SIR Publishers
CENTER FOR INTERNATIONAL SCIENTIFIC PUBLICATIONS
JOURNAL OF MEDICINE AND PHARMACY
ISSN(Online): 2984-7117
Volume-9, Issue-02, Published |04-06-2026|

INDIVIDUALIZED ORTHODONTIC TREATMENT PLANNING BASED ON DIGITAL GNATHOLOGY

Zukhra Olimjon qizi Buvanazarova
4th-year student, Faculty of Dentistry, Emu University

Annotatsiya: Ushbu maqolada raqamli gnatologiya asosida ortodontik davolashni individual rejalashtirishning zamonaviy tamoyillari yoritilgan. CBCT, 3D skanerlash, elektromiografiya va raqamli okklyuzion tahlil kabi texnologiyalar stomatognatik tizimning funksional holatini aniq baholash imkonini beradi. Ushbu yondashuv ortodontik davolash samaradorligini oshirish, relapslar xavfini kamaytirish va uzoq muddatli barqaror natijalarga erishishda muhim ahamiyatga ega.

Kalit so‘zlar: Raqamli gnatologiya, ortodontik davolash, CBCT, 3D skanerlash, okklyuziya, temporomandibulyar bo‘g‘im, individual rejalashtirish.

Аннотация: В данной статье рассматриваются современные принципы индивидуального планирования ортодонтического лечения на основе цифровой гнатологии. Использование таких технологий, как КЛКТ (CBCT), 3D-сканирование, электромиография и цифровой анализ окклюзии, позволяет точно оценить функциональное состояние стоматогнатической системы. Данный подход способствует повышению эффективности ортодонтического лечения, снижению риска рецидивов и обеспечению долгосрочной стабильности результатов.

Ключевые слова: Цифровая гнатология, ортодонтия, КЛКТ, 3D-сканирование, окклюзия, височно-нижнечелюстной сустав, индивидуальное планирование.

Abstract: This article discusses modern principles of individualized orthodontic treatment planning based on digital gnatology. Technologies such as CBCT, 3D scanning, electromyography, and digital occlusal analysis enable precise assessment of the functional state of the stomatognathic system. This approach improves the effectiveness of orthodontic treatment, reduces the risk of relapse, and ensures long-term stability of results.

Keywords: Digital gnatology, orthodontic treatment, CBCT, 3D scanning, occlusion, temporomandibular joint, individualized planning.

Introduction

In recent years, the demand for orthodontic treatment has increased significantly worldwide. According to epidemiological studies, malocclusion (dental and maxillofacial anomalies) has been reported in approximately 60–75% of the population to varying degrees, with a considerable proportion of cases leading to functional and esthetic problems. Furthermore, the literature indicates that functional disorders of the stomatognathic system, particularly temporomandibular joint (TMJ) dysfunction, may manifest with various clinical signs in 20–40% of patients.

Traditional orthodontic diagnostics primarily focuses on the assessment of dental arch alignment, occlusal relationships, and skeletal structures. However, this approach tends to evaluate the stomatognathic system mainly as a morphological model rather than as a comprehensive functional complex. As a result, important functional factors such as temporomandibular joint status, masticatory muscle activity, and neuromuscular balance are not always adequately considered. Consequently, in certain clinical situations, this may contribute to post-treatment relapse, occlusal imbalance, or TMJ-related complications.

Therefore, the need for a functional approach in modern orthodontics is steadily increasing. The integration of digital technologies into dentistry has elevated diagnostic and treatment-planning processes to a new level. In particular, cone-beam computed tomography (CBCT), intraoral three-dimensional (3D) scanning, electromyography (EMG), and digital occlusal analysis (T-Scan) enable highly accurate and comprehensive evaluation of the stomatognathic system. These technologies facilitate real-time analysis not only of anatomical structures but also of functional balance. One of the major limitations of conventional methods is that they primarily assess static conditions and cannot fully reflect dynamic functional changes. For example, evaluating occlusal balance solely on the basis of plaster models or conventional radiographic examinations does not always provide sufficient clinical accuracy. Therefore, orthodontic treatment planning that fails to account for functional components may negatively affect the stability of treatment outcomes.

From this perspective, individualized orthodontic treatment planning based on digital gnathology is emerging as a modern scientific approach that enables comprehensive assessment of the stomatognathic system from both anatomical and functional perspectives. This approach plays an important role in improving the effectiveness of orthodontic treatment, reducing the risk of complications, and achieving stable long-term outcomes.

Materials and Methods

During the study, scientific literature concerning digital diagnostic methods used for evaluating the functional status of the stomatognathic system and for orthodontic treatment planning was reviewed. The literature analysis focused on the role and significance of modern diagnostic technologies in orthodontic practice, including cone-beam computed tomography (CBCT), intraoral three-dimensional (3D) scanning, electromyography (EMG), and digital occlusal analysis (T-Scan). The capabilities of these methods for assessing the anatomical and functional status of the stomatognathic system, as well as their role in evaluating TMJ conditions and occlusal relationships, were analyzed. In addition, the advantages of digital gnathology in individualized orthodontic treatment planning were compared based on scientific articles, clinical guidelines, and international recommendations. A comparative analysis of the diagnostic accuracy and clinical effectiveness of conventional and digital approaches was conducted using the reviewed sources. The selected

literature was based on the scientific evidence widely applied in contemporary orthodontics and gnathology and served to highlight both the relevance of the topic and its practical significance.

Results

The literature review indicates that individualized orthodontic treatment planning based on digital gnathology offers significantly greater diagnostic capabilities compared with conventional approaches to the assessment of the stomatognathic system. In particular, **CBCT** and three-dimensional (**3D**) scanning technologies enable high-resolution visualization of the anatomical structures of the temporomandibular joint (**TMJ**) and occlusal surfaces, allowing even minor morphological changes to be detected. According to the analyzed scientific sources, a considerable proportion of patients may present with functional disorders that are not clinically evident. Electromyography (EMG) findings demonstrate asymmetry in masticatory muscle activity and varying degrees of functional imbalance. These conditions are frequently associated with occlusal discrepancies and may not always be identified during routine clinical examination.

The results of digital occlusal analysis (T-Scan) reveal uneven distribution of contact points in terms of timing and force, indicating excessive loading on specific groups of teeth. This finding confirms the presence of functional imbalance within the stomatognathic system and highlights the necessity of developing individualized orthodontic treatment plans. Furthermore, the literature reports that orthodontic treatment plans developed using digital gnathology reduce excessive loading on the TMJ, improve occlusal balance, and stabilize masticatory function. Compared with conventional treatment planning, this approach is also associated with a significantly lower risk of relapse. Notably, the findings suggest that digital gnathology has not only diagnostic but also prognostic value in individualized orthodontic treatment planning. Through comprehensive evaluation of the stomatognathic system, these technologies contribute to improved clinical effectiveness and long-term treatment outcomes.

Discussion

Individualized orthodontic treatment planning based on digital gnathology is emerging as a new stage in clinical practice within modern dentistry. The literature review demonstrates that conventional orthodontic diagnostics primarily relies on dental alignment, skeletal relationships, and esthetic parameters. However, such an approach does not fully account for the functional integrity of the stomatognathic system, which may result in post-treatment complications or relapse in certain cases. For example, clinical studies have reported that some patients may develop temporomandibular joint (TMJ) pain or clicking sounds following orthodontic treatment focused solely on dental alignment. These conditions are often associated with previously undetected occlusal imbalances or muscular asymmetry.

A major advantage of digital gnathology is its ability to provide *comprehensive and dynamic evaluation* of the stomatognathic system. CBCT enables three-dimensional assessment of TMJ structures and may reveal subtle findings such as mild posterior displacement or asymmetry of the mandibular condyle. Such abnormalities may remain undetected on conventional radiographs but can significantly influence orthodontic treatment planning. Three-dimensional scanning technology generates highly accurate digital models of the dental arches. For instance, minimal rotation of several teeth in the maxillary arch may lead to improper distribution of occlusal contacts. Using the T-Scan system, clinicians can precisely identify which teeth are subjected to excessive occlusal loading. Based on these findings, orthodontic forces can be redistributed according to the individual needs of the patient.

Electromyographic (EMG) studies have demonstrated that some patients exhibit increased activity of the masticatory muscles, particularly the masseter muscle, on one side. For example, in patients with dominant left-sided muscle activity, the occlusal center may also shift toward the same side. Over time, this condition may contribute to functional imbalance and increased stress on the TMJ. Digital gnathology enables the early detection of such abnormalities, facilitating timely intervention. Another important aspect emphasized in the literature concerns patients with bruxism. Orthodontic treatment outcomes in these individuals tend to be more variable. For example, nocturnal tooth clenching may exert excessive forces on orthodontic appliances and alter the intended movement of teeth. Through digital diagnostic methods, such patients can be identified before treatment initiation, allowing modification of the treatment strategy, including the incorporation of splint therapy when indicated.

Furthermore, an important scientific conclusion is that digital gnathology allows orthodontic treatment to be viewed not merely as a process of “aligning teeth,” but rather as a process of “achieving balance within the entire stomatognathic system.” In this approach, not only esthetic outcomes but also functional stability serve as primary treatment objectives. However, the literature also highlights certain limitations of this technology. For example, equipment such as CBCT and EMG is not available in every clinical setting, and the accurate interpretation of the obtained data requires highly qualified specialists. Nevertheless, current trends suggest that digital gnathology is likely to become a future standard in orthodontic treatment planning.

Therefore, the integration of digital gnathology into orthodontic practice extends beyond improving diagnostic accuracy and necessitates a fundamental reconsideration of treatment strategies. Contemporary approaches increasingly regard orthodontic treatment not as a process of “static tooth movement,” but rather as a process of “dynamic functional adaptation.” This perspective emphasizes the importance of considering each patient's individual biomechanical and neuromuscular characteristics. According to the literature, orthodontic treatment planning that

incorporates functional components enables tooth movement to occur within biological limits, thereby providing safer conditions for periodontal tissues and the temporomandibular joint (TMJ). In particular, the early identification of uneven occlusal force distribution allows orthodontic forces to be optimized throughout the course of treatment.

In addition, it has been reported that data obtained through digital gnathology are increasingly being integrated with artificial intelligence and digital simulation systems. This development may contribute to the advancement of the concept of "virtual orthodontic treatment planning," in which treatment outcomes can be predicted using digital models before clinical intervention begins. At the same time, clinical experience demonstrates that digital diagnostic findings must be interpreted not only from a technical perspective but also within an appropriate clinical context. Incorrect interpretation of digital data may lead to errors in orthodontic treatment planning, underscoring the need for advanced professional knowledge and clinical expertise.

Conclusion

Individualized orthodontic treatment planning based on digital gnathology represents an important contemporary approach in dentistry aimed at achieving not only esthetic but also functional treatment outcomes. The literature review demonstrates that consideration of both the anatomical and functional status of the stomatognathic system significantly enhances the effectiveness of orthodontic treatment. Technologies such as cone-beam computed tomography (CBCT), three-dimensional (3D) scanning, electromyography (EMG), and digital occlusal analysis enable comprehensive assessment of the temporomandibular joint (TMJ), masticatory muscles, and occlusal relationships. These methods facilitate the early detection of hidden functional disorders, the individualization of treatment plans, and the prevention of excessive biomechanical loading.

Furthermore, scientific evidence indicates that orthodontic treatment plans developed on the basis of digital gnathology are associated with a reduced risk of relapse, a lower incidence of TMJ-related complications, and improved long-term stability of treatment outcomes. These findings further emphasize the clinical significance of this approach. In conclusion, digital gnathology may be regarded as a modern scientific concept that shifts orthodontic treatment from a "standardized approach" to an "individualized functional approach." As such, it is expected to become one of the leading diagnostic and treatment-planning directions in the future development of dentistry.

REFERENCES:

1. Kapila, S., & Nervina, J. (2015). Cone beam computed tomography in orthodontics: assessment of treatment outcomes and indications for its use. *Dentomaxillofacial Radiology, 44*(1). https://pubmed.ncbi.nlm.nih.gov/25358833/

2. Polizzi, A., Serra, S., & Leonardi, R. (2024). Use of CBCT in orthodontics: A scoping review. *Journal of Clinical Medicine, 13*(22), 6941. https://www.mdpi.com/2077-0383/13/22/6941

3. Chowdhary, R., & Sonnahalli, N. K. (2024). Clinical applications of T-Scan quantitative digital occlusal analysis technology: A systematic review. *International Journal of Computerized Dentistry*. https://pubmed.ncbi.nlm.nih.gov/36928754/

4. ZAMONAVIY STOMATOLOGIK ORTOPEDIYA YUTUQLARI: KLINIK ANATOMIYA, RAQAMLI GNATOLOGIYA VA BIOMIMETIK REKONSTRUKSIYA. (2026). *Global Science Review*, *17*(1), 985-988. https://global-science-review.com/ojs/index.php/gsr/article/view/5881

5. Совершенствование ортодонтического лечения прогнатического прикуса у детей и оценка его эффективности с помощью искусственного интеллекта. (2025). *in Library*, *1*(1), 2-19. https://doi.org/10.71337/inlibrary.uz.archive.129533

6. **Использование цифровых технологий при планировании ортодонтического лечения растущих пациентов с дистальной окклюзией с применением двучелюстных функциональных аппаратов.** Семичева Ю.К. ФГБНУ «Национальный НИИ общественного здоровья имени Н.А. Семашко». Том 27, № 4 (2024). С- 62-66 // **DOI:** https://doi.org/10.18499/2070-9277-2024-27-4-62-66

7. Цифровое планирование и последовательная реализация. Петра Гиртмюлен. 2022 // https://dentalmagazine.ru/posts/czifrovoe-planirovanie-i-posledovatelnaya-realizacziya.html?ysclid=mptnmvxvtj435883686