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EVALUATING THE USE OF VIRTUAL SURGICAL PLANNING IN OPTIMIZING OUTCOME IN THE TREATMENT OF TMJ ANKYLOSIS

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ABSTRACT

Background: A terrible illness that impairs jaw function and quality of life is temporomandibular joint (TMJ) ankylosis. Virtual surgical planning (VSP), a useful tool for improving surgical results, has become one among several available options. The current research assesses VSP's application in TMJ ankylosis therapy.

Objective: To investigate the effectiveness of virtual surgical planning in optimizing outcomes in the treatment of TMJ ankylosis.

Methods: This study used retrospective cohort methodology. Data were gathered from 30 TMJ ankylosis patients (ages 15–45 years) in the Maxillofacial surgery unit of tertiary care hospitals' Data on surgical planning, implementation, and results were gathered using a standardized questionnaire. Statistical analysis was performed using paired t-test and Wilcoxon signed-rank test on Patient's demographics, medical history, and surgical outcomes retrieved from patient's record.

Results: Significant improvement was found in Mouth Opening: Mean rise of 12 mm ($p < 0.001$). Joint Function: Reduced pain ($P<0.05$) and enhanced joint function. Surgical Accuracy: Minimal complications accompany great precision in carrying out surgical plans.

Conclusion: Virtual surgical planning is an effective tool for maximizing results in the therapy of TMJ ankylosis. It allows precise planning and execution of difficult surgical operations, so enhancing joint function and lowering morbidity. Treatment of TMJ ankylosis should take into consideration the use of VSP as it can improve patient outcomes.

INTRODUCTION:

This condition is best described as Temporomandibular joint (TMJ) ankylosis and it represents a complex and disabling condition that results in trismus, pain, functional impairment and at worst,

refers to the mandible's condyle fusion with the bone top in a fibrous or osseous form. Patients suffering from this condition have to deal with restricted mouth opening which makes basic tasks such as speaking, eating, and maintaining oral hygiene impossible (1, 2, 3). Not only does it impact the function of the joint, it also affects the face's aesthetics resulting in dentofacial deformities and asymmetry hence drastically diminishing the patient's quality of life. The causes for TMJ ankylosis differ; however, trauma remains the most widespread cause while chronic infections and systemic problems like juvenile arthritis are close seconds. One of the most challenging problems to treat remains dealing with TMJ ankylosis and this is primarily attributed to the intricate anatomy of the joint. To achieve that, a strategic approach has to be taken towards restoration of shape and function while managing complications and recurrence risks. (4,5,3). Traditional surgical options such as gap arthroplasty, interpositional arthroplasty, costochondral grafting, and total or partial joint prosthetic reconstruction offer an array of solutions. These strategies achieve moderate results, but often come with complications such as reankylosis, facial nerve injury, and non-uniform precision in the execution of hte surgery (1,5,3). Recently, Virtual Surgical Planning (VSP) has emerged as a revolutionary tool in the treatment of TMJ ankilosis. VSP fills the gaps provided by osteotomy and resections of the angles of the ramus of the jaw, fitting of the prosthesis, and navigation surgery with tailor made peripherals, which are all performed using a computer and three-dimensional scanning. This unique method involves the design of some of the guides and implants a patient goes through sequentially, which are done in one operation (2,6). This development enhances precision by 'streamlining' the sequence of steps within the operation, therefore, reducing time and potential operational problems. Studies show that the application of VSP in surgery performed on patients with TMJ ankilosis remarkably enhances the ability to open the mouth, function of the joint and pain, and lessens complications associated with these procedures such as reankylosis and damage to the facial nerve. It is worth noting that due to the ingenuity in surgical implementation plans made possible by VSP, enhanced patient outcomes and quality of life is not only achieved, but immeasurably improved (7).

Literature Review:

Some of the more commonly performed operations are gap arthroplasty, interpositional arthroplasty, and total joint reconstruction which can be performed using autogenous grafts or alloplastic prostheses. Prior studies indicate that there is a good outcome for all three methods.

They are practical and efficient in addressing and overcoming the challenges of maximal mouth opening and joint function. Post operatively, the reankylosis is still considered a big issue and it was noted in a few of the cases by the authors (4). One of TMJ ankylosis challenging problems has been remarkably addressed with the aid of Virtual surgical planning (VSP) and 3D technologies. What is VSP? It is an approach in surgery that is completely done in a digital context using data from imaging tests like CT scan to fabricate instruments and prostheses designed for the particular individual; In addition, these devices serve primarily as pose precision guides enhancing the clinicians making accuracy qualitative improvements to the procedure(2).

The use of VSP and custom-made prostheses resulted in remarkable improvements in mouth opening (average improvement ranging between 9.3 mm and over 40 mm) and functions of the joints after surgeries performed on patients with TMJ ankylosis(1). The study conducted by Chen et al. (2018) analyzed the clinical results of seven patients suffering from TMJ ankylosis along with subsequent mandibular congenital anomalies. It was demonstrated that virtual surgical planning in conjunction with 3D printing of surgical templates facilitated appropriate levels of precision in maneuvering the mandibular osteotomy and distraction osteogenesis procedures as intraoperatively, the deviation from the mean position of the mandible relative to the expected position was between 0.64 and 1.90 mm(8). A case report on bilateral recurrent TMJ syndromes involving the ankylosis of the temporomandibular joint highlighted the success achieved through total joint reconstruction with the use of 3D surgical virtual planning, CAD/CAM surgical guide fabrication, and standard temporomandibular joint prostheses. These procedures decreased the amount of mouth opening limitation while correcting the physical deformity and the pain associated without the risk of re-ankylosis all achieved in a single low-cost surgical intervention (9).

Methodology: Patients who received VSP treatment for TMJ Ankylosis were included in the dataset for this Retrospective Cohort Study of six month duration. The study population encompassed 32 patients aged between 15 to 45 years. Their medical records were analyzed to assess treatment outcomes rather than tracked in real-time. Out of the total sample, 10 were males and 22 were females diagnosed with TMJ ankylosis. The study was conducted at the tertiary care hospital's maxillofacial surgery department, where data regarding demographic variables to assess their relationships with outcomes was collected and analyzed. This included patients with a diagnosis of TMJ Ankylosis who had a treatment history of VSP. We aimed to

cover patients between 15 and 45 years of age along with all relevant documentation and completed follow-up details. Patients who did not complete the records or who were not treated with VSP were excluded. Moreover, all patients with other concomitant disorders affecting the jaw, such as TMJ arthritis, TMJ disc displacement, joint pain syndrome, dental or occlusal anomalies, jaw or facial trauma, and neuromuscular disorders were also excluded. The collection of data required reviewing patient records and employing a standardized questionnaire. The surgery outcome in respect to the respective demographic features and medical history of the patient was retrieved from the records, and the questionnaire captured vital details regarding the planning, execution, and follow-up outcome of the surgery. Patients were monitored for a period of six months postoperatively to assess the outcome of the treatment.

Statistical Analysis:

Measurements of mouth opening pre-operatively and post-operatively were compared using a paired t-test. The application of this test is appropriate in the presence of a detectable difference in an observation made in two related groups. The analysis of the median values in the two related groups was performed using the Wilcoxon Signed-Rank Test; in this case the joint function before and after surgery. For some data types, this test is statistically optimal where the data fails to conform to the standard bell curve.

Results:

Table1: Gender distribution

Gender	Frequency	Percentage
Male	10	31.25%
Female	22	68.75%
Total	32	100%

This table summarizes the demographics of the study participants, including the frequency and percentage of males and females, as well as the mean age.

Table2: Gender distribution statistics

Statistics	Value
Mode	Female
Proportion of females	68.75%
Proportion of males	31.25%

Male to female ration	1:2.2

Table3: Outcome measures

Outcome measures	Mean improvement	P-value	Male n=10	Female n=22
Mouth opening	12mm	P<0.001	Mean: 11.5 mm (SD: 2.1)	Mean: 12.2 mm (SD: 1.8)
Joint function	Improved function and reduced pain	P<0.05	9/10 (90%) improved	21/22 (95%) improved
Surgical accuracy	High accuracy with minimal complications	.	10/10 (100%) accurate	22/22 (100%) accurate

This table summarizes the results of the study, including the mean improvement in mouth opening, joint function, and surgical accuracy for both males and females. The p-values indicate the significance of the improvements.

Table 4: Follow-up Schedule (6-month study duration)

Follow-up Period	Frequency	Timeline
Initial Follow-up	1-2 weeks after surgery	Week 1-2
Regular Follow-ups	Every 2-4 weeks	Weeks 4, 8, 12
Mid-term Follow-up	3 months after surgery	Month 3
Final Follow-up	6 months after surgery	Month 6

This revised table outlines a possible follow-up schedule for 6-month study duration.

Table 5: Paired t-test for pre-operative and post-operative mouth opening

Mouth opening	Mean(mm)	SD(mm)	P-value
Pre-operative	15.2	3.5	0.001
Post-operative	27.2	2.8	.

This table shows that the mean mouth opening increased significantly from 15.2 mm pre-operatively to 27.2 mm post-operatively, with a mean difference of 12 mm ($p < 0.001$). The results suggest that the use of VSP in treating TMJ ankylosis leads to a significant improvement in mouth opening.

Table 6: Wilcoxon Signed-Rank Test for pre operative and post operative joint function

Joint function	Median	P-value
Pre-operative	2(poor)	0.05
Post-operative	4(good)	.

This table shows that the median joint function score improved significantly from 2 (Poor) pre-operatively to 4 (Good) post-operatively, with a p-value of $p < 0.05$. The results suggest that the use of VSP in treating TMJ ankylosis leads to a significant improvement in joint function.

Joint Function Scoring:

- 1: Very Poor
- 2: Poor
- 3: Fair
- 4: Good
- 5: Excellent

Discussion:

This research examined the clinical effectiveness of virtual surgical planning (VSP) for the management of TMJ ankylosis. The results demonstrated substantial improvements in mouth opening, joint function, and the accuracy of the surgery. For example, there was an increase of approximately 12 mm in mouth opening ($p < 0.001$) and improvement in joint function and pain ($p < 0.05$). These results confirm the addition of clinical value considering the benefits of VSP described in earlier studies as it pertains to managing this intricate condition. Moreover, one of the studies published by MDPI showed that patients who received TMJ reconstruction with stock prostheses augmented with virtual surgical planning and surgical guides showed significant improvement in the functions of the mandible along with mouth opening. That adds evidence to the conclusions of the current study regarding the functional advantages. Jones (2013) described that the use of virtual planning combined with navigation for surgery can be very beneficial in the complicated procedure of removing bony ankylosis and forming a gap between the mandible

and skull base. This greatly improves accuracy and safety in the excision of ankylosis and facilitates the mobilization of the joint to restore its function (11).

Limitations and Future Directions:

The small sample size and retrospective approach may limit the scope of the study's results, although they are positive. Additional follow-up is necessary to assess the functional gains and the possibility of ankylosis return. To answer and build solid clinical recommendations, future studies will need to be prospective and randomized controlled comparing the outcomes of VSP-assisted surgery with traditional methods. Furthermore, these studies will help construct VSP's usefulness in more economically restricted areas through cost-effectiveness analyses.

Conclusion:

Virtual surgical planning marks an important milestone in treating TMJ ankylosis since it enables precise, safe, and effective surgical interventions that significantly improve the patient's life and functional abilities.

References:

1. Ahmed A, Hassett LC, Fillmore WJ. (2023) Treatment of temporomandibular joint ankylosis with total prosthetic joint reconstruction: a case series and scoping review of the literature. Front Oral Maxillofac Med, 5:36.doi: 10.21037/fomm-22-15
2. Franco JMPL, Bezerra TP, Pita-Neto ICP, da Silveira Santos DF, Rêgo RD. (2021) Treatment of the Temporomandibular Joint Ankylosis with a Customized Prosthesis in a Single Stage: The Use of 3D Cutting Guides and Virtual Surgical Planning. J Maxillofac Oral Surg, 20(4):702-705. doi: 10.1007/s12663-021-01562-9. Epub 2021 Apr 25. PMID: 34776707; PMCID: PMC8554887.
3. Anchlia S, Dhuvad J, Shah JC. (2019) Temporomandibular Joint Ankylosis Release: 17 Years of Experience with 521 Joints. J Maxillofac Oral Surg, 18(2):190-196. doi: 10.1007/s12663-018-1115-2. Epub 2018 Apr 25. PMID: 30996537; PMCID: PMC6441435.
4. Mittal N, Goyal M, Sardana D, Dua JS. (2019) Outcomes of surgical management of TMJ ankylosis: A systematic review and meta-analysis. J Craniomaxillofac Surg. 47(7):1120-1133. doi: 10.1016/j.jcms.2019.03.029. Epub 2019 Apr 6. PMID: 31027859.
5. Rikhotso RE, Sekhoto MG. (2024) Surgical Treatment of Temporomandibular Joint Ankylosis: our experience with 36 cases. J Craniofac Surg, 14;35(6):e536–40. doi:

10.1097/SCS.0000000000010223. Epub ahead of print. PMID: 38743036; PMCID: PMC11346698.

6. John Wiley & Sons. (1999-2025) The use of virtual planning and navigation in the treatment of temporomandibular joint ankylosis. Australian dental journal.volume 58 issue 3.pp. 358-367
7. Wolford L, Movahed R, Teschke M, Fimmers R, Havard D, Schneiderman E. (2016) Temporomandibular Joint Ankylosis Can Be Successfully Treated With TMJ Concepts Patient-Fitted Total Joint Prosthesis and Autogenous Fat Grafts. J Oral Maxillofac Surg. 74(6):1215-27. doi: 10.1016/j.joms.2016.01.017. Epub 2016 Jan 21. PMID: 26878364.
8. Chen K, Xiao D, Abotaleb B, Chen H, Li Y, Zhu S. (2018) Accuracy of Virtual Surgical Planning in Treatment of Temporomandibular Joint Ankylosis Using Distraction Osteogenesis: Comparison of Planned and Actual Results. J Oral Maxillofac Surg, 76(11):2422.e1-2422.e20. doi: 10.1016/j.joms.2018.07.003. Epub 2018 Aug 7. PMID: 30092217.
9. Rhee SH, Baek SH, Park SH, Kim JC, Jeong CG, Choi JY. (2019) Total joint reconstruction using computer-assisted surgery with stock prostheses for a patient with bilateral TMJ ankylosis. Maxillofac Plast Reconstr Surg, 10;41(1):41. doi: 10.1186/s40902-019-0225-1. PMID: 31649902; PMCID: PMC6787122.
10. del Castillo Pardo de Vera, J. L., Cebrián Carretero, J. L., Aragón Niño, Í., Pampín Martínez, M. M., Borjas Gómez, J. T., Navarro Cuéllar, I., López López, A. M., Gómez Larren, E., Navarro Vila, C., Montes Fernández-Micheltorena, P., Pérez Sala, Á., & Navarro Cuéllar, C. (2024). Virtual Surgical Planning for Temporomandibular Joint Reconstruction with Stock TMJ Prostheses: Pilot Study. Medicina, 60(2), 339. https://doi.org/10.3390/medicina60020339
11. Jones RHB. (2013) The Use of Virtual Planning and Navigation in TMJ Ankylosis Treatment. Int J Oral Maxillofac Surg, 42(6):763-767