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THE IMPORTANCE OF CLINICAL-BIOMETRIC, RADIOLOGICAL, AND EXPERIMENTAL STUDIES FOR OPTIMIZING COMPLEX ORTHODONTIC TREATMENT OF DENTAL AND MAXILLOFACIAL ANOMALIES (BASED ON LITERATURE SOURCES)).

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ABSTRACT

Success in the treatment of dentofacial anomalies is mainly depends on correct diagnostics. In diagnostics and treatment planning, in prophylaxis of secondary deformation a big attention is paid to clinical data, biometric research, craniofacial studies of lateral cephalometries, analysis of soft tissues. One of the important factors to reach an optimal result is a decision of the anchorage. In case of extraction orthodontic treatment compete, approach is reached in the environment where the alveolar bone volume is maintained by applying biocompatible bone materials. Literature analysis showed that orthodontic treatment planning of dentofacial anomalies with extraction of different teeth is important and requires further research.

Key words: *biometric research, decision of the anchorage in orthodontics, osteoplastic materials.*

INTRODUCTION

The most common dilemma in orthodontic treatment is the choice between extraction and non-extraction methods. In the diagnosis of dentofacial anomalies (DFA), along with traditional clinical data, biometric methods of investigation play a significant role (Makhsudov S.N., 2001). The study of the structure of the skull and face can be obtained through the analysis of lateral cephalometric radiographs (CR). The analysis of soft tissue contours is also important in the diagnosis and treatment planning. One of the key factors in achieving optimal orthodontic treatment results is the selection of anchorage. Rational treatment of jawbone diseases, which prevents the formation of bone defects, can only be successful with a competent approach, where the main aspect is the preservation of the alveolar ridge volume and the prevention of deformities (Zherdev K.V., 2007) by using various biocompatible bone materials.

Orthodontic dental care for malocclusions of the dentofacial system is relevant and requires further research to obtain reliable results.

Objective: To study the importance of clinical-biometric, radiological, and experimental research for justifying the optimization of comprehensive orthodontic treatment of dentofacial anomalies based on literary sources.

Literature Review on Clinical-Biometric Data: Angle and his followers were opponents of tooth extraction for orthodontic indications. The correction of dental occlusion did not always lead to satisfactory facial proportions and aesthetics. In order to improve facial aesthetics and ensure the stability of the occlusal

relationship, in the 1940s, orthodontists increasingly began to remove teeth. In the 1960s, Tweed, a student of Angle, after noticing a high percentage of relapses following orthodontic correction, suggested treating some malocclusions by extracting teeth to ensure stable treatment results.

The improvement of orthodontic techniques and treatment methods now allows avoiding tooth extractions (Lutskaia I.K. et al., 2012). Non-extraction therapy becomes possible with the use of functional appliances in "growing" patients (Abduazimov A.D., Nazarova V.F., Shamhukhamedova F.A., 2002).
Previously, biometric research was conducted on jaw models and in the oral cavity. Currently, the opportunities for studying diagnostic models have expanded through scanning of the jaws with intraoral scanners in three mutually perpendicular directions: transverse, sagittal, and vertical.

In the pathogenesis of malocclusions of individual teeth, the leading factors are both the lack of space for tooth placement and the overall underdevelopment of the alveolar process and jaw bones. During the growth of children and the formation of the bite, a small percentage of tight tooth positions undergo self-regulation. Research by G.I. Sablina showed that one year after examination, the frequency of tight tooth positions remained unchanged in 38.4% of children, worsened in 3.13%, and decreased in 5.98% of children. Additionally, in 6.55% of children, tight tooth positions appeared in the frontal area as other teeth erupted.

In the biometric method for models by McNamara, it is based on the fact that the growth of the jaws in the transverse plane during the period from 9 to 15 years is 3-4 mm. Special attention is given to biometric methods proposed by Moyers and Tanaka with Johnston, which allow for the prediction of the total size of permanent canines and premolars in the upper and lower jaws with a probability of 75% before eruption. The Tanaka and Johnston method is applied in mixed dentition to determine the space deficiency in the dental arch for both the upper and lower jaws and possible space deficiency for permanent teeth. However, the literature review revealed that these methods are not applicable for many ethnic groups.

Some authors suggest using only the radiometric measurement method for such predictions as the most reliable (Zilberman Yerucham, Koyoumdjisky-Kaye Edith, 1997). Additionally, as with Teleradiograph (TRG) analysis, there is a recent trend to conduct biometrics using automated computer programs, which allow data to be entered into a computer where they are processed, and the result is provided (E.E. Nasimov et al., 2020).

Thus, biometric studies of patient jaws, alongside clinical data, are an important research method for making an accurate diagnosis and planning treatment in orthodontics.

MATERIALS AND METHODS

Literature Review on Radiographic-Cephalometric Data:

To decide which method of orthodontic treatment to choose — extraction or non-extraction — the orthodontist must focus on the careful collection and analysis of data, which includes new indicators and methods (Spencer Gerald W., 2008).

Guilherme and colleagues analyzed post-treatment lateral cephalograms (LCR) of 62 Class II patients, divided into two groups. The first group consisted of 42 patients who underwent orthodontic treatment without tooth extraction, while the second group had 20 patients who underwent treatment with extraction of premolars in the upper jaw. The results showed that in cases of correcting Class II anomalies in patients with crowding in the frontal area, the extraction method resulted in a more stable retention period compared to the treatment outcomes in the first group. The same authors conducted a survey of 52 patients who underwent open bite treatment, with 31 patients in the extraction group and 21 in the non-extraction group. The results

showed that treatment outcomes in patients who had premolars extracted for orthodontic indications in both jaws were significantly more stable than in cases where open bite was corrected without extracting individual teeth.

Kenji Takada and co-authors developed and proposed a computer mathematical program for determining the choice between extraction and non-extraction orthodontic treatment (accuracy 90.4%). More than 25 indicators must be entered, which provide information about the sagittal plane relationship, vertical dentoalveolar relationship, and transverse condition of the dental arches.

Sercan Akyalçın et al. conducted a comparative analysis of profile changes in lateral cephalograms of patients treated with and without extractions. The most significant difference was observed in the upper and lower lip areas, but the difference was no more than 1 mm. Although the prominence of the lips depends on the interincisal angle, the authors concluded that, regardless of whether the treatment was extraction or non-extraction, the changes in the profile were not significant.

The method of surgical-orthodontic correction was proposed by Gőrkmen Kurt and co-authors for correcting tooth crowding in the frontal area.

Alihan Ertan Erdinc and co-authors conducted a comparative analysis of questionnaires before, after, and in the post-retention period of orthodontic correction of tooth crowding in the frontal area using extraction and non-extraction methods. The patients were divided into two groups, with 49 patients in each group. The first group underwent treatment without tooth extractions, while the second group had first premolar extractions in both jaws. The authors identified a significant difference in the interincisal angles on the lateral cephalograms before and after orthodontic treatment for tooth crowding with the non-extraction method.

The authors believe that for lip protrusion, the removal of premolars is a direct indication before orthodontic treatment (Gokalp H, 2010; Hodges Andrew, Rossouw Paul Emile, Campbell Phillip M., et al., 2009).

According to the analysis conducted by Mirjam Berneburg and co-authors since 1940, the primary feature of the lower third of the face that determines the attractiveness of women is the area of the lips. Female attractiveness is characterized by full lips and lip protrusion, while male attractiveness is determined by the position and size of the chin.

For obtaining lateral projection images, cone-beam computed tomography (CBCT) can also be used. CBCT in orthodontic practice can be utilized to obtain three-dimensional images. Bruno Frazaõ Gribel and co-authors conducted a comparative evaluation of cephalometric data of hard tissues obtained from lateral cephalograms and CBCT. The study objects were 10 dried skulls with radiopaque markers applied to them. Based on the obtained data, the authors found that the corresponding cephalometric data varied; CBCT provides more accurate data, and the authors recommend using CBCT to reduce the radiation exposure to patients.

Another group of scientists conducted similar research (Lee Francis C.C., Noar Joseph Harold., 2011). The scientists concluded that CT could be an alternative to lateral cephalograms only when calculating the following indicators: SN, SNA, SNB, and anterior facial height. However, data such as SBa, BaN, posterior facial height, incisor inclination, and so on, obtained through this method, are prone to errors.

Currently, there are more than 80 methods of cephalometric analysis for lateral and frontal projection cephalograms, each consisting of 14 or more indicators. Despite the abundance of methods for decoding lateral cephalograms, the search for and identification of new indicators remains relevant.

Literature Review on the Choice of Anchorage in Orthodontic Treatment

Currently, for absolute stabilization of the anchorage, transpalatal and facial arches, mini-micro-implants, and on plants are used.

Heather L. Zablocki and colleagues conducted a retrospective analysis of questionnaires from patients who had their first premolars removed from the upper and lower jaws for orthodontic treatment. The patients were divided into two groups, one group used a transpalatal arch for molar stabilization, while the other group did not. After comparative analysis, the authors concluded that in cases of orthodontic treatment using the extraction method, the results in both groups were similar. Therefore, clinicians should use alternative devices, such as mini-implants or implants, to stabilize the anchorage in cases of orthodontic treatment with tooth extraction.

Based on a comparative analysis of correction of crowding in the anterior section, Ingalill Feldmann and colleagues found that retraction of the teeth en masse using palatal mini-implants is a less painful procedure and the treatment proceeds with less discomfort compared to orthodontic correction using premolar extraction or retraction with implants. An additional argument in favor of using mini-implants in the mid-palatal suture area is that the mini-implant placed in this area is stable in 96% of cases.

Studies on the results of orthodontic treatment for patients with anomalies in the position of individual teeth using the extraction method, with mini-implants used as absolute anchorage, showed that mini-implants significantly improve and facilitate the work of the orthodontist and, consequently, optimize the quality and shorten treatment time.

RESULTS AND DISCUSSIONS

Literature Review on Experimental Studies

Despite the arguments in favor of various therapies for orthodontic treatment of dentofacial anomalies (DFA), authors do not consider the impact of the consequences of tooth extraction on orthodontic tooth movement in the post-extraction (PE) area. Therefore, we reviewed studies aimed at improving bone tissue regeneration. For instance, V.S. Kuznetsova (2020) conducted an experimental study using a composite material based on chitosan gel.

In 2021, A.V. Vasilyev proposed an experimental study developing a new class of osteoinductive bone-plastic materials based on hardening hydrogels for use in dentistry and maxillofacial surgery.

N.L. Fathudionova studied the biocompatibility and osteogenic properties of a new composite hardening osteoplastic material based on highly purified collagen hydrogel.

Payam A. Sanjideh and colleagues conducted experimental research on dogs. The goal was to determine whether the procedure of corticectomy around the premolar accelerates its movement in the PE zone and how secondary corticectomy affects further movement. The authors obtained the following results: corticectomy significantly accelerates tooth movement, and after secondary corticectomy, the rate of movement is maintained. However, compared to subjects who did not undergo secondary corticectomy, the difference was not significant.

Existing osteogenic biomaterials (BMs), according to J.E. Davies, do not turn into bone themselves but act as a matrix for subsequent bone formation in the defect area.

Despite certain progress in studying immunological, biochemical, morphological, and other aspects of bone-plastic transplantation, there are still several issues that hinder the wider use of autogenous, allogeneic, and xenogeneic bone materials for restoring and preventing various defects of the alveolar bone.

A.I. Korolenko, in an experiment on rabbits, used ground rib cartilage in a paste-like consistency to fill the socket of an extracted tooth.

Allogeneic bone transplantation, in terms of its clinical significance, has taken a significant place after autogenic bone plastic surgery. This explains the extensive research aimed at improving the outcomes of allogeneic transplants (Saveliev V.I., Rodyukova E.N., 1985).

Recently, studies have been conducted to identify the differences between the outcomes of allogeneic and autogenic bone transplants due to the traumatic nature of the bone harvesting procedure for the latter.

The use of frozen blocks of cancellous bone for augmenting the atrophied alveolar ridge of the upper jaw with the aim of subsequent dental implantation also ensures good osteointegration (Nissan Joseph, Mardinger Ofer, Calderon Shlomo et al., 2010).

S.P. Mudry used a special paste containing bone chips, gypsum, fibrin powder, antibiotics (streptomycin and penicillin), and ferric chloride to prevent alveolar atrophy after tooth extraction. According to the author's clinical and experimental study, epithelialization of the blood clot occurred on the 11th-12th day, which was 1-2 days earlier than without wound filling, and bone tissue regeneration at the site of the operation was observed within 6-8 months. However, even after 1 year and 8 months, the author found gypsum chunks in some bone preparations, which later acted as foreign bodies and were rejected or caused severe inflammatory processes.

P.N. Fialko, through experimental and clinical observations, proved the positive bioplastic properties of the allograft demineralized lyophilized bone (ADLB). Cortical bone, deprived of inorganic salts during the demineralization process, serves as an effective stimulator of osteoreparation due to its high induction and conduction potential.

BoneCeramic has been used in over 300,000 clinical cases worldwide for implant placement and periodontitis treatment. According to a publication on PubMed from 55 studies, the use of synthetic bone particles in periodontitis significantly improved bone condition, increased tooth survival, and closed defects by 85% within 1 year.

Bio-Oss, used for over 25 years, is also applied to restore hard tissues lost during periodontitis. Its effectiveness has been researched in more than 900 scientific works. It is one of the leading materials in regenerative dentistry worldwide. It integrates well with bone, creates a new bone scaffold, and, resorbing over several years, stimulates the growth of the patient's own hard tissue. The resorption rate is calibrated so that the material does not collapse at the grafting site while the new bone fills the area.

A review of literature on improving bone regeneration highlights the breakthrough use of platelet-rich plasma (PRP) for accelerating growth in bone and soft tissue defect areas. This relatively new biotechnology is attracting increasing attention in the medical and cosmetic communities (Mayborodin I.V., 2011). PRP is also used in surgical dentistry to initiate histogenesis.

Nina Broggini and co-authors conducted an experimental study on rabbits, comparing bone formation in defect areas using autogenous bone, a combination of autogenous bone with PRP, and healing under a blood clot. In the early stages, the authors found no differences between healing under a blood clot and using PRP. The use of autogenous bone alone showed earlier bone remodeling than when combined with PRP.

E.V. Milova studied the possibility of optimizing reparative regeneration of jawbone tissue using the patient's own blood auto plasma enriched with platelets and fibrin group proteins. A prosthesis was then made

and applied to the prosthetic bed. Based on the results of the conducted research, the author proved that the proposed method of preventing alveolar ridge atrophy is rational.

All the above-mentioned studies on the effect of autogenous, allogenic, and alloplastic materials on osteogenesis suggest that this field of medicine is still not sufficiently studied.

Recently, there has been a trend in surgical interventions to use materials based on hydroxyapatite – both its "pure" forms and complexes, particularly with collagen. V. Checchi and co-authors conducted a comparative evaluation of biocompatible hydroxyapatite and nano-crystals of hydroxyapatite implanted into fresh sockets of extracted teeth. Histological, radiographic, and clinical comparative evaluations of the post-extraction area did not reveal any differences.

In dental practice, a bio composite material called CollapAn, consisting of hydroxyapatite, collagen, and an antibiotic, has found wide application for filling bone defects and cavities.

Sh.A. Boymurodov conducted observations of 38 patients with fractures of the upper jaw's alveolar ridge, dividing them into two groups. In the first group, the bone wound healed under a blood clot, while in the second group, CollapAn-L was used in various forms (granules, plates, and gel). Based on the obtained data, the author concluded that the use of the osteoplastic material CollapAn-L in the treatment of alveolar ridge fractures increases the treatment's effectiveness and reduces the frequency of defects and deformities.

A.V. Khromushkin recommends using the osteoplastic material CollapAn to fill the sockets of extracted teeth with simultaneous dental implant placement. The use of CollapAn significantly reduces the treatment time for patients, reduces psycho-emotional stress, saves the doctor’s time, and expands the indications for dental implantation.

G.G. Okropiridze and co-authors studied the antimicrobial activity of CollapAn samples modified with various antimicrobial agents against clinical strains of microorganisms. The results of the conducted studies indicated that CollapAn, modified with various antimicrobial agents, demonstrated antimicrobial activity against clinical test strains of both aerobic and anaerobic microorganisms of various species in in vitro experiments. An important feature was the prolonged action of CollapAn. The obtained data confirmed its use as a preventive and therapeutic agent in the complex treatment of infectious complications, particularly osteomyelitis, in trauma and orthopedic patients.

K.V. Zherdev conducted scientific research aimed at experimentally-morphological and clinical justification for the use of Collapan-gel to replace bone defects in children with tumor-like diseases and focal chronic bone inflammation, in accordance with the principles of minimally invasive surgery. In all patients who underwent open spinal surgeries with the use of Collapan-gel to prevent spinal fusion failure, bone block formation was noted within 3-4 months. There was no failure of the spinal fusion, indicating the prospects of using Collapan-gel in surgical treatment.

A.V. Fedurchenko carried out a comparative clinical-experimental study of the effect of various osteoplastic materials (CollapAn, Osteoplast, and Hydroxyapol) on osteogenesis dynamics and bone wound healing during surgical treatment of chronic periodontitis, root cysts of the jaws, tooth replantation in chronic periodontitis, and bone plastic surgery for the removal of impacted wisdom teeth. The author found that the time for complete bone tissue restoration in the experiment, when filling an artificially created defect with "CollapAn," "Osteoplasty," and "Hydroxyapol," was, on average, 1.5 and 3 months, respectively, which is 1.3 times faster than healing under a blood clot. For the plastic surgery of small and medium-sized bone cavities, the use of the alloplastic material "CollapAn" was found to be effective.

A.P. Jusev used CollapAn in the form of granules or plates for conducting sinus lift surgery prior to dental implant placement. After the sinus lift surgery with simultaneous dental implant placement, control X-rays taken after 4 months showed bone tissue indistinguishable from the surrounding hard tissues. Thus, the author concluded that CollapAn can replace autogenous bone in sinus lift surgeries, significantly reducing the need for harvesting autogenous bone material or eliminating it altogether. The same author suggested using CollapAn-L for restoring the volume of atrophied alveolar ridge bone in cases of tooth extraction or orthodontic tooth movement, using a method to increase the width of the alveolar ridge via a splitting technique for subsequent dental implant placement. Six months after exposing the alveolar ridge for implant placement, the author noted well-formed bone.

CONCLUSION

Thus, the conducted literature analysis showed that the choice of rational and substantiated orthodontic treatment for anomalies of the dentofacial system, when the extraction of individual teeth is necessary, is still insufficiently studied. All the above-mentioned literary data, based on comprehensive research, including experimental studies, have prompted the search for new comprehensive treatment methods aimed at creating optimal conditions for the unobstructed orthodontic movement of teeth in the post-extraction segment within the alveolar process of the jaw. The above suggests that biomaterials do not transform into bone themselves but only contribute to the activation of the growth of the body's own cells, as well as the augmentation of the tooth socket. Alloplastic biocompatible materials are effectively replaced by bone tissue, so they can be used for the restoration of bone tissue.

REFERENCES

1. Abdouazimov A.D., Nazarova V.F., Shamukhamedova F.A., et al. Evaluation of treatment methods for patients with anomalies in the position of individual teeth // Stomatologiya. - 2002. - No. 1-2. - P. 59-61.
2. Abdullaev Sh.Yu., Makhmudov A.A., Khramova N.V. On materials used for replacing bone defects and eliminating deformities in the maxillofacial area // Stomatologiya. - 2010. - No. 1-2. - P. 92-96.
3. Azimov M.I., Kudratov Sh.Sh. Use of demineralized bone tissue from newborn Karakul lambs to fill jaw defects after cyst removal // Stomatologiya. - 2003. - No. 1-2. - P. 64-67.
4. Aripova G.E., et al. On methods of expanding the upper jaw (according to literary sources), Scientific and Practical Journal "Stomatologiya", No. 4, 2020.
5. Boymurodov Sh.A. Use of Collapan-L material in upper jaw alveolar ridge injuries // Stomatologiya. - 2009. - No. 6. - P. 17-21.
6. Zherdev K.V. Use of the Collapan-gel implant in pediatric bone pathology: Abstract of dissertation ... Cand. med. sciences / K.V. Zherdev. - Moscow, 2007. - 23 p.
7. Mayborodin I.V., Drovosekov M.N., Kolesnikov I.S. Cellular technologies in dentistry of the maxillofacial area // Stomatologiya. - 2011. - No. 5. - P. 60-63.
8. Makhsudov S.N. Clinical, radiological, and biometric indicators of anomalies in the eruption and position of the permanent lateral teeth, methods of diagnosis, prevention, and treatment: Abstract of dissertation ... Cand. med. sciences / S.N. Makhsudov. - Tashkent, 1991. - 17 p.
9. Milova E.V. Possibilities for reducing atrophic processes in the supporting tissues of the prosthetic bed during orthopedic treatment of patients with removable dentures: Dissertation ... Cand. med. sciences. - Volgograd, 2007. - 145 p.
10. Nasimov E.E. et al. Determining the width of dental arches by incisors and calculating the proportionality coefficients of the frontal teeth (OZDR-RKPFZ.exe) / Intellectual Property Agency of the Republic of Uzbekistan // Registration of software for computers // T. 2020.
11. Rakhmanova D.R. Optimization of orthodontic tooth movement using Collapan-L material // Stomatologiya. - 2010. - No. 1-2. - P. 91-92.
12. Fedurchenko A.V. Clinical and experimental justification for choosing an osteoplastic material to replace bone defects in the jaws: Abstract of dissertation ... Cand. med. sciences / A.V. Fedurchenko. - Stavropol, 2009. - 22 p.

13. Fialko P.N. Use of allogeneic transplant material based on crushed fruit bone and methyluracil in the treatment of patients with jaw cysts: Dissertation. - M., 1984. - 193 p.
14. Chen Kun, Han Xianglong, Lan Huang. Tooth movement after orthodontic treatment with 4 second premolar extractions// AJO-DO.- 2010.-Vol.138.-P.770-7
15. Davies J.E. Mechanism of Endosseous Integration // Int. J. Prosthodont. — 1998. —Vol. 245. — P. 391-401
16. Gökalp H, Kurt G.Magnetic resonance imaging of the condylar growth pattern and disk position after chin cup therapy: a preliminary study.//Angle Orthod.- 2005.-Vol.75(4).-P.568-75
17. Gribel Bruno Frazaõ, Gribel Marcos Nadler, Frazaõ Diogo Campos Accuracy and reliability of craniometric measurements on lateral cephalometry and 3D measurements on CBCT scans// Angle orthodontist.-2011.-Vol.81 (1).-P.26-35
18. Heather L. Zablocki, James A. Effect of the transpalatal arch during extraction treatment //AJO-DO.-2008.- Vol. 133 (6).-P. 852-860.
19. Kurt Gőrkmen, Işeri Haluk, Kişnişci Reha Rapid tooth movement and orthodontic treatment using Dentoalveolar Distraction (DAD)// Angle orthodontist журнал.-2010.-Vol. 80(3).-P. 597-606.
20. Lee Francis C.C., Noar Joseph Harold. Evaluation of the CT scanogram for assessment of craniofacial morphology//Angle orthodontist.-2011.-Vol.81(1).-P.701-715.
21. McNamara J.A., Brudon W.L. Orthodontics and dentofacial orthopedics.-Michigan, 2002.-554p.
22. Spencer Gerald W. Extraction and evidence-based decision making // AJO-DO.-2008.-Vol. 134(1).-P. 6-7.
23. Zilberman Yerucham, Koyoumdjisky-Kaye Edith, Vardimon Alexander. Estimation of Mesiodistal Width of Permanent Canines and Premolars in Early Mixed Dentition //Journal of Dental Research.-1997.-Vol. 56.-P. 911-915.