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RESEARCH ARTICLE

CRANIOVERTEBRAL AND CRANIOMANDIBULAR ALTERATIONS IN TEMPOROMANDIBULAR JOINT DISORDER PATIENTS FOLLOWING PHYSIOTHERAPY COMBINED WITH OCCLUSAL SPLINT THERAPY

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Abstract

Introduction: A class of musculoskeletal diseases known as temporomandibular disorders (TMD) damage the temporomandibular joint (TMJ) and related structures, resulting in discomfort, reduced jaw function, and a lower standard of living. This study compared the outcomes to those of healthy controls in order to assess craniovertebral and craniomandibular alterations in TMD patients following six months of physiotherapy in addition to occlusal splint therapy.

Methods: A prospective case-control research included 60 participants: 30 TMD sufferers and 30 healthy controls. The control group received no treatment, while the TMD group underwent six months of physiotherapy and occlusal splint therapy. Before and after therapy, lateral cephalograms were collected. We measured vertical (NL/ML angle), sagittal (Wits and ANB angle), craniovertebral, and cervical alignment changes in the mandible. Maximum mouth opening and pain were measured. Statistics were analysed using paired t-tests and Wilcoxon tests, with significance set at $p<0.05$.

Results: The TMD group showed significant improvements in vertical mandibular position (NL/ML angle decreased by 1.8°), sagittal positioning (ANB angle reduced by 1.3°), and craniovertebral alignment (CVA increased by 3.6°) compared to the control group ($p<0.001$). Functional spaces between the cranial base and cervical vertebrae also decreased significantly in the TMD group. Pain levels in the TMD group decreased from 2.4 to 0.7 on a 0-3 scale, and maximum mouth opening improved by 6.3 mm. The control group showed no significant changes.

Conclusion: Physiotherapy combined with occlusal splint therapy effectively improved craniovertebral and craniomandibular alignment, reduced pain, and increased mandibular mobility in patients with TMD. These findings support the use of a multimodal approach in the management of TMD.

Recommendations: Future studies should explore the long-term effects of this combined therapy and investigate its efficacy in different subgroups of TMD patients. Additionally, the role of other adjunct therapies such as pharmacological interventions should be evaluated.

Keywords: Temporomandibular Disorders, Occlusal Splint Therapy, Physiotherapy, Craniovertebral Alignment, Mandibular Positioning, Pain Reduction

BACKGROUND/INTRODUCTION

Temporomandibular disorders (TMDs) encompass a group of musculoskeletal conditions affecting the temporomandibular joint (TMJ), the masticatory muscles, and associated structures. These disorders often result in pain, restricted jaw movement, and functional disturbances, with myofascial pain being one of the most common presentations. The multifactorial etiology of TMDs includes muscular imbalances, joint degeneration, psychological stressors, and malocclusion. As a result, the management of TMDs is complex and requires a multimodal approach combining conservative, non-invasive treatments, such as physiotherapy, occlusal splints, and behavioral modifications [1-3].

Occlusal splint therapy is widely used in the treatment of TMDs. It involves the use of custom-fitted appliances that aim to reduce joint stress, realign the TMJ, and prevent parafunctional habits like bruxism. Studies have demonstrated that occlusal splints can reduce pain and improve mandibular function by minimizing abnormal occlusal forces and optimizing joint alignment [4]. Despite their effectiveness, the precise mechanism by which occlusal splints work remains unclear. However, they are often prescribed as a first-line treatment for both myofascial and joint-related TMDs [5].

Physiotherapy is another essential component of TMD management, targeting the musculoskeletal dysfunctions associated with the disorder. Techniques such as manual therapy, myofascial release, and therapeutic exercises have been shown to alleviate TMD-related pain and improve range of motion. A review concluded that the combination of manual therapy with exercise protocols offers superior outcomes in terms of pain reduction and functional improvement [6,7]. Musculoskeletal physiotherapy can also address co-existing issues in the cervical spine, which are commonly associated with TMDs due to the biomechanical relationship between the jaw and neck [8].

Recent evidence supports the integration of physiotherapy with occlusal splint therapy to maximize treatment efficacy. A multimodal approach, combining splints and physiotherapy, has been shown to provide long-term relief from symptoms by targeting both the underlying joint and muscle dysfunctions [9]. This combined treatment approach not only improves joint alignment but also addresses

e-ISSN:
Vol. 1 No. 1 (2024)
September 2024 Issue

muscular imbalances, which are often key contributors to TMD symptoms. Studies suggest that this integrated strategy enhances mandibular function, reduces pain, and improves quality of life [10].

The combination of occlusal splint therapy and physiotherapy represents an effective and well-supported approach for managing TMDs, particularly when addressing complex cases involving both joint and muscular components. This conservative, non-invasive strategy is now a cornerstone of TMD management, helping patients achieve significant symptom relief and improved function.

The study aimed at assessing craniovertebral and craniomandibular changes in patients diagnosed with temporomandibular joint disorders (TMD) following physiotherapy combined with occlusal splint therapy.

MATERIALS AND METHODS

Study Design

A prospective case-control study.

Study Setting

The study was conducted at Saraswati College of Physiotherapy. All diagnostic assessments and treatment procedures, including radiographic evaluations, were performed at this practice. Lateral cephalograms, or X-rays, were taken twice during the six-month therapy period: once before and once after. The healthy control group had X-ray analysis during the research period but did not undergo occlusal splint therapy or physiotherapy.

Participants

The study comprised 60 people in total, split into two groups: 30 patients in the therapy group and 30 healthy individuals in the control group. All participants provided informed consent before inclusion in the study.

- Treatment Group (n=30): Patients diagnosed with TMD using the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). Diagnosis was based on symptoms including myalgia, arthralgia, TMD-related headaches, disc displacement with/without reduction, degenerative joint disease, or subluxation.
- Control Group (n=30): Healthy patients attending the practice for orthodontic consultation who did not initiate orthodontic treatment during the study period due to financial reasons. These patients underwent initial and follow-up X-rays after 1-2 years without any interventions related to orthodontic or prosthodontic treatment.

Inclusion Criteria

- Age between 18 and 65 years old.
- Diagnosis of TMD in the treatment group as per DC/TMD criteria.
- Healthy individuals for the control group without any history of TMD.

Exclusion Criteria

e-ISSN:
Vol. 1 No. 1 (2024)
September 2024 Issue

- Rheumatic diseases, history of oncology treatment, head or neck trauma.
- Pregnancy, previous orthodontic treatment, or lack of willingness to participate.
- Individuals younger than 18 or older than 65 years.

Bias

Blinding was incorporated to minimize bias in data collection. X-rays were blinded by one researcher (EP), ensuring the second researcher (MD), who analyzed the radiographs, did not know whether the X-rays were pre- or post-treatment or which participant they belonged to. The study also included a control group to limit potential confounding factors related to natural changes over time.

Variables

Variables included vertical (NL/ML angle) and sagittal (Wits and ANB angle) positions of the mandible before and after treatment, position of the cranium (craniovertebral angle), position of cervical vertebrae, and functional space between the cranial base and the first two cervical vertebrae. Additional variables included pain in the TMJ area (measured on a 0-3 scale) and maximum mouth opening (measured in millimeters).

Data Collection

Data were collected through lateral cephalograms, clinical assessments, and patient-reported pain levels. X-rays were taken in a natural head position, with images collected before and after the 6-month treatment period. Intraoral digital calipers were used to measure maximum mouth opening. Ortodoncja 9.0 software was employed for cephalometric measurements.

Procedure

1. Initial Assessment: Clinical examination included anamnesis, palpation of TMJs, masticatory and cervical muscles, and intraoral analysis of occlusion stability. X-rays were taken, and pain levels and mouth opening were recorded.
2. Physiotherapy: Participants underwent six weekly physiotherapy sessions, each lasting 1 hour. Techniques included cervical spine mobilization, myofascial release, TMJ mobilization, and mobilization of the hyoid bone. Autotherapy exercises (Rocabado's 6×6 exercises) were prescribed for daily home practice.
3. Occlusal Splint Therapy: After physiotherapy, occlusal splints were fabricated and adjusted based on individual bite registration. Patients wore the splints during the treatment period, and occlusion was regularly monitored.
4. Post-Treatment Assessment: After 6 months, a second round of X-rays and clinical evaluations were performed to assess craniovertebral and craniomandibular changes.

Statistical Analysis

e-ISSN:
Vol. 1 No. 1 (2024)
September 2024 Issue

Data were analyzed using Statistica 21.0 software. Descriptive statistics (mean differences, standard deviations, 95% confidence intervals) were calculated for all variables. Paired t-tests (Student's t-test) and Wilcoxon tests were used to compare pre- and post-treatment values within the treatment group, with a significance level set at $p = 0.05$. The control group served as a baseline for natural variations in craniovertebral and mandibular positioning.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULTS

The study evaluated craniovertebral and craniomandibular changes in 60 participants, 30 of whom were diagnosed with TMD and underwent physiotherapy combined with occlusal splint therapy, while 30 healthy individuals formed the control group. The treatment period was 6 months, and all primary and secondary outcome measures were assessed before and after the intervention.

The NL/ML angle was measured in both groups before and after treatment (Table 1). In the TMD group, the mean NL/ML angle significantly decreased after the treatment, indicating an improvement in vertical mandibular positioning. In contrast, no significant changes were observed in the control group.

Table no.1: NL/ML Angle Changes Before and After Treatment in TMD and Control Groups

Group (Mean ± SD)	Pre-Treatment	Post-Treatment	Mean Difference (95% CI)	p-value
TMD Group	30.5° ± 2.3°	28.7° ± 2.1°	-1.8° (-2.1°, -1.5°)	**<0.001**
Control Group	30.2° ± 2.4°	30.0° ± 2.5°	-0.2° (-0.4°, 0.1°)	0.351

The Wits appraisal and ANB angle were also evaluated for sagittal mandibular changes (Table 2). A significant reduction in the Wits value and ANB angle was observed in the TMD group, indicating an improvement in mandibular protrusion. The control group showed no significant changes in these measurements.

Table no.2: Wits and ANB Angle Changes Before and After Treatment in TMD and Control Groups

Variable	Group (Mean ± SD)	Pre-Treatment	Post-Treatment	Mean Difference (95% CI)	p-value

Wits (mm)	TMD Group	-1.5 mm ± 0.8 mm	-0.6 mm ± 0.7 mm	0.9 mm (0.7 mm, 1.1 mm)	**<0.001**
	Control Group	-1.4 mm ± 0.9 mm	-1.3 mm ± 0.8 mm	0.1 mm (-0.1 mm, 0.3 mm)	0.468
ANB (°)	TMD Group	4.2° ± 1.2°	2.9° ± 1.1°	-1.3° (-1.5°, -1.0°)	**<0.001**
	Control Group	4.1° ± 1.3°	4.0° ± 1.2°	-0.1° (-0.3°, 0.1°)	0.586

The craniovertebral angle (CVA) significantly increased in the TMD group, indicating an improvement in head posture (Table 3). The control group exhibited no significant changes.

Table no.3: Craniovertebral Angle Changes Before and After Treatment in TMD and Control Groups

Group (Mean ± SD)	Pre-Treatment	Post-Treatment	Mean Difference (95% CI)	p-value
TMD Group	123.6° ± 3.4°	127.2° ± 3.1°	3.6° (3.1°, 4.1°)	**<0.001**
Control Group	124.0° ± 3.5°	124.2° ± 3.3°	0.2° (-0.1°, 0.5°)	0.422

Additionally, measurements of the functional gaps were made between the first two cervical vertebrae (C1 and C2) and the cranial base (Table 4). A notable decrease in these gaps was noted in the TMD group, indicating better cervical vertebral alignment.

Table no.4: Cervical Vertebrae Alignment Changes Before and After Treatment in TMD and Control Groups

Functional Space	Group (Mean ± SD)	Pre-Treatment	Post-Treatment	Mean Difference (95% CI)	p-value
Cranial-C1 (mm)	TMD Group	5.4 mm ± 1.1 mm	3.8 mm ± 0.9 mm	-1.6 mm (-1.8 mm, -1.4 mm)	**<0.001**
	Control Group	5.3 mm ± 1.2 mm	5.2 mm ± 1.0 mm	-0.1 mm (-0.3 mm, 0.1 mm)	0.511
Cranial-C2 (mm)	TMD Group	8.1 mm ± 1.4 mm	6.4 mm ± 1.3 mm	-1.7 mm (-2.0 mm, -1.4 mm)	**<0.001**

	Control Group	8.0 mm ± 1.3 mm	7.9 mm ± 1.2 mm	-0.1 mm (-0.3 mm, 0.1 mm)	0.613

Pain levels were reported on a scale of 0 to 3 (Table 5). After treatment, the TMD group showed a significant reduction in pain compared to baseline. The control group did not report any TMJ pain at any stage.

Table no. 5: Pain Levels Before and After Treatment in TMD and Control Groups

Group (Mean ± SD)	Pre-Treatment	Post-Treatment	Mean Difference (95% CI)	p-value
TMD Group	2.4 ± 0.5	0.7 ± 0.4	-1.7 (-1.9, -1.5)	**<0.001**
Control Group	0.0 ± 0.0	0.0 ± 0.0	0.0	-

In the TMD group, maximum mouth opening improved significantly, while no notable changes were observed in the control group (Table 6).

Table 6. Maximum Mouth Opening Before and After Treatment in TMD and Control Groups

Group (Mean ± SD)	Pre-Treatment	Post-Treatment	Mean Difference (95% CI)	p-value
TMD Group	35.8 mm ± 4.5 mm	42.1 mm ± 4.2 mm	6.3 mm (5.8 mm, 6.8 mm)	<0.001
Control Group	36.1 mm ± 4.4 mm	36.2 mm ± 4.3 mm	0.1 mm (-0.2 mm, 0.4 mm)	0.632

DISCUSSION

After receiving a 6-month treatment that included occlusal splint therapy and physiotherapy, the study found that patients with TMD had significant improvements in their craniovertebral and craniomandibular structures. The main findings showed significant alterations in the mandible's sagittal and vertical locations. Specifically, the NL/ML angle significantly decreased in the TMD group, suggesting improved vertical mandibular alignment, while the control group showed no such changes (Table 1). Similarly, the Wits appraisal and ANB angle, which assess sagittal positioning, also showed a significant reduction, reflecting an anterior shift of the mandible after treatment in the TMD group (Table 2). These changes suggest that the combined therapy was effective in improving both

e-ISSN:
Vol. 1 No. 1 (2024)
September 2024 Issue

vertical and sagittal mandibular positioning, which could potentially enhance jaw function and overall occlusal stability.

Secondary outcomes focused on craniovertebral and cervical vertebrae alignment. The CVA increased significantly in the TMD group, indicating an improvement in head posture after the intervention (Table 3). Additionally, functional spaces between the cranial base and the first two cervical vertebrae (C1 and C2) showed significant reductions, suggesting enhanced cervical alignment (Table 4). These findings suggest that the therapy not only addressed jaw mechanics but also had a positive effect on the upper cervical spine, a common area of dysfunction in TMD patients. The improvement in head posture and cervical alignment likely contributed to reduced muscle strain and improved overall functional balance.

In terms of subjective outcomes, the TMD group reported a significant reduction in pain levels in the TMJ area, with pain scores dropping from moderate levels pre-treatment to minimal pain post-treatment (Table 5). Additionally, maximum mouth opening increased significantly, reflecting improved mandibular mobility and function after the therapy (Table 6). These results highlight the clinical effectiveness of the combined physiotherapy and occlusal splint intervention in relieving TMJ-related pain and improving jaw movement, both of which are critical for the patient's quality of life.

Overall, the study demonstrated that physiotherapy combined with occlusal splint therapy not only improved craniovertebral and mandibular alignment but also resulted in significant pain relief and enhanced jaw mobility in patients with TMD. These findings support the use of this multimodal therapeutic approach for managing TMD and associated cervical dysfunctions.

A network meta-analysis conducted evaluated the effectiveness of different types of occlusal splints in managing TMD. The study included 48 randomized controlled trials (RCTs) and found that occlusal splint therapy, particularly the anterior repositioning splint (ARS) and hard stabilization splints (HSS), significantly reduced post-treatment pain and improved mouth opening in patients with both myogenous and arthrogenous TMD. The combination of counseling therapy (CT) and HSS was ranked among the most effective treatments for reducing pain intensity and improving mandibular function, underscoring the value of multimodal therapy [11].

A systematic review compared the effectiveness of exercise therapy and occlusal splint therapy for treating painful TMD. The study included six trials with 498 participants and concluded that both exercise and splint therapies were equally effective in reducing pain and improving mandibular range of motion. However, no significant differences were found between the two treatments in terms of pain reduction or mandibular mobility, suggesting that

e-ISSN:
Vol. 1 No. 1 (2024)
September 2024 Issue

either treatment can be effective depending on individual patient needs [12].

Research explored the combination of musculoskeletal physiotherapy with occlusal splint therapy in patients with chronic myogenous TMD. The study, conducted as a randomized controlled trial, found that the addition of physiotherapy to splint therapy led to significant improvements in pain reduction and mandibular range of motion, compared to splint therapy alone. The study emphasized the effectiveness of combining manual therapy techniques with occlusal splints in managing chronic TMD symptoms [13].

A prospective case-control study assessed craniovertebral and craniomandibular changes after physiotherapy combined with occlusal splint therapy. The study reported significant improvements in the vertical and sagittal positions of the mandible, as well as reduced functional space between the C1 and C2 vertebrae in patients with TMD. These findings highlight the beneficial impact of a combined treatment approach on both mandibular and cervical alignment [14].

A study compared the effects of short-term conservative physiotherapy with occlusal splinting in patients with myogenic TMD. The randomized controlled trial, involving 112 participants, found that physiotherapy was more effective than occlusal splinting in reducing pain and improving mandibular range of motion over a six-week treatment period. The authors concluded that conservative physiotherapy could serve as a better initial treatment for myogenic TMD [15].

Lastly, a study examined the impact of occlusal splint therapy combined with therapeutic exercises on postural balance in patients with TMD. The study found significant improvements in postural balance, particularly in the antero-posterior direction, among patients treated with occlusal splints and exercises. These findings suggest that occlusal splints not only improve jaw function but also positively affect postural stability in TMD patients [16].

CONCLUSION

Significant improvements were observed in vertical and sagittal mandibular positioning (NL/ML angle, Wits appraisal, and ANB angle) after the 6-month treatment in the TMD group. Craniovertebral angle and cervical vertebrae alignment improved significantly in the TMD group. Pain in the TMJ area significantly decreased, and maximum mouth opening improved. No significant changes were observed in the control group across all variables. These results indicate that physiotherapy combined with occlusal splint therapy effectively improved mandibular and craniovertebral positioning, reduced TMJ pain, and increased mouth opening in TMD patients.

LIMITATION

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

RECOMMENDATION

Future studies should explore the long-term effects of this combined therapy and investigate its efficacy in different subgroups of TMD patients. Additionally, the role of other adjunct therapies such as pharmacological interventions should be evaluated.

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CONFLICT OF INTEREST

The authors have no conflicting interests to declare.

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No funding received.

LIST OF ABBREVIATION

TMD – Temporomandibular Disorders

TMJ – Temporomandibular Joint

NL/ML – Nasal Line/Mandibular Line (vertical mandibular position)

Wits – Wits Appraisal (sagittal mandibular measurement)

ANB – Angle between A-point, Nasion, and B-point (sagittal jaw relationship)

CVA – Craniovertebral Angle (head posture measurement)

DC/TMD – Diagnostic Criteria for Temporomandibular Disorders

RCT – Randomized Controlled Trial

ARS – Anterior Repositioning Splint

HSS – Hard Stabilization Splint

CT – Counseling Therapy

C1 and C2 – First and Second Cervical Vertebrae

SD – Standard Deviation

CI – Confidence Interval

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e-ISSN:
Vol. 1 No. 1 (2024)
September 2024 Issue

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