ORIGINAL ARTICLE

CONTENTS

Analysis of neuromuscular and occlusal characteristics of the dentition in patients with temporary fixed orthopedic construction on dental implants in case of complete loss of teeth in one of the jaws

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ABSTRACT

Aim: To evaluate the neuromuscular and occlusal characteristics of the dentition in patients with complete tooth loss in one of the jaws who were fitted with temporary fixed prosthetic structures for immediate loading of dental implants.

Materials and Methods: Using the method of synchromyography (Teethan system), functional parameters was analyzed in three groups of patients: with structures based on a cast beam, with a welded beam, and with polymethyl methacrylate (PMMA).

Results: The results emphasize the importance of choosing the type of temporary structure depending on the functional requirements, patient characteristics, and long-term prospects for adaptation.

Conclusions: The study emphasizes the importance of choosing the type of construction to ensure effective rehabilitation of patients with complete loss of teeth in one of the jaws and prevention of possible complications. The researchers recommend using cast or welded beams to achieve optimal long-term clinical results.

KEY WORDS: immediate load on implants, Teethan, intraoral welding, complete tooth loss, neuromuscular and occlusal characteristics, cast beam, dental implantation, temporary fixed prosthetic structures

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INTRODUCTION

Tooth loss, especially in the case of complete loss of teeth on one or both jaws, is one of the most common and at the same time the most complex dental problems in modern society, which affects not only the physiological function of chewing and articulation, but also the psycho-emotional state of patients, their social adaptation and overall quality of life [1- 3].

Dental implants are a proven and reliable method of restoring teeth in case of complete loss, providing stable and long-lasting results. Temporary fixed orthopedic structures, which are placed on implants for immediate loading, allow patients to restore chewing function immediately after surgery, which is especially important for maintaining quality of life during rehabilitation [4-8].

However, one of the most important aspects is to study the effect of such structures on the neuromuscular function and occlusal characteristics of the dentition. Failure to meet proper standards in restoring occlusion, as well as inadequate load on implants, can lead to masticatory muscle dysfunction, temporomandibular joint (TMJ) pain, and the development of joint dysfunction [9-11]. Therefore, a thorough study of neuromuscular characteristics and occlusal functions in patients with temporary dental implant prostheses is critical to achieve stable treatment results and prevent possible complications. Insufficient attention to this aspect can lead to disorders in muscle activity, which, in turn, can affect the patient's occlusal functions. It is also important to determine the optimal parameters of the load on the implants during different periods of treatment to reduce the risk of complications, such as bone resorption around the implants, implant mobility with their loss [12-14].

The relevance of this study is also confirmed by the need to optimize approaches to the treatment of patients with complete tooth loss. Due to the development of new technologies and methods, such as digital implant planning technologies and 3D visualization, methods for assessing the functional and anatomical parameters of the dentition are being improved, which can significantly improve the accuracy and effectiveness of treatment [15-21].

In view of the above, the study of neuromuscular and occlusal characteristics in patients with temporary fixed dental implant prostheses is important for the development of more effective and safe methods of rehabilitation of patients with complete tooth loss in one of the jaws and will contribute to the optimal rehabilitation process and reduce the likelihood of complications. This will improve the effectiveness of treatment and the quality of life of patients.

AIM

To analyze the chewing, neuromuscular and occlusal characteristics of the dentition by synchromyography (digital Teethan system) in patients who received a temporary fixed orthopedic structure for immediate loading with support for dental implants in case of complete tooth loss in one of the jaws.

MATERIALS AND METHODS

For a comparative assessment of the effect of different implant-supported prosthetic structures for immediate loading on the neuromuscular and occlusal components of the dentition, we chose temporary acrylic prostheses with dentures reinforced with a cast beam, temporary composite prosthetic structures with a welded beam, and temporary prosthetic structures made of PMMA.

Analysis of the occlusal characteristics of the dento-maxillary apparatus was performed using Teethan digital technology. The study is aimed at improving the methods of rehabilitation of patients with complete tooth loss in one of the jaws, which will increase the effectiveness of treatment and reduce the risk of complications.

During the surgical stage, dental implants of the AnyOne system made in Korea with a diameter of 3.5 mm to 4.5 mm and a length of 10 to 13 mm were used.

The study included a comparative assessment of the functional state of the masticatory muscles in 128 patients (59 men and 69 women) prosthetized with temporary structures supported by 6 implants using three different approaches: 41 patients – temporary acrylic dentures with set teeth reinforced with a cast beam (Cr-Co) (first group), 45 patients – temporary composite orthopedic structures (printed on a 3-D printer) with a welded beam (Cr-Co), which is made by selective laser sintering (second group) and 42 patients with a temporary orthopedic structure made by milling from PMMA (third group).

Five functional indicators were used for the analysis: Poc, Bar, Tors, Impact and Asym, which were measured at different time points (1 week, 1 month, 3 months, 6 months after prosthetics). To improve the perception of information, we visualized it in the form of graphs (Fig. 1, Fig. 2, Fig.3, Fig. 4, Fig. 5).

RESULTS

At the early stage of adaptation (1 week), there were significant differences between the groups: The group with the cast beam showed the best results in all indices. The Bar index was 1.35 ± 0.12, and the Asym index was 0.96 ± 0.10, indicating good structural stability and even load distribution. Group 2 (with a welded beam) showed intermediate values. The Bar index was 1.23 ± 0.15 ($p = 0.048$ compared to the first group), and the Asym index was 1.05 ± 0.11 ($p = 0.038$). This indicates certain "instability" of the structure associated with some inaccuracies during its assembly in the surgical stage, but it is much better than in the third group. The third group (temporary structure made of PMMA) demonstrated the worst performance. The Bar index was 0.92 ± 0.20 and the Asym index was 1.22 ± 0.14 ($p < 0.001$ compared to both groups). This is due to the mobility of the structure and the uneven distribution of the chewing load. Thus, in the first week after prosthetics, the advantages of the cast beam stiffness were obvious, and structures based on intraoral welding proved to be more stable than prostheses made of PMMA. At the stage of 1 month after prosthetics, patients in all groups showed adaptation, but differences persisted. The first group continued to show the best results. The Poc index was 1.25 ± 0.14, and the Bar index was 1.34 ± 0.10, which was significantly higher than in the third group ($p < 0.001$).

The second group demonstrated improvement in functional performance. The Poc index was 1.18 ± 0.16, and Asym decreased to 0.89 ± 0.10, which was still higher than the first group ($p = 0.034$), but better than the third group ($p < 0.001$). The third group continued to show poor results. The Asym index was 1.12 ± 0.13, and the Bar index was 1.03 ± 0.18, indicating insufficient structural stability. Adaptation to structures using cast and welded beams was faster than to lamellar prostheses, as evidenced by significant differences in the Asym and Bar indices.

At 3 months after prosthetics, the differences between the first and second groups began to decrease. The first group showed stable results. The Bar index was 1.34 ± 0.10, and the Impact index was 1.22 ± 0.11. These scores remained better than those of the third group ($p < 0.001$). The second group almost equaled the first group in most indices. The Bar value was 1.30 ± 0.13, and Impact was 1.20 ± 0.12 ($p = 0.092$ compared to the first

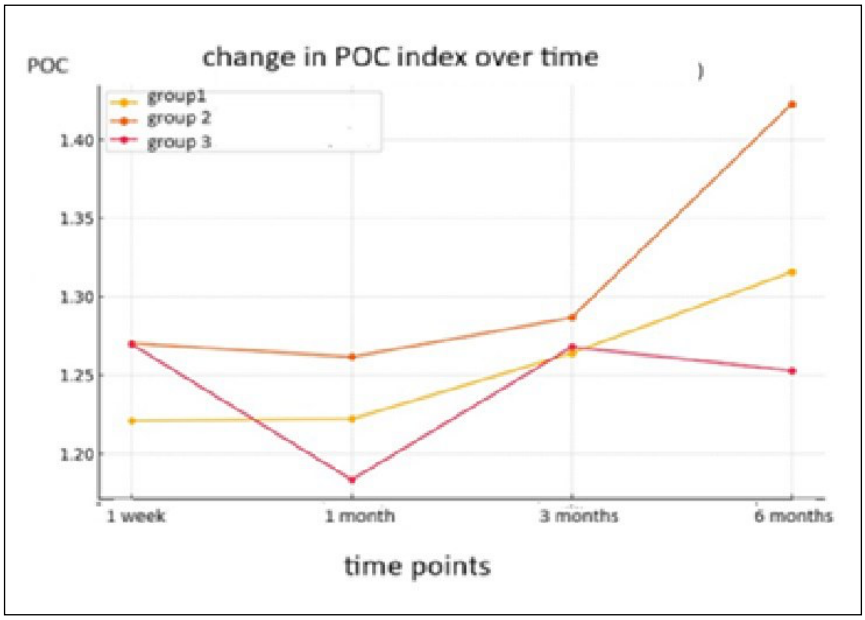

Fig. 1. Graph comparing the Poc index for the three groups at different time points

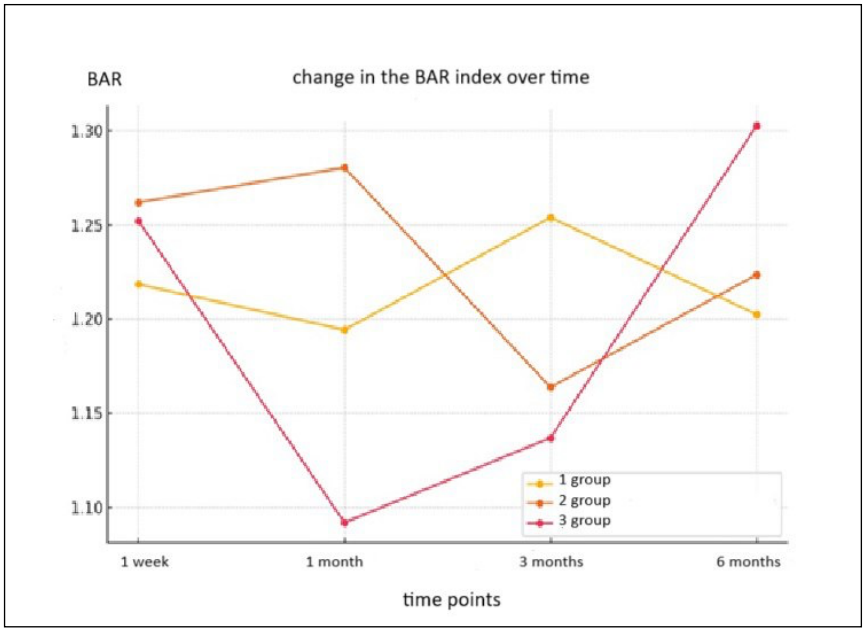

Fig. 2. Graph comparing the Bar index for the three groups at different time points

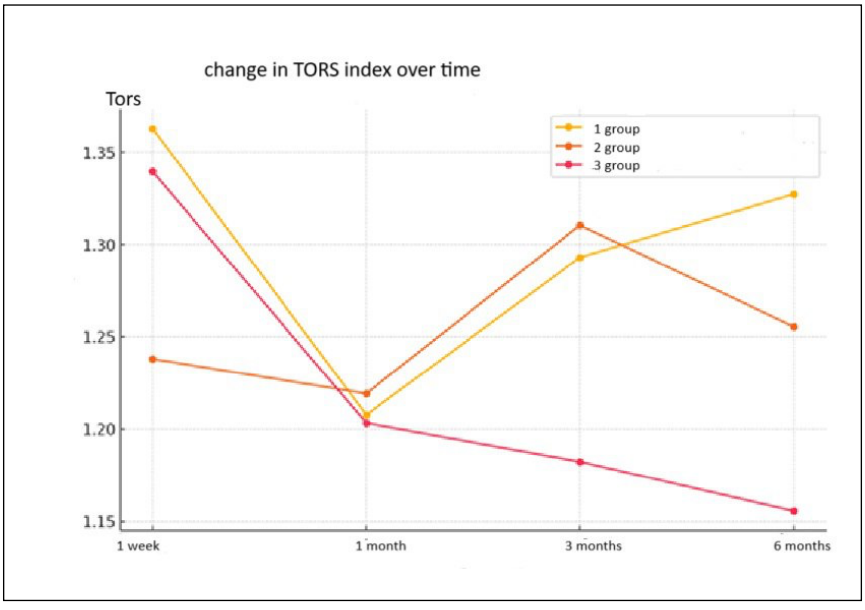

Fig. 3. Graph comparing the Tors index for the three groups at different time points

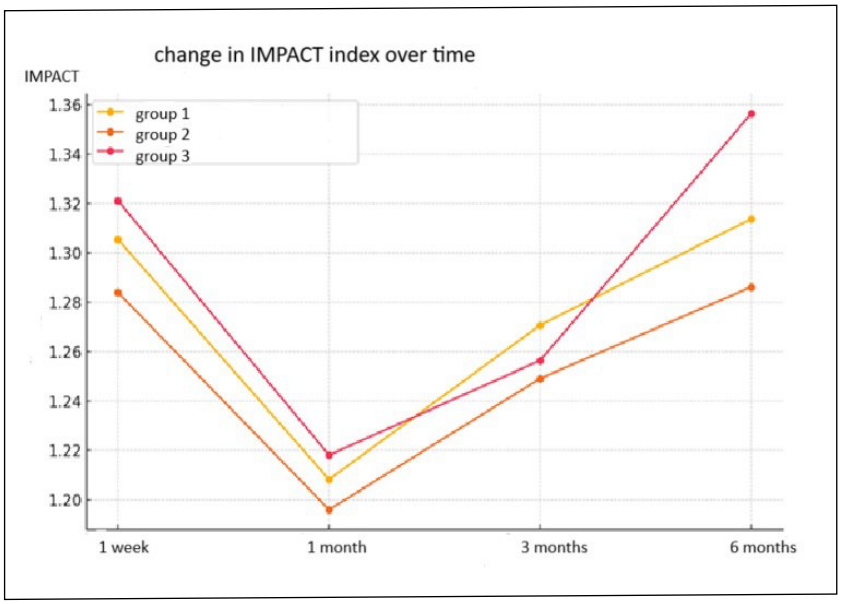

Fig. 4. Graph comparing the Impact Index for the three groups at different time points

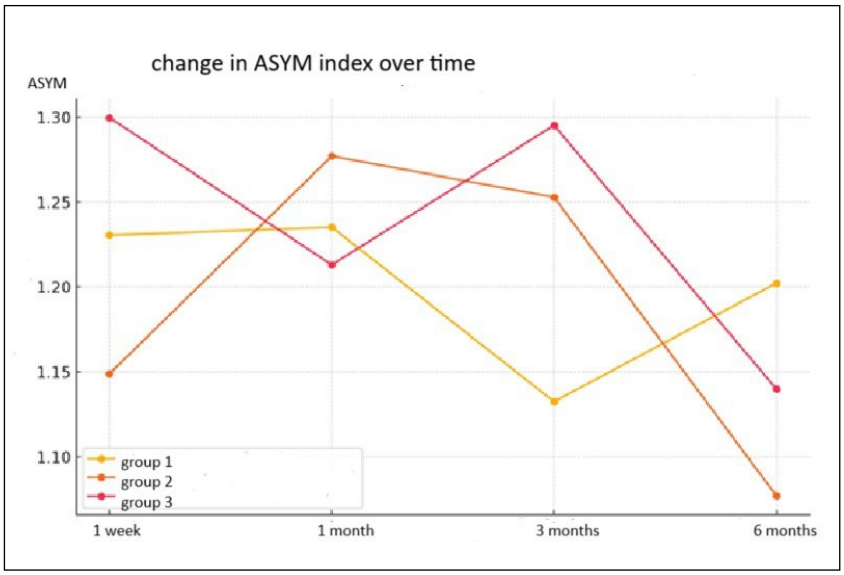

Fig. 5. Graph comparing the Asym index for the three groups at different time points

group). However, Asym index remained slightly higher (0.83 ± 0.08) compared to the first group (0.80 ± 0.07, p = 0.062). The third group showed a slight improvement, but the scores remained the worst. The Asym index was 1.01 ± 0.10, and the Bar index was 1.05 ± 0.18, indicating worse adaptation.

The results of the third month show that the cast and welded beam constructions provide similar functional stability, while the PMMA temporary prosthesis remains less effective.

At 6 months after prosthetics, most of the indicators in the first and second groups reached similar values. The first group continued to demonstrate the best results, with the Asym index at 0.75 ± 0.07 and the Bar index at 1.35 ± 0.07. The second group showed almost identical results. The Bar index was 1.33 ± 0.08, and the Asym index was 0.79 ± 0.06 (p = 0.048 compared to the first group).

The third group showed improvement, but still lagged behind. The Bar index was 1.11 ± 0.15, and the Asym index was 1.01 ± 0.10, which confirms poor adaptation and limited stability.

DISCUSSION

An objective analysis of the functional state of the masticatory muscles before and after dental interventions allows for a more accurate assessment of the patient's initial condition, reasonable planning of restoration, and monitoring the effectiveness of treatment, regardless of its form (restorations, implantation, orthodontic intervention, etc.) [10-12].

Our results confirm that the type of temporary orthopedic structure has a significant impact on neuromuscular adaptation and occlusal stability in patients with complete tooth loss. Our study is in line with previous

studies that indicate the importance of stiffness and accuracy of fixation of orthopedic structures to achieve optimal functional outcome [5, 6].

In the study, a group of patients with temporary prostheses on a cast beam demonstrated the best functional results in the early stages, due to the high rigidity of the structure and even load distribution. The second group – with a welded beam – showed similar results to the first group at 3 and 6 months, confirming the effectiveness of this approach. In contrast, PMMA structures were significantly inferior in terms of stability and load symmetry, indicating that their use in such clinical cases is limited.

The data on the superiority of the cast beam over polymeric structures confirm the findings of Doroshenko O and Shepelynskiy O. (2024), who emphasize that stiffer structures contribute to a more even distribution of the masticatory load and reduce the risk of TMJ dysfunction [22]. At the same time, the results of the second group, in which welded beams were used, show that welding is a promising alternative, which is confirmed by the study by Galucci GO. et al. (2018), which states that immediate loading of implants is possible provided the structure is stable [23].

The poor results of PMMA constructions are consistent with the data of Frazer R.Q. et al. (2005), which indicate insufficient stability of acrylic prostheses compared to metal frames [24]. The high Asym index and low Bar in this group confirm the presence of load asymmetry, which can lead to hyperactivity of individual muscles and functional imbalance.

The methodology for assessing neuromuscular activity using digital synchromyography (Teethan) allowed us to objectively assess the functional effectiveness of different types of temporary structures, which is important for individualizing the approach to rehabilitation. Similarly to the study by Saracutu O.I. et al. (2021), we found that digital analysis methods can detect early signs of dysfunction and optimize design solutions [25, 26].

Thus, the results of our study confirm the effectiveness of cast and welded beams as temporary implant structures. They ensure rapid patient adaptation, stability of neuromuscular balance, and reduce the risk of complications. Further studies should be aimed at evaluating long-term results, in particular after the transition to permanent prosthetics.

CONCLUSIONS

1. The study found that the use of a cast beam in temporary structures provides the highest functional stability of the masticatory muscles at all stages of observation. Stiffness of the structure and uniform load distribution contributed to the best performance of the Poc, Bar, Tors, Impact and Asym indices.
2. The welded beam showed comparable results to the cast beam, especially at 3 and 6 months after prosthetics. Slight differences in the Asym index indicate a slightly lower stability of the structure in the early stages of adaptation, however, by the 6 month these differences these differences practically disappear. This makes it possible to consider the welded beam an effective alternative to the cast one.
3. Temporary prostheses made of PMMA showed the worst results for all indices at all stages of observation. The instability of the structure and uneven distribution of the chewing load significantly affected the adaptation of the masticatory muscles, which confirms the limited use of them for temporary prosthetics on implants in patients with complete tooth loss in one of the jaws.
4. Based on the data obtained, it is recommended to use cast or welded beams for temporary implant-supported structures in patients with complete loss of teeth in one of the jaws, as they provide rapid adaptation of patients and stability of the masticatory muscle function. Temporary prostheses made of PMMA should be used only in exceptional cases when other designs cannot be used.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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