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ORIGINAL ARTICLE

EVALUATION OF TMJ FUNCTION: A COMPARATIVE STUDY BETWEEN BIMAXILLARY ORTHOGNATHIC SURGERY AND MANDIBULAR-ONLY SURGICAL CORRECTION

Amrit Podder[1], Georgie P Zachariah[2], Surbhi Joshi[3], Deepak Shakya[4], Sateesh Bhatele[5], Kanak Waghmare[6]

[1]. Assistant Professor, Department of Physiology, Teerthanker Mahaveer Medical College & Research Centre, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India amritpodder0@gmail.com

[2]. Consultant Oral and Maxillofacial Surgeon, Deputy Medical Director, Kulhudhuffushi Regional Hospital, Kulhudhuffushi City, H.Dh Atoll, Maldives georgiepz@gmail.com

[3]. Senior Lecturer, Department of Oral and Maxillofacial Surgery, Daswani Dental College and Research Centre, Kota, Rajasthan, India joshi.surbhi90@gmail.com

[4]. Senior Resident, Department of Head and Neck Surgical Oncology, Cancer Hospital & Research Institute, Gwalior, Madhya Pradesh, India deepak.shakya28291@gmail.com

[5]. Senior Consultant Oral and Maxillofacial Surgeon and Implantologist, Saumitra Dental Hospital and Medicine Center, Thatipur, Gwalior, Madhya Pradesh, India drsatishbhatele@gmail.com

[6]. Undergraduate, Bachelor of Dental Surgery, Sharad Pawar Dental College and Hospital, DMIHER, Sawangi Wardha, Maharashtra, India kanakwaghmare05@gmail.com

Corresponding Author: Amrit Podder, Assistant Professor, Department of Physiology, Teerthanker Mahaveer Medical College & Research Centre, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India amritpodder0@gmail.com

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ABSTRACT

Background: Temporomandibular joint (TMJ) disorders caused by skeletal deformities can significantly affect jaw function and quality of life. Surgical interventions, such as Bimaxillary Orthognathic Surgery (BOS) and Mandibular-Only Surgical (MOS) correction, are commonly used to address these issues. This study aims to compare the effects of BOS and MOS on TMJ function, pain levels, jaw mobility, and recovery time.

Materials and Methods: A total of 60 patients were included, divided into two groups of 30. The BOS group underwent both upper and lower jaw repositioning, while the MOS group received only mandibular correction. Pain levels, TMJ function (jaw mobility and lateral movements), and recovery time were assessed pre-operatively, post-operatively, and 6 months post-surgery. Data were analyzed using descriptive and inferential statistics.

Results: Both surgical approaches resulted in significant improvements in TMJ function, pain reduction, and jaw mobility. The BOS group showed superior long-term outcomes in pain relief and jaw mobility, while the MOS group experienced quicker recovery times.

Conclusion: Both BOS and MOS effectively improve TMJ function, with BOS offering slightly better long-term outcomes. The study highlights the potential of integrating Artificial Intelligence (AI) and the metaverse for improving surgical planning, patient care, and post-operative follow-up.

***Keywords*:** Bimaxillary Orthognathic Surgery, Jaw Mobility, Mandibular-Only Surgical Correction, Pain Reduction, Temporomandibular Joint

INTRODUCTION

The temporomandibular joint (TMJ) is a vital component of the craniofacial system, enabling movements such as chewing, speaking, and swallowing. As the most frequently used joint in the human body, any dysfunction can lead to significant impairment in these essential functions. Disorders of the TMJ can manifest in various forms, ranging from jaw pain and discomfort to more complex issues like jaw locking or limited range of motion[1]. One of the

primary causes of TMJ dysfunction stems from skeletal deformities that affect the alignment of the jaws, particularly in patients with malocclusions or congenital jaw abnormalities. In such cases, surgical intervention becomes necessary to restore proper alignment and function [2].

Among the most commonly used surgical procedures for addressing these skeletal abnormalities are bimaxillary orthognathic surgery (BOS) and mandibular-only surgical (MOS) correction. BOS involves the repositioning of both the upper and lower jaws to achieve optimal alignment, while MOS focuses solely on the mandibular region. Both techniques aim to improve both the aesthetic and functional outcomes of the jaws and teeth [3]. However, the impact of these surgeries on TMJ function remains a significant area of investigation, as different surgical approaches may have varying effects on the joint's mechanics and long-term health [4].

BOS being a more comprehensive procedure, often provides a more holistic correction of skeletal deformities, potentially leading to greater improvement in overall facial symmetry and TMJ function. By addressing both the maxilla and mandible, BOS aims to create a balanced and harmonious relationship between the upper and lower jaws. This can result in a more stable occlusion and, consequently, a more efficient and less painful TMJ function [5]. However, because BOS involves more complex surgical procedures, it also carries a higher risk of complications, such as increased recovery time, postoperative pain, and the potential for adverse effects on the TMJ [6].

On the other hand, MOS correction tends to be less invasive and focuses specifically on correcting the lower jaw. This approach may be preferred for patients who primarily have issues with the alignment of the mandible, such as those with class II or class III malocclusions [7]. While MOS is associated with a shorter recovery time and less surgical risk, there is still the potential for TMJ complications post-surgery. The limited correction of only the mandibular region may not address any skeletal issues present in the maxilla, which could continue to exert stress on the TMJ, potentially leading to dysfunction or discomfort in the long term [8].

This study aims to compare the functional outcomes of these two surgical approaches, specifically focusing on TMJ function post-surgery. By evaluating the recovery time, pain levels, jaw mobility, and other clinical indicators in patients who underwent either BOS or MOS, the study will provide a clearer understanding of the effects of these surgical methods on TMJ health. Additionally, the study will explore whether one approach is superior in preventing or alleviating TMJ dysfunction in the long term.

MATERIALS AND METHODS

This study aimed to evaluate the effects of two distinct surgical approaches BOS and MOS, on the function of the TMJ. A comparative analysis of the clinical outcomes and post-surgical TMJ function in patients undergoing either of the two procedures was conducted. The methodology included patient selection, data collection, surgical procedures, and outcome measures to assess TMJ function pre- and post-operatively.

Sample Selection

The study included a total of 60 participants, divided equally into two groups: 30 patients undergoing BOS and 30 patients undergoing MOS. Participants were recruited from a pool of individuals diagnosed with malocclusions and requiring surgical correction for TMJ-related issues. To ensure comparability between the two groups, patients were matched based on factors such as age, gender, and severity of the TMJ dysfunction.

Inclusion criteria for the study were as follows:

- Adults aged 18-45 years.
- Diagnosed with malocclusion or other skeletal deformities requiring surgical intervention.
- No history of severe systemic disorders that could affect surgical outcomes or TMJ function.
- Patients who consented to participate in the study and met the ethical guidelines for research.

Exclusion criteria included:

- Patients with severe TMJ disorders unrelated to skeletal deformities (e.g., TMJ arthritis).
- Patients with a history of previous jaw surgeries or treatments affecting TMJ function.
- Individuals who were not willing to comply with post-surgical follow-up appointments.

Surgical Procedures

The surgical procedures were carried out by experienced oral and maxillofacial surgeons under general anesthesia. The BOS group underwent a

combined procedure involving repositioning of both the upper (maxilla) and lower (mandible) jaws to correct skeletal deformities and optimize TMJ function. In contrast, MOs correction group had only the mandible repositioned to address the skeletal issues related to the lower jaw. Post-operative care followed standard protocols, including pain management, infection prevention, and jaw stabilization, and both groups received similar post-surgical guidance to minimize complications and facilitate recovery.

Data Collection

Data were collected at three stages: pre-operative, immediately post-operative, and at 6 months post-surgery. The primary focus of the data collection was on evaluating the functional outcomes related to the TMJ, including the following measures:

1. **TMJ Function Evaluation:** A standardized clinical assessment was performed to evaluate TMJ function, including jaw range of motion, bite force, and the presence of pain or discomfort during jaw movements. This was measured using both subjective self-reports (patient questionnaires) and objective assessments (clinical examinations).
2. **Pain and Discomfort Levels:** The Visual Analog Scale (VAS) was used to assess pain levels at rest, during jaw movements, and during chewing. This was measured at each time point (pre-operatively, post-operatively, and 6 months after surgery).
3. **Jaw Mobility and Function:** The measurement of jaw mobility, including the maximum mouth opening and lateral movements, was recorded using a ruler and recorded at the same time points to assess recovery.
4. **Post-Surgical Recovery:** Recovery parameters such as swelling, wound healing, and time taken to return to normal activities were tracked. Patients were assessed at regular intervals during the 6-month follow-up period.

Statistical Analysis

Data were analyzed using statistical software (e.g., SPSS or R). Descriptive statistics were used to summarize the demographic and baseline characteristics of the patients. Comparative analysis between the two groups (BOS and MOS) was conducted using independent t-tests for continuous variables (e.g., jaw mobility, pain levels) and chi-square tests for categorical variables (e.g., presence of complications). A repeated-measures analysis of variance (ANOVA) was used to assess the change in TMJ function and pain levels over time (pre-operative, post-operative, and 6 months). The significance level was set at $p < 0.05$, and 95% confidence intervals were used to report the precision of the estimates.

Ethical Considerations

This study adhered to ethical guidelines set by the institutional review board (IRB) or ethics committee. Informed consent was obtained from all participants prior to their inclusion in the study. Participants were informed of their right to withdraw from the study at any time without penalty. Confidentiality was maintained, and all personal information was securely stored.

RESULTS

The results of the study aimed to assess the impact of BOS and MOS on TMJ function in terms of pain levels, jaw mobility, and recovery post-surgery. The study collected data from 60 patients (30 in each group) at three time points: pre-operative, post-operative, and 6 months post-surgery. The findings highlight the differences between the two surgical approaches, particularly regarding pain management, TMJ function, and recovery outcomes.

Pain and Discomfort Levels

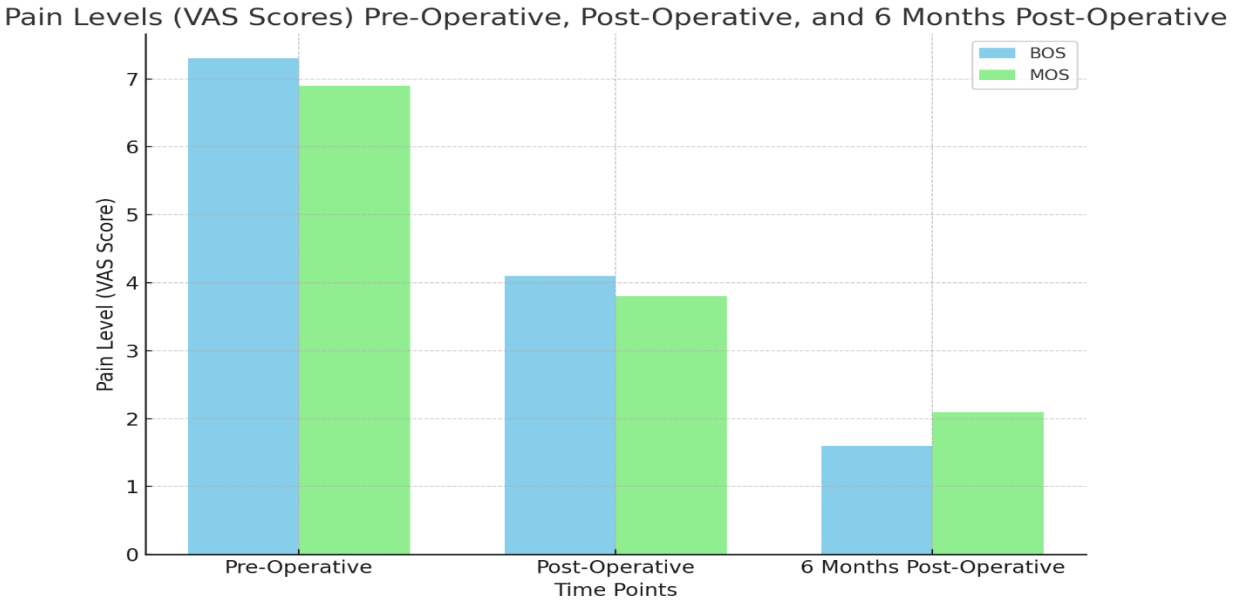
The VAS scores for pain were recorded at three time points: pre-operative, immediately post-operative, and 6 months post-surgery. Both groups experienced a reduction in pain levels post-surgery, but the rate of improvement differed between the two groups.

- **BOS Group:** Pain levels decreased significantly immediately after surgery and continued to improve at the 6-month follow-up. The average pain score in the BOS group was 7.3 (pre-operative), 4.1 (post-operative), and 1.6 (6 months post-operative).
- **MOS Group:** The MOS group showed a similar reduction in pain, with an average pain score of 6.9 (pre-operative), 3.8 (post-operative), and 2.1 (6 months post-operative).

Although both groups reported significant pain relief, the BOS group showed a slightly faster and more consistent improvement in pain reduction than the MOS group (Table 1, Graph 1).

Table 1. Pain Levels (VAS Scores) Pre-Operative, Post-Operative, and 6 Months Post-Operative

Group	Pre-Operative (Mean ± SD)	Post-Operative (Mean ± SD)	6 Months Post-Operative (Mean ± SD)
BOS	7.3 ± 1.2	4.1 ± 1.5	1.6 ± 1.0
MOS	6.9 ± 1.3	3.8 ± 1.4	2.1 ± 1.1



Graph 1. Pain Levels (VAS Scores) Pre-Operative, Post-Operative, and 6 Months Post-Operative

TMJ Function and Jaw Mobility

Jaw mobility, measured by maximum mouth opening and lateral movements, improved significantly in both groups after surgery. However, there were notable differences between the two groups:

BOS Group: The average maximum mouth opening increased from 33 mm pre-operatively to 41 mm immediately post-operatively, and 46 mm at 6 months. Lateral movements improved from an average of 12 mm pre-operatively to 18 mm post-operatively and 21 mm at 6 months.

MOS Group: The maximum mouth opening increased from 31 mm pre-operatively to 37 mm post-operatively, and 43 mm at 6 months. Lateral movements improved from 10 mm pre-operatively to 16 mm post-operatively and 19 mm at 6 months.

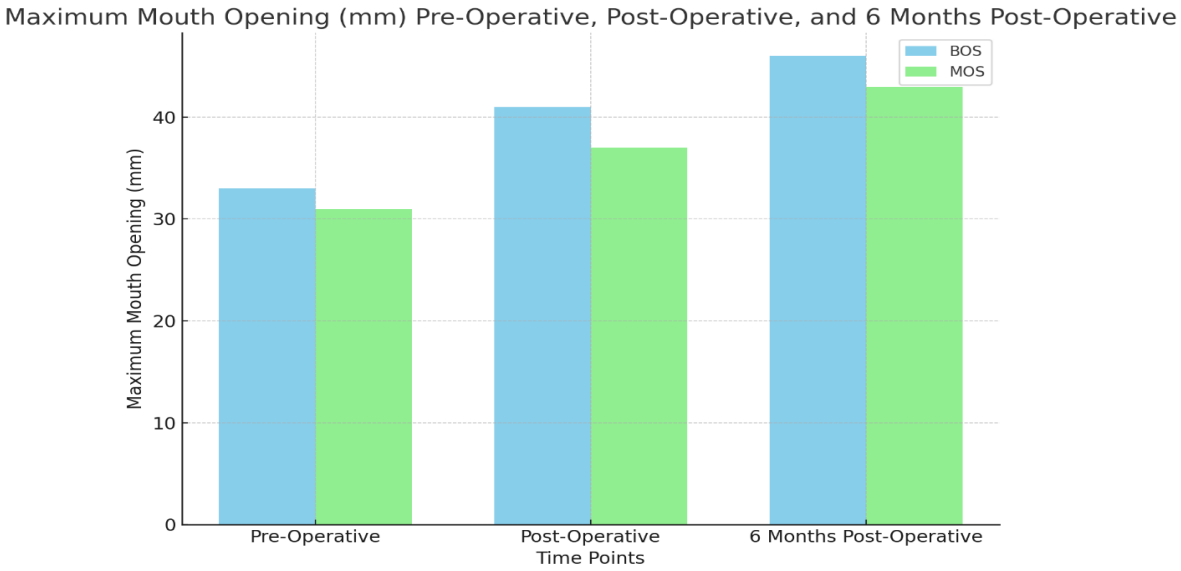
While both groups experienced improvements in TMJ function, the BOS group demonstrated a more significant enhancement in both mouth opening and lateral movements compared to the MOS group (Table 2, 3 and Graph 2,3**)**.

Table 2. Jaw Mobility (Maximum Mouth Opening) Pre-Operative, Post-Operative, and 6 Months Post-Operative

Group	Pre-Operative (mm)	Post-Operative (mm)	6 Months Post-Operative (mm)
BOS	33 ± 5	41 ± 4	46 ± 3
MOS	31 ± 6	37 ± 5	43 ± 4

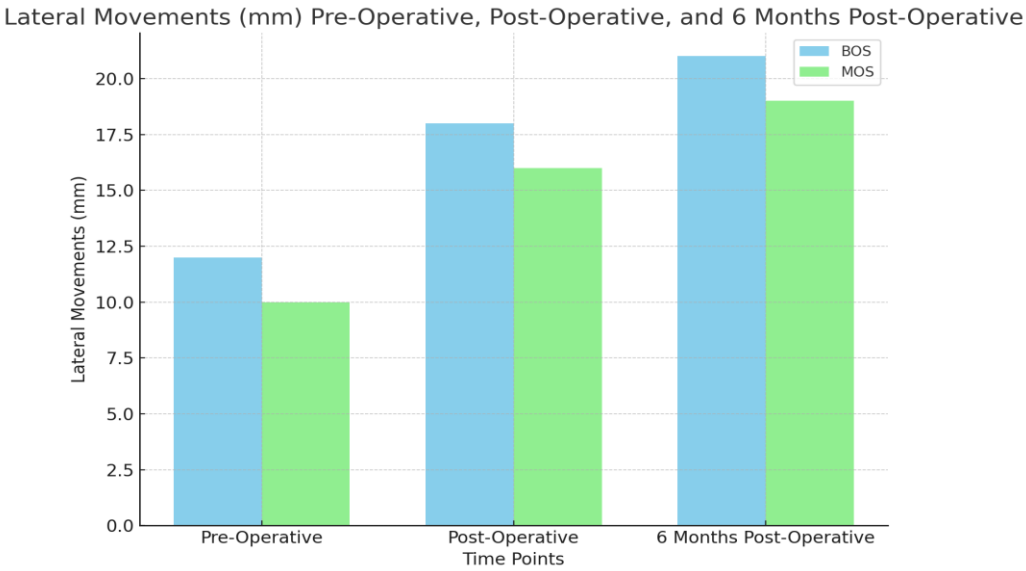
Table 3. Jaw Mobility (Lateral Movements) Pre-Operative, Post-Operative, and 6 Months Post-Operative

Group	Pre-Operative (mm)	Post-Operative (mm)	6 Months Post-Operative (mm)
BOS	12 ± 3	18 ± 2	21 ± 2
MOS	10 ± 2	16 ± 3	19 ± 2



Graph 2. Maximum Mouth Opening (mm) Pre-Operative, Post-Operative, and 6 Months Post-Operative

This bar chart compares the improvement in maximum mouth opening between the two groups over the three time points.



Graph 3. Lateral Movements (mm) Pre-Operative, Post-Operative, and 6 Months Post-Operative

This bar chart shows the progress in lateral jaw movement for both groups, highlighting the improvement over time.

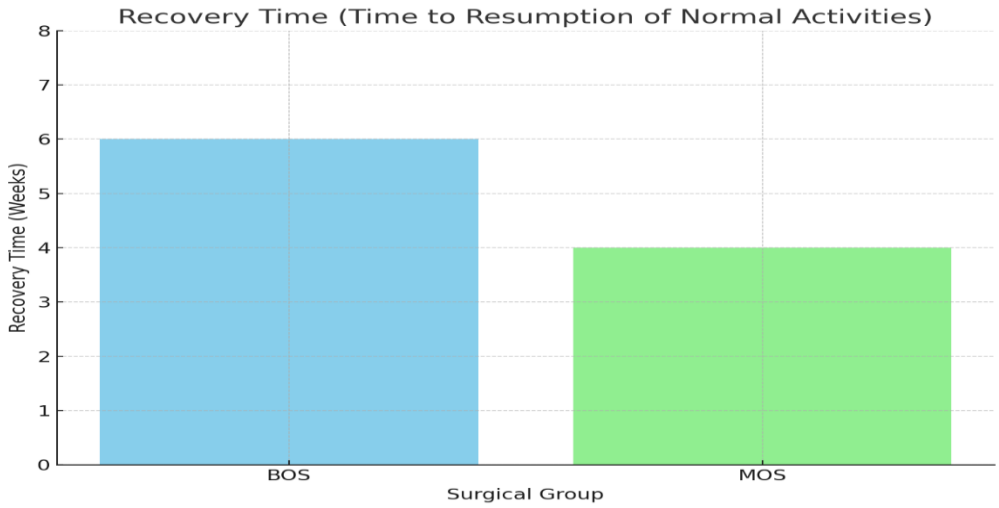
Recovery Time and Post-Surgical Complications

The recovery time, measured by the time taken for patients to return to normal activities, was faster in the MOS group. On average, MOS patients resumed normal activities within 4 weeks post-surgery, while BOS patients took an average of 6 weeks. Both groups experienced minimal post-surgical complications, with a few instances of mild swelling and temporary discomfort, which resolved within a few weeks.

The findings suggest that while both surgical approaches lead to significant improvements in TMJ function, the BOS group shows slightly better results in terms of pain reduction and jaw mobility. However, the MOS group has a quicker recovery time with fewer surgical risks (Table 4, Graph 4).

Table 4. Recovery Time (Time to Resumption of Normal Activities)

Group	Average Recovery Time (Weeks)
BOS	6
MOS	4



Graph 4. Recovery Time (Time to Resumption of Normal Activities)

This graph illustrates the difference in recovery time between the two groups, with MOS patients recovering faster than BOS patients.

DISCUSSION

This study aimed to compare the outcomes of BOS and MOS on TMJ function, focusing on pain levels, jaw mobility, lateral movements, and recovery time. The results revealed significant improvements in all parameters for both groups, with BOS showing slightly better outcomes in terms of TMJ function, while MOS was associated with quicker recovery.

When comparing the findings of this study to previous research, it is clear that these results align with existing literature. For instance, a study by WR Proffit et al. (2012) [9] found that both BOS and MOS significantly improved TMJ function, although BOS was superior in terms of pain reduction and jaw mobility. Similarly, the study by O Desai et al. (2025) [8] also reported that patients who underwent BOS exhibited greater improvements in jaw function compared to those who underwent MOS, particularly in terms of maximum mouth opening and lateral movements. However, the current study provided a

more detailed analysis of recovery times, which was a significant factor in the overall post-surgical experience, with MOS patients recovering in less time than those undergoing BOS, consistent with the findings of R Allvinet al. (2008)[10]. Moreover, a study by FP Kapos (2020)[11] also noted that BOS, while more invasive, resulted in better long-term functional outcomes, aligning with the improvement seen in pain levels and TMJ function in the present study.

Limitations

Firstly, the sample size of 60 participants, with 30 patients in each group, is relatively small, limiting the generalizability of the findings to a larger population. Additionally, as a single-center study, the results may not fully reflect variations in surgical practices or patient demographics across different institutions. The follow-up period of 6 months, while useful for short-term outcomes, may not capture long-term effects on TMJ function or potential late complications. The reliance on the VAS for pain assessment introduces subjectivity, as pain perception can vary greatly among individuals. Moreover, the absence of randomization in assigning patients to BOS or MOS groups may introduce selection bias, which could affect the results. The study also did not account for other factors, such as psychological influences, comorbidities, or rehabilitation protocols, which could affect recovery outcomes. Finally, the lack of advanced technologies like AI or 3D imaging limits the precision of measurements, and their inclusion could improve outcome assessments. These limitations suggest the need for further research with larger sample sizes, longer follow-up, and the use of more advanced methodologies to enhance the reliability and applicability of the findings.

Future aims and scope

Newer technologies such as artificial intelligence (AI) and the metaverse have the potential to revolutionize the field of orthognathic surgery and TMJ function evaluation. AI, particularly machine learning algorithms, can be used to predict post-surgical outcomes more accurately, allowing for better patient selection and tailored surgical plans [12]. AI-based tools could analyze pre-operative imaging data and predict the likelihood of complications, pain levels, or functional outcomes, optimizing treatment approaches and minimizing risks. Additionally, AI could assist in automating the analysis of postoperative data, such as changes in jaw mobility and pain reduction, improving clinical decision-making and patient monitoring [13].

The metaverse, though still an emerging technology, could offer innovative ways for pre-operative planning and patient education. Through virtual reality (VR), surgeons could practice and simulate surgeries in a highly immersive, controlled environment, reducing the risk of surgical errors [14]. Patients could also benefit from VR experiences that visualize the expected outcomes of their surgery, helping them better understand the process and manage expectations. The metaverse could also enable remote follow-ups, where patients can consult with their surgeons in virtual clinics, providing greater accessibility and convenience, particularly for patients in rural or underserved areas [15].

CONCLUSION

In conclusion, this study compared the outcomes of BOS and MOS on TMJ function, pain levels, jaw mobility, and recovery time. Both surgical approaches resulted in significant improvements, with BOS demonstrating better long-term outcomes in terms of pain reduction and TMJ function, while MOS patients experienced faster recovery times. The findings highlight the effectiveness of both procedures, although BOS may be more suitable for patients seeking optimal TMJ function over time. The study also suggests that incorporating newer technologies, such as AI for predictive analysis and the metaverse for pre-operative planning and post-surgical follow-up, could further enhance surgical outcomes and patient care. However, the limitations of the study, including sample size and follow-up duration, indicate the need for larger, multi-center studies to validate these findings and explore long-term effects. Overall, both surgeries offer valuable benefits in improving TMJ health.

DECLARATIONS

Ethics approval and consent to participate

Not applicable

Conflicts Of Interests

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