

## Immediate effect of proprioceptive neuromuscular facilitation on pain and maximal mouth opening in temporomandibular dysfunction: A pilot study

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**Objective:** To evaluate the immediate effect of proprioceptive neuromuscular facilitation (PNF) exercises on pain and maximal mouth opening in individuals with temporomandibular disorder (TMD).

**Methodology:** This prospective, quasi experimental pilot study included nine female individuals between the age of 18 to 25 who were diagnosed with TMD by Research Diagnostic criteria for Temporomandibular Disorder (TMD/RDC). PNF exercises were performed for a session with 30 minutes using neck, jaw and tongue patterns with rhythmic stabilization (RS) and combination of isotonic (CI) techniques. Maximal mouth openings were measured with caliper, pain intensities were measured with visual analogue scale

and pressure pain thresholds by hand algometer.

**Results:** After PNF application, maximally assisted opening and pain threshold increased, and pain intensity decreased significantly ( $p < 0.05$ ). PNF had a positive effect on all measurements.

**Conclusion:** PNF exercises increased mouth opening, increased the pressure pain threshold, and decreased pain intensity immediately in individuals with TMD. In TMD, PNF exercises are seen as one of the options that can be used to increase mouth opening and reduce pain.

**Keywords:** Orofacial pain, temporomandibular joint disorders, therapeutic, pain threshold.

## INTRODUCTION

Temporomandibular dysfunction (TMD) is a uniterm containing all problems related to the temporomandibular joint (TMJ) and musculoskeletal system, which is characterized by limited mandibular movements and pain.<sup>1,2</sup> Pain mostly affects the neck region and causes the misalignment, especially in unilateral TMJ disorders.<sup>3</sup> For treatment, nonsurgical approaches such as pharmaceuticals, occlusal splints, physiotherapy, manual treatment and manual therapy can be used. Exercise is the main physiotherapy approach and there are TMD specific exercises such as Rocabado and Goldfish exercises.<sup>2-4</sup> However, PNF application, which is a different exercise method, has not been used for TMD until now.

Proprioceptive Neuromuscular Facilitation (PNF) was designed for the individuals who have pain due to paralyzed muscles. In this method, the movements of the body are made easier by the contractions with diagonal movements of limbs and body, thus improving the functions of the patients.<sup>5</sup> PNF causes contraction in the strong part of the body by using manual resistance in order to move a weak body part painlessly. Techniques are used in musculoskeletal rehabilitation to indirectly decrease pain, to improve function and increase joint range of motion (ROM).<sup>6,7</sup> Rhythmic stabilization (RS) is one of the original PNF techniques which is characterized by isometric contractions in different

directions against manually provided resistance, while the resistance direction is changed, the obeyed individual tries to maintain the position.<sup>8</sup> Increasing ROM passive/active, muscle strength, balance and stability and decreasing pain are among its purposes.<sup>8,9</sup> Combination of Isotonic (CI) is another PNF technique used in order to increase movement ability. It contains eccentric, concentric, isometric contractions and is used for the treatment of the strength inadequacy and lack of ROM.<sup>10</sup> Therefore, in this study we investigated the immediate effect of previously unapplied PNF exercises on pain and maximum mouth opening levels in individuals with TMD.

## METHODOLOGY

We carried out a single center, prospective, quasi experimental study and was approved by University Non-Interventional Clinical Research Ethics Committee (Letter No: 10840098-604.01.01-E.60748). All procedures followed were in accordance with the ethical standards of Helsinki Declaration. Informed consent was obtained from all participants. Thirty – two females between 18 to 25 years old who came to us with one or more TMD symptoms such as clenching, grinding, joint sounds, jaw pain when eating a solid diet, limited jaw movements and painful movements were evaluated for the presence of TMD by a dentist. The diagnosis and classification of temporomandibular dysfunction was

done by “Temporomandibular Dysfunction Research Diagnostic Criteria” (TMD/RDC) survey-based evaluation method.<sup>11</sup>

During the examination process, 9 of 32 females were diagnosed with disc displacement with reduction and myofascial trigger points who have restricted mouth opening and were included in the study. The exclusion criteria were as follows: Having orthopedic, neurological or hematological cervical disorders which may affect the jaw; receiving occlusal treatment, an operation history in the jaw and related structures and those with vertigo that prevents head movements during exercises.

Primary outcome measure was maximal mouth openings and secondary was pain intensity and pain pressure threshold. Maximal mouth openings were measured with analog caliper rule, pain intensity was measured with Visual Analogue Scale (VAS) and pressure pain thresholds with hand-held pressure algometer. All these evaluations were taken at baseline and immediately after exercises.

In the baseline evaluation, participants were asked to rate the severity of pain felt in the TMJ and related muscles with the VAS which was divided to 10 equal intervals. Pressure pain threshold was measured by the physiotherapist with the hand algometer (Baseline FDK, Wagner Instruments, Greenwich) over the m.temporalis, m. masseter, m.sternocleidomastoideus (SCM) and m.trapezius. Unassisted, maximum unassisted, maximum assisted mouth openings were measured with the analog caliper at the endpoint of the mouth opening motion.

First diagonal movement is flexion-right rotation-right lateral flexion, and extension-left rotation-left lateral flexion, the second diagonal is flexion-left rotation-left lateral flexion and extension – right rotation-right lateral flexion of the head and neck patterns of PNF were applied. In both diagonals, mouth opening, mandibular retrusion, tongue elevation with neck flexion and mouth closing, mandibular protraction, tongue depression with extension were performed. All of these patterns were applied using techniques of RS and CI. Individuals with TMD were initially taught exercises with rhythmic initiation and 15 repetitions were applied as warm-up period before techniques were applied.

**Statistical Analysis:** The data were analyzed using SPSS version 22. One-sample Kolmogorov test was performed for normality. Since the data did not show normal distribution, Wilcoxon test was used to determine the difference between pre- and post-treatment evaluation in the same group ( $p < 0.05$ ) was considered significant.

## RESULTS

Nine females participated in PNF exercises. Demographic characteristics are shown in Table 1. Maximally assisted mouth opening values increased significantly compared to baseline values ( $p < 0.05$ ). There was no statistically significant difference between painless unassisted mouth opening and maximal unassisted mouth opening amounts ( $p > 0.05$ ) (Table 2).

**Table 1: Demographic information of individuals.**

Variable	Min	Max	M ± SE
Age (year)	18,00	25,00	20,20 ± 1,65
Height (cm)	158,00	178,00	166,53 ± 5,24
Weight (kg)	43,00	95,00	56,42 ± 9,55
BMI (kg/m <sup>2</sup> )	16,26	33,66	20,32 ± 3,11

Left temporalis, right-left masseter, left SCM, right-left trapezius pain threshold values showed significant difference after exercise period ( $p < 0.05$ ). Pain values determined by VAS at post-term exercise also indicated a significant difference ( $p < 0.05$ ) (Table 2).

## DISCUSSION

Only women were included in this study, since it is observed in the literature that TMD is 4 – 6 times more frequently in females. Okeson et al reported that TMD may result abnormal alignment or deformation of the neck.<sup>12</sup> This argument supports Janda’s approach that when an injury occurs in the musculoskeletal system, it inflicts structural damage to the surrounding tissues.<sup>13</sup> TMD has multifactorial etiology. De Wijer et al suggested that it is necessary to evaluate and treat the cervical region in addition to the stomatognathic system.<sup>14</sup> Tongue movement may cause disruption in the TMJ and with the pull of the tongue, realigning the cervical spine with orofacial myofunctional therapy and relaxing the muscles surrounding the TMJ has been tried.<sup>15,16</sup> In a study involving 20 women with myofascial pain and mixed TMD, cervical mobilization and cervical exercises showed maximum mouth opening and pressure pain threshold on the masseter showed significant change.<sup>17</sup>

In another study involving 50 individuals with TMD, the cervical spine high-velocity, low-amplitude thrust (HVLAT) mobilization technique was applied and no significant change was found in mouth opening and pain in numerical analog scale.<sup>18</sup> The immediate effects of the mobilization or manipulation techniques applied to

**Table 2: Mouth opening, pain threshold and pain intensity assessment results and differences before and after PNF exercises.**

		Before PNF M ± SE	After PNF M ± SE	p
Mandibular Opening (mm) N = 9	Unassisted	34.26 ± 2.78	37.17 ± 2.48	0.120
	Maximal Unassisted	42.83 ± 3.15	45.00 ± 2.65	0.400
	Maximal Assisted	46.37 ± 3.03	48.37 ± 2.86	<b>0.035</b>
Pressure Pain Threshold (kg/cm <sup>2</sup> ) (N = 9)	R Temporalis	2.347±0.449	2.425 ± 0.268	0.157
	L Temporalis	2.562± 0.481	3.125± 0.446	<b>0.017</b>
	R Masseter	1.525 ± 0.328	1.662 ± 0.320	<b>0.017</b>
	L Masseter	1.650± 0.247	2.125±0.219	<b>0.026</b>
	R SCM	2.125± 0.295	2.056±0.249	0.497
	L SCM	1.875 ± 0.130	2.275± 0.139	<b>0.026</b>
	R Trapezius	2.581 ± 0.365	2.900± 0.293	<b>0.033</b>
	L Trapezius	2.700 ± 0.138	3.350±0.420	<b>0.011</b>
Pain intensity (N = 9)	VAS	4.37 ± 0.50	1.25 ± 0.41	<b>0.010</b>

L: Left, M: Mean, PNF: Proprioceptive Neuromuscular Facilitation, R: Right, SE: Standard Error  
SCM: Sternocleidomastoideus, VAS: Visual Analog Scale

the cervical region as a conventional management method are similar to the instant effects of the PNF application.

The philosophy of PNF is not only to address physical problems that cause pain or activity limitation in body structures and body functions, but also to use the holistic and positive approach to focus on improving activity level and body structures and body functions.<sup>19</sup>

Espejo-Antúnez et al. applied the hold-relax PNF technique to the hamstring muscle due to the limited number of manual therapy applied to the area for TMD. In both groups, significantly active mouth opening increased, pressure pain threshold and pain intensity decreased.<sup>20</sup> Lee et al, suggested that the 4 – week PNF program can be used to improve stability and mobility.<sup>21</sup> Long-term application, evaluation and follow-up process are recommended for future research. In addition, the sample size was small. The age range in this pilot study was very narrow. In order to continue our study in the young adult age group, we plan to conclude by including different age groups. Lastly, participants were self-selected volunteers, they may be more active and motivated for the treatment and its effect.

## CONCLUSION

We observed that 30 – minutes of upper cervical and masticatory muscle PNF exercises immediately increased the maximal mouth opening, reducing pain

and pain threshold. In TMD, PNF exercises are seen as an option that can be used.

### Author Contributions:

Conception and design: Gizem Ergezen, Esra Atilgan, Alaaddin Kilicaslan.  
Collection and assembly of data: Gizem Ergezen.

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Drafting of the article: Gizem Ergezen, Alaaddin Kilicaslan.

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