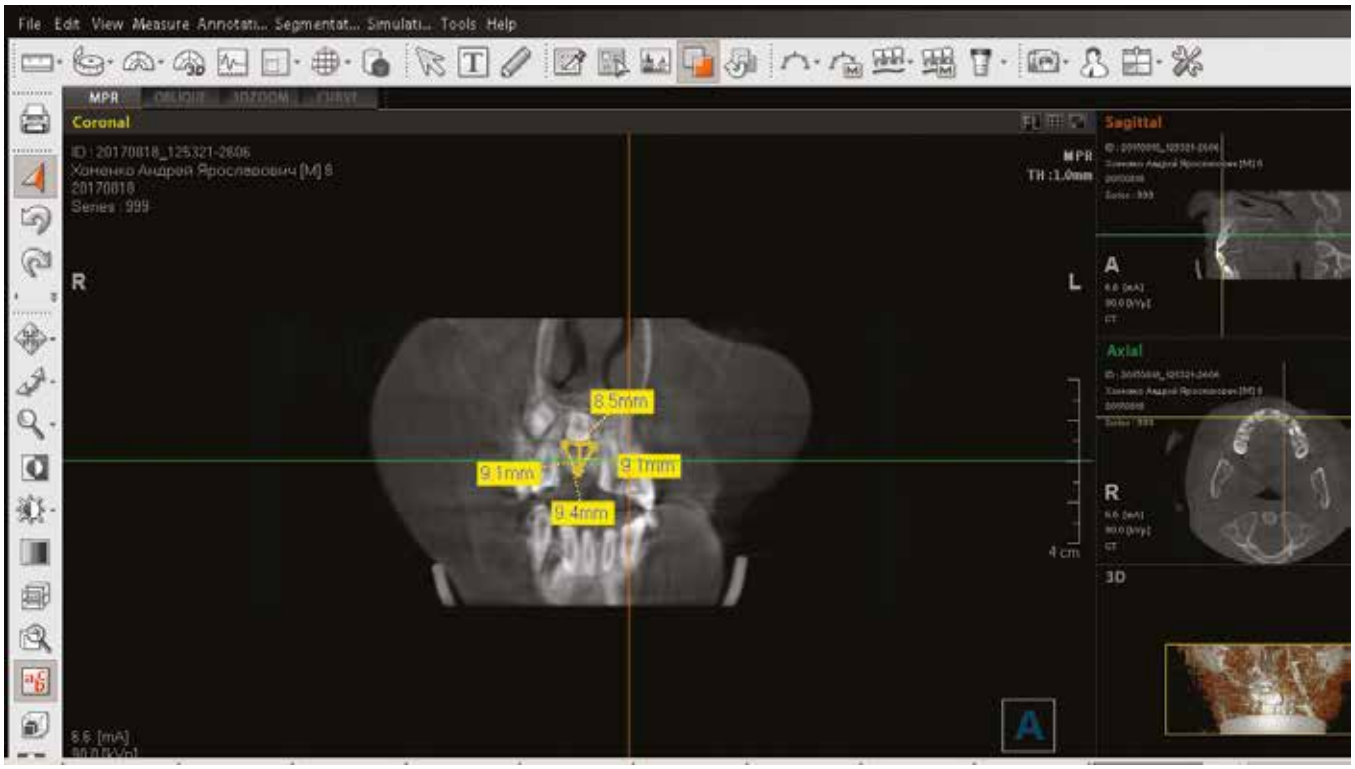

Fig. 2. Patient X CT, 9 years. Modeling of OSA towards crown of impacted 11 tooth.

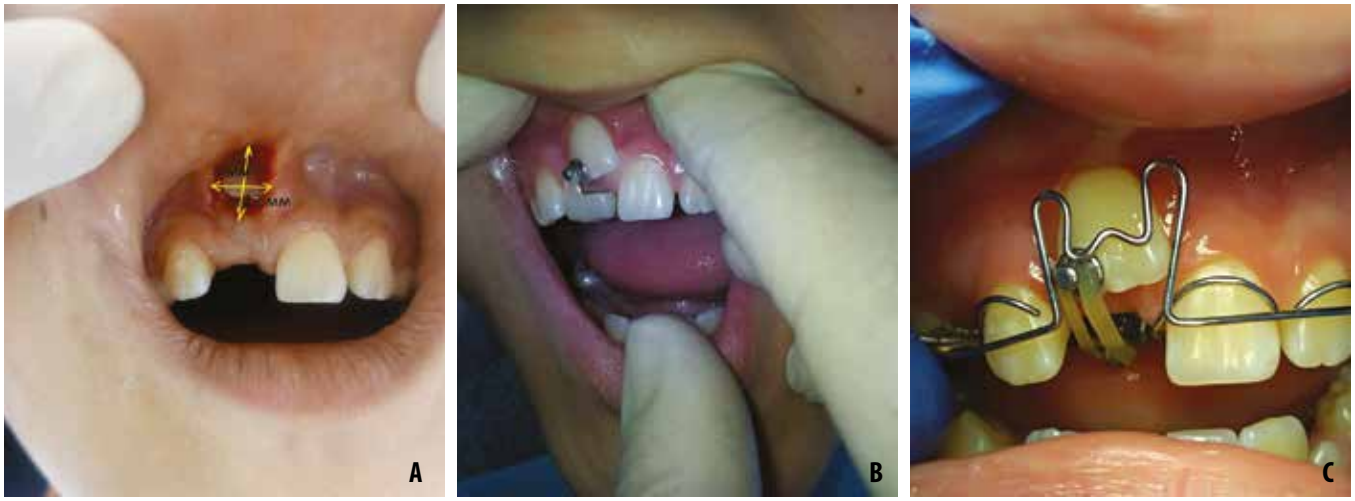

Fig. 3. Intraoral Photographs of Patient X. (9 years) oral cavity:
a – after OSA to the crown of impacted 11;
b, c – during orthodontic traction to dentition.

removal of temporary teeth, delay in the dental arch of temporary teeth, underdevelopment of the dentition and jaws as a result of functional insufficiency of muscles of the maxillofacial region

The most likely causes of dental impaction were identified in all patients. Specially designed study protocol (attachment 1.) was filled in for each patient.

All patients underwent surgical orthodontic treatment. First, surgical exposure of the crowns of the impacted teeth was carried out and after the disappearance of the visible postoperative signs, soft tissues edema, morbidity, buttons were fixed on their surface and active orthodontic traction of the impacted tooth using elastic ligament was initiated. Orthodontic treatment was performed using various removable orthodontic appliances in 8 patients, and braces were used in 16 patients. The active period of orthodontic treatment ended with adjustment and correction of occlusal plane, normalization of intermaxillary correlations, achievement of optimal functional occlusion and stabilization of treatment results

Assessment of statistical significance of the results was determined by Wilcoxon T-test. Differences were considered trustworthy at generally accepted in biomedical research error probability $p < 0,05$.

Fig. 4. Orthopantomogram during orthodontic traction of impacted 11 tooth.

Fig. 5. Orthopantomogram of Patient E., 12 years. Impacted 23 tooth .

RESULTS AND DISCUSSION

To improve the quality of diagnostics and optimize treatment methodological approaches, we determined the predicted sizes of surgical window on CT slices and using formula calculated CT index of opening of surgical access (OSA) to crowns of impacted teeth using the formula, which to a certain extent served as a guideline in choosing further treatment tactics.

$$\frac{\text{OSA width}}{\text{OSA length}} \times 100\% = \text{CT index of OSA to crowns of impacted teeth}$$

At the next stage, intraoral photos of operative access to the crowns of impacted teeth were performed and photometric index of OSA to the crowns of impacted teeth was calculated according to the formula :

$$\frac{\text{OSA width}}{\text{OSA length}} \times 100\% = \text{CT index of OSA to crowns of impacted teeth}$$

Analyzing data of clinical study, it should be noted that treatment strategy was aimed primarily to ensure process of eruption of impacted teeth. Orthodontic correction of patients envisaged, first of all, the elimination of obstacles in the way of eruption, if necessary to provide space in dental arch and simultaneous treatment of associated bite malocclusions.

Mean values of CT and FM of OSA width and length to impacted teeth crowns were determined with mean squared error of each result (m) , values of CT and FM indices of OSA to crowns of impacted teeth and index of statistical significance (p) were determined on the results of study (Tab. I).

It was established that the mean values of CT and FM of width and length of OSA for crowns of impacted teeth and the value of CT and FM indices of OSA for crowns were not significantly different ($p>0,05$). That is, the calculation of CT indices of OSA of crowns of impacted teeth allowed objectively predict the size of surgical window, reducing the risk of unnecessary damage to mucous membrane, what was confirmed by data of FM indexes of OSA.

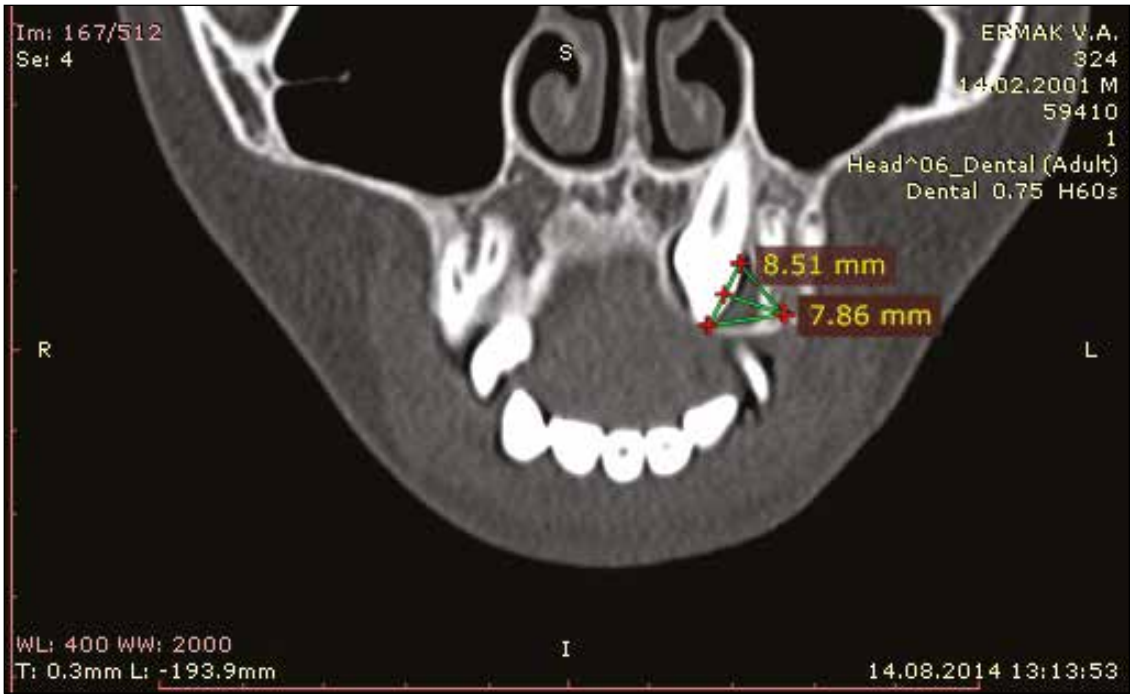

Fig. 6. CT of Patient E, 12 years. Modelling of SOA to the crown of impacted tooth 23.

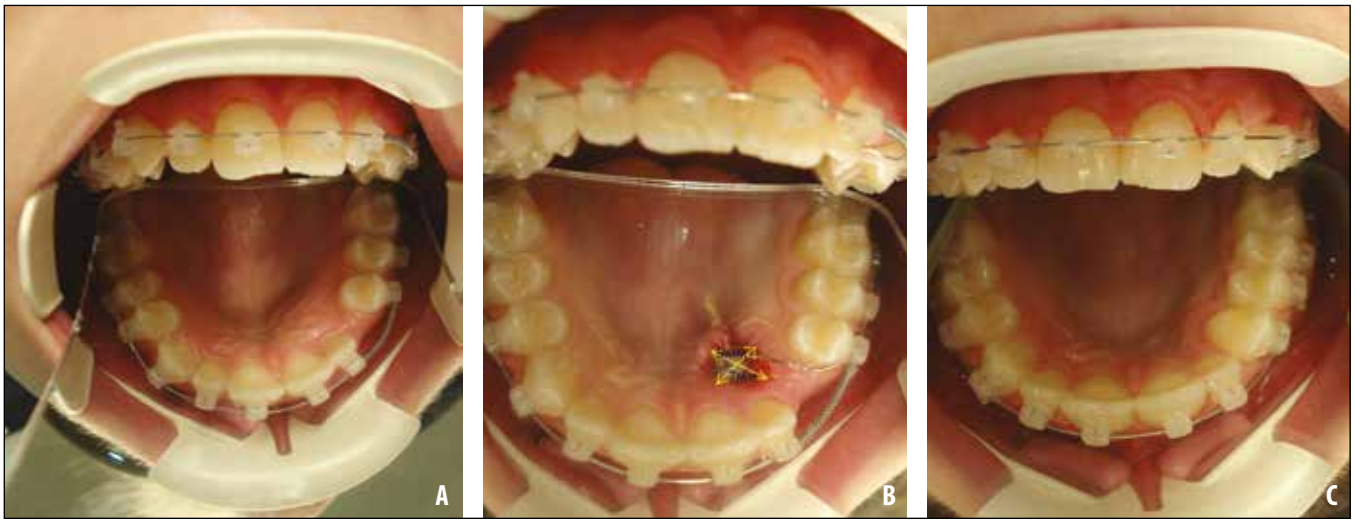

Fig. 7. Case 2. Intraoral photos:
a – the first stage of orthodontic treatment;
b – after surgical procedure (OSA width – 7,00 mm, OSA length – 9,00 mm; FM index of OSA to the crown of impacted 23 tooth – 77,78%;
c – tooth 23 after traction to dentition.

Case 1. Patient H., 9 – year-old child, complained of aesthetic appearance, as a result of maxillary right central incisor absence. Impacted 11 tooth was diagnosed according to clinical examination and orthopantogram (Fig. 1).

Orthodontic treatment using a removable plate-prosthetic appliance with a screw was initiated. The patient underwent 3D computed tomography, and OSA dimensions were modeled to the crown of t impacted tooth 11 (OSA width – 8,50 mm, OSA length – 9,40 mm; CT OSA index – 90,43% (Fig. 2).

After eight months, the patient underwent a surgical exposure of the crown of impacted tooth 11 and guide channel has been formed (Figure 3, a), photometric study was carried out: OSA width – 8,00 mm, OSA length – 12,00 mm; FM index of OSA – 66.67%. Three days after the operation, the button was fixed and orthodontic traction of the impacted tooth 11 was started with elastic ligaments.

To monitor orthodontic treatment orthopantomogram was done after 2 month of treatment (Fig.4).

Term of traction to dental arch of impacted 11 tooth was 3 month.

Case 2. Patient E., 12 years old, complained of an aesthetic appearance due to the absence of the maxillary left canine. After analyzing the orthopantomogram, impacted tooth 23 was diagnosed (Fig.5)

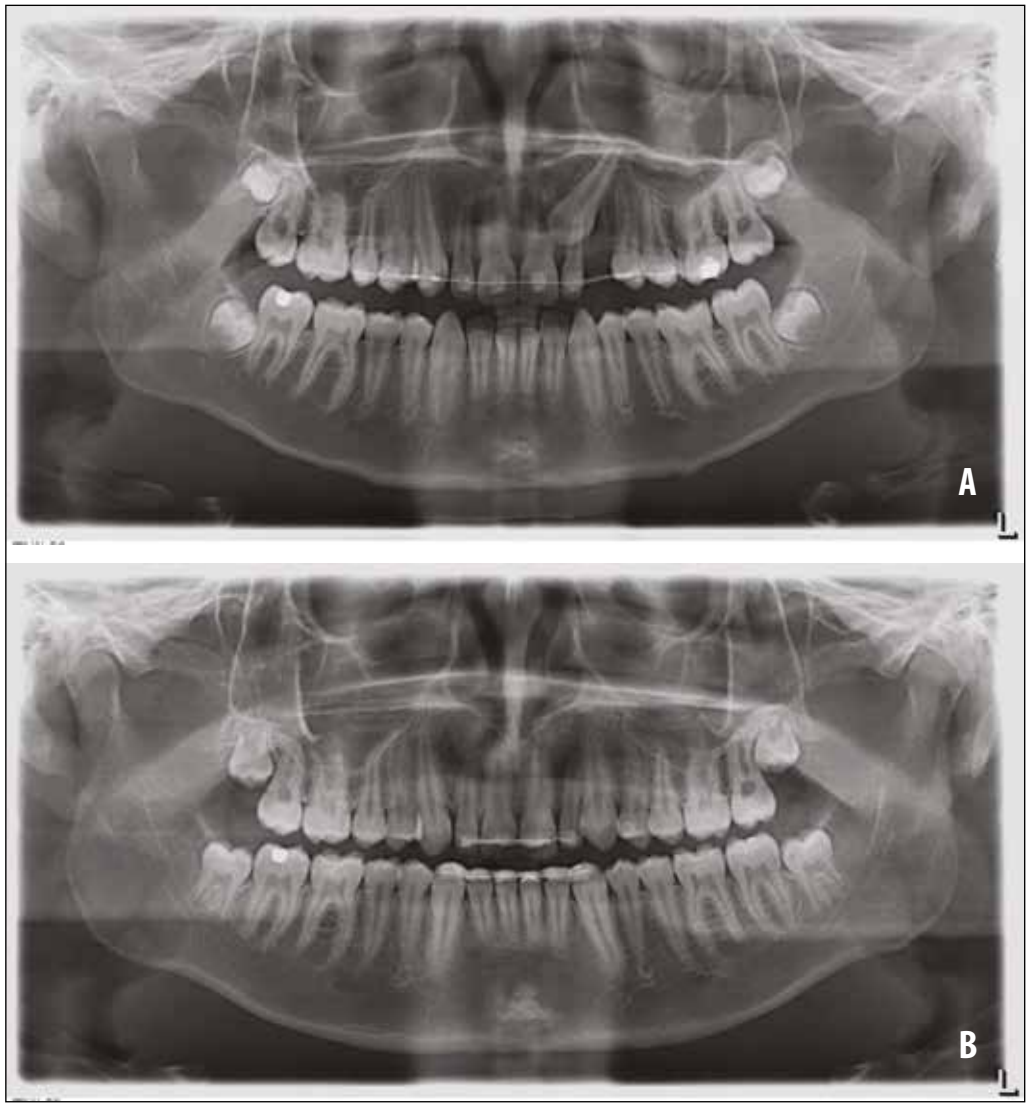

Fig. 8. Case 2.
Orthopantomogram:
a – on the first stage of orthodontic treatment of impacted 23 tooth;
b – two years after treatment.

The patient underwent 3D computed tomography and modeled OSA dimensions (width – 8,51 mm, length – 7,86 mm; CT OSA index – 108,27% (Fig. 6). Active orthodontic treatment was carried out in 2 stages: the first is to create space for tooth 23, to correct shape of dental arch of the upper jaw by braces; the second stage is the surgical exposure of the crown of tooth 23, formation of surgical opening access to the crown of impacted tooth, fixation of button, traction of tooth 23 into the dental arch, normalization of the intermaxillary ratio.

Term of orthodontic traction of impacted 23 tooth to dental arch was 10 month (Fig.8).

Therefore, planning of optimal path for surgical uncovering of impacted teeth crowns from under mucosa allows to arrange more physiological conditions for eruption.

CONCLUSIONS

To improve the quality of diagnosis and optimization of methodological approaches to treatment of patients with teeth impaction, we have proposed CT and FM OSA indices to the crowns of impacted teeth. The developed indices serve as specific reference points for optimization of diagnostic process, for reducing of probability of repeated surgical interventions and choosing the optimal path for instrumental orthodontic treatment of patients with impacted teeth.

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Authors' contributions:
According to the order of the Authorship.

Conflict of interest:
The Authors declare no conflict of interest.

CORRESPONDING AUTHOR
Maryna I. Dmytrenko
Ukrainian Medical Stomatological Academy
Shevchenko 23 str., 36011 Poltava, Ukraine
tel: +380506324055
e-mail: dmitrenko25@ukr.net

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Attachment 1.

Study Protocol № ___
Date_____
Name, Family name_____Date of birth_____
Diagnostic models_____
Malocclusion: Angle class- ; deep - ; open - ; cross-

<table>
<tr><td>Group membership of impacted tooth</td><td></td><td colspan="5">State of impacted teeth</td></tr>
<tr><td rowspan="2"></td><td colspan="2" rowspan="2">On orthopantomogram Angle of inclination of longitudinal axis of impacted tooth
a) from 15° to 45°,
b) from 46° to 89°
(nearly horizontal position) and c) from 90°</td><td rowspan="3">On OPTG
Level of impacted tooth position
a) high position – closer to jaw basis,
b)in alveolar process ; c) under mucous memrane</td><td colspan="2" rowspan="2">Modelling of OSA on CT</td><td rowspan="2"></td></tr>
<tr><td></td></tr>
<tr><td></td><td>SpP</td><td>MP</td><td colspan="2">OSA width</td><td>OSA length</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type of impaction</td><td>I– 85-95°</td><td>II –35-85° vestibular or oral shift; less then 2 mm</td><td>III– 35-85°, vestibular or oral shift; more then 2 mm</td><td>IV – hotizontal or oppositly to tooth eruption,</td><td>V – due to presence of supernumerary tooth
VI – due to transposition</td></tr>
<tr><td colspan="2" rowspan="2">Depth of impaction</td><td rowspan="2">On CT image deep</td><td>superficial</td><td>I</td><td>II</td><td></td></tr>
<tr><td>III</td><td>VI</td><td></td><td></td></tr>
<tr><td>Stage of root formation</td><td></td><td>Unformed</td><td>Formed to ½</td><td>Completely formed root</td><td colspan="2">Ankylosis</td></tr>
<tr><td></td><td colspan="5"></td></tr>
<tr><td>№</td><td colspan="6">Causes of impacted teeth</td></tr>
<tr><td></td><td></td><td colspan="3">Hereditary</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Somatic diseases</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Infectious diseases</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Avitaminosis. Rickets</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Supernumerary teeth</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Maxillofacial trauma</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Early removal of temporary teeth</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Delay of temporary teeth in dental arch</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Surgical procedures on account of odontoma, cyst of maxillofacial region</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Malformation of tooth bud stage</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Transposition of tooth germs</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Inadequate formation of impacted teeth</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Ankylosis</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Lack of space in dental arch (trasversal plane)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Lack of space in dental arch (sagittal plane)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Lack of space in dental arch (vertical plane)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Pathologically changed mucous membrane above impacted teeth</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Bone barrier, deep location of impacted tooth</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Macrodontia (absolute, relative)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">One-sided chewing</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Infantile swallowing</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Anomaly of frenulum linguae attachment</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Mouth breathing</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Fluorosis of teeth</td><td></td></tr>
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