

ORIGINAL RESEARCH

IJPHY

EFFECTIVENESS OF ROCABADO'S TECHNIQUE FOR SUBJECTS WITH TEMPOROMANDIBULAR JOINT DYSFUNCTION – A SINGLE BLIND STUDY

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ABSTRACT

Background: A temporo-mandibular joint dysfunction or TMD is a group of conditions characterized by pain in the muscles of mastication, the temporo-mandibular joint or both. Rocabado has described techniques includes the Rocabado's manipulation and Rocabado's exercises which have both been individually advocated for treatment of TMD. The purpose of study is to determine the effectiveness of Rocabado's techniques on TMJ dysfunction symptoms, pain, TMJ Range of Motion (ROM) and jaw functional limitation for subjects with temporo-mandibular joint dysfunction with restricted mouth opening mobility.

Method: Pre to post test experimental study design, subjects with temporo-mandibular joint dysfunction randomized into two groups with 15 subjects into each group with total of 30 subjects in Study and control group, respectively. The study group received the Rocabado's technique which consisted of Rocabado's non-thrust TMJ manipulation and Rocabado's exercises along with conventional TMJ exercises and the control group received only conventional TMJ exercises. The exercises were performed for 6 times per each session, six times in a day, one session under supervision and remaining five sessions by the subject at home for 6 days in a week for duration of 2 weeks. The outcome measurements such as VAS for pain, TMJ ROM, Fonseca's questionnaire rating for TMJ dysfunction symptoms and jaw function limitation score (JFLS) was measured before and after two weeks of intervention.

Results: Comparative analysis, using Independent 't' test and Mann Whitney U- test found that the means of VAS, TMJ ROM, Fonseca's questionnaire and JFLS scores showed statistically significant difference ($p < 0.05$) when the pre-intervention means and post-intervention means were compared between two groups.

Conclusion: It is concluded that Rocabado's technique found to have statistically and clinically significant added effect with conventional TMJ exercises and showed greater percentage of improvements in reducing TMJ dysfunction symptoms, pain, jaw functional limitation and increasing TMJ ROM comparing with only conventional TMJ exercises in subjects with Temporomandibular joint dysfunction with restricted mouth opening mobility.

Key words: Temporo-mandibular joint dysfunction, Jaw pain, Jaw mobility, Rocabado's manipulation, Rocabado's exercises, Fonseca's questionnaire, TMJ exercises, Jaw function.

Received 29th January 2015, revised 02nd February 2015, accepted 04th February 2015



www.ijphy.org

DOI: 10.15621/ijphy/2015/v2i1/60050

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INTRODUCTION

A temporo-mandibular joint dysfunction or TMD is a term collectively used to describe a group of musculoskeletal condition occurring in the temporo-mandibular region. This condition is characterized by pain in the muscles of mastication, the temporo-mandibular joint (TMJ) or both.^{1, 2} TMD is prevalent in 20% to 85% of the population with an incidence of more in women (6.3%) than men (2.8%).^{3,4} Clinically significant TMD related jaw pain occurs in about 5% to 6% of the population; there is impaired mouth opening upto 23% and pain upto 19% of the population, it is most common in people in age group between 20 to 40 years. Symptoms associated with TMD are pain, locking of the joint, clicking/ popping or grating sounds associated with difficulty in opening and closing of the mouth, headache, reduced ROM of the TMJ joint. It is generally accepted that TMD have a multi-factorial etiology. Some researchers and clinicians emphasize more on joint dysfunction and others focus more on muscular problem. Functional relations with spine dysfunction need to be considered in the management of patients with TMD.

TMD has been extensively studied by Dr. Mariano Rocabado, developed 6 x 6 exercise program means 6 types of exercises, 6 repetitions of exercises and done 6 times in a day that has a significant importance in management of TMD.⁵ Rocabado's technique consists of non-thrust TMJ manipulation and Rocabado's exercises. The objective of the TMJ manipulation is to normalize the ROM and relieve the soft tissue tension in the entire region of the jaw, neck and head.⁶ Studies have found that Rocabado's non-thrust technique found to have a significant role in improvement of TMD by reducing pain and improving function. Rocabado 6 x 6 exercise program found to decrease pain and improve function of the masticator muscles, and correct forward head posture, restore joint mobility restriction, muscle length limitation, postural and functional limitations.^{7,8} The auto-mobilisation and 6x6 Rocabado's exercise protocol intervention for temporo-mandibular joint open lock found to improve neuromuscular control during activities involving extreme mouth opening. It was also found from the studies that these techniques improve neuro-muscular control during patient's self-limitation activities involving mouth opening, and prevented subsequent episode of open lock.⁹

As there are limited studies available on effectiveness of Rocabado's techniques in temporo-mandibular joint dysfunction; the present study was with a research question whether the Rocabado's technique does have an effect on

improving temporo-mandibular joint dysfunction symptoms, pain, TMJ ROM and jaw functional limitation for subjects with temporo-mandibular joint dysfunction. Hence, the purpose of the study is to find the effectiveness of Rocabado's techniques such as Rocabado's exercises with Rocabado's non-trust manipulation on TMD symptoms, pain, TMJ ROM and jaw functional limitation for subjects with temporo-mandibular joint dysfunction with restricted mouth opening mobility. It was hypothesised that there will be a significant effect of Rocabado's techniques on improving temporo-mandibular joint dysfunction symptoms, pain, TMJ ROM and jaw functional limitation for subjects with the temporo-mandibular joint dysfunction.

METHODOLOGY

An experimental study design with two groups- Study Group and Control Group. As this study involved human subjects the Ethical Clearance was obtained from the Ethical Committee of KTG College of Physiotherapy and K.T.G. Hospital, Bangalore as per the ethical guidelines for Biomedical research on human subjects. This study was registered with University registration No. 09_T031_47177. Subjects included were with clinical symptoms of TMD, pain over temporo-mandibular joint with more than two week of duration, spasm or tenderness in muscles of mastication, painful mouth opening and closing and limited mouth opening temporo-mandibular joint movement, age group between 20 to 40 years.⁹ Subjects excluded were with significant history of open dislocations,¹⁰ dental and orthodontic problems like occlusal abnormalities and trauma, dental prosthesis or using any functional appliances in their mouths (e.g.; dentures, braces) or prescribed and fitted within 12 weeks prior to their participation in the study, subjects receiving any other form of treatment for their TMJ dysfunction, systemic or local pathological conditions affecting TMJ function, history of jaw surgeries. Subjects were recruited from various rehabilitation centers and dental clinics across Bangalore. The study was conducted at KTG Multi Specialty Hospital, Bangalore. Subjects who meet inclusion criteria were recruited by Simple random sampling method using closed envelopes, randomly allocated subjects into two groups. Subjects who meet inclusion criteria were informed about the study and a written informed consent was taken. Total 30 Subject (n=30) 15 in each group who completed the study was considered for analysis. Subjects were blinded throughout the treatment sessions, subjects from both the groups were not allowed to have any interaction to each other and

the subjects were not aware of what kind of treatment they received and its effects. The duration of intervention was carried for 2 weeks.

Procedure of Intervention for Study Group:

Subjects in this group received the Rocabado's technique which consisted of Rocabado's non-thrust TMJ manipulation, Rocabado's exercises along with conventional TMJ exercises for 2 weeks.¹¹

Rocabado's non-thrust manipulation: (Figure-1)

Non-thrust temporo-mandibular joint manipulations consisted of medial glide, lateral glide and anterior glide as described by Rocabado.^{6,11,12} Each glide was given for 10-15 repetitions for 5-6 times in a session. The grade of mobilization was begin with Grade-1 or 2 and progressed to Grade-4 depending on subject condition. Total duration of mobilization was lasted for 20 minutes.^{13,14} a. Anterior Glide of the mandible: The technique was applied while subject was lying supine with the mouth slightly open and the mandible relaxed. The examiner places the

thumb on the subject's lower teeth inside the mouth with the index finger on the mandible outside the mouth. The mandible was then distracted by pulling down with the thumb and forward with the index finger while the other fingers pushed against the chin, acting as a pivot joint. The examiner could feel the tissue stretch of the joint and each joint was done individually. The other hand and arm of the examiner was used to stabilize the head; b. Lateral Glide of the mandible: The examiner places the thumb inside the mouth of the subject along the medial side of the mandible and teeth, than pushes the thumb laterally leading to the mandible to glide laterally. Each joint was mobilized individually; c. Medial Glide of the mandible: The technique was applied while subject was side lying position with the mandible relaxed. The examiner places the thumb (or over lapping thumbs) over the lateral aspect of the mandibular condyle outside the mouth and applies a medial pressure to the condyle, gliding the condyle medially. Each joint was done individually.

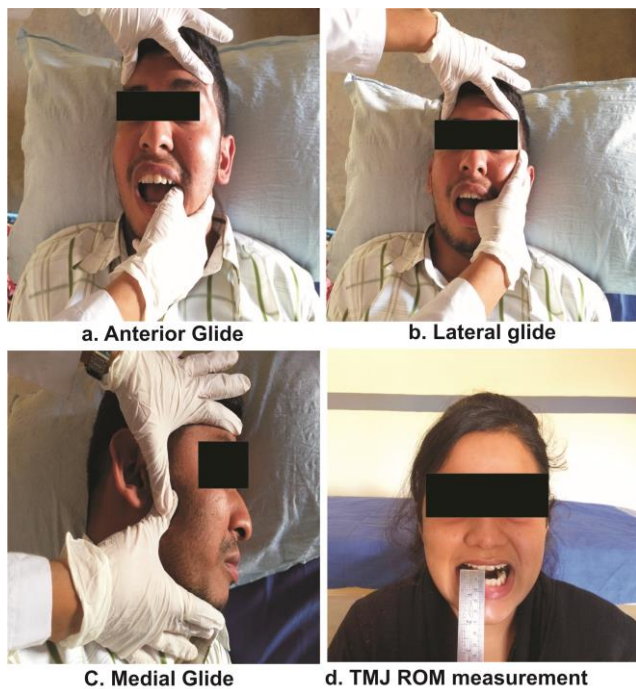
Rocabado's 6X6 Exercise Program: Procedure of exercise program is explained in the table-1.

Table-1: Rocabado's 6X6 Exercise Program⁵

a. Rest position of the tongue	Rest the tongue and jaw promoting diaphragmatic breathing to decrease activity of the accessory muscles. This was performed by keeping the lips together and teeth slightly apart. The subject was asked to put the anterior 1/3 of the tongue against roof of mouth with slight pressure as if the subject is trying to make a "cluck" sound with the tongue. The subject was given a special instruction that he/she is not allowed to touch the tongue to the teeth. Next, the subject was asked to breathe through the nose by using the diaphragm
b. Shoulder posture correction	This exercise was done in order to correct the abnormal scapular protraction through shoulder girdle retraction. The subject was instructed to draw the shoulders backward and downward by pulling the shoulder blades together.
c. Stabilization of head flexion	The subject was asked to stabilize the upper cervical spine by clasping hands together behind the neck over C2-C7 cervical vertebrae. The subject was then asked to keep the head straight and nod the head forward. This is not a neck flexion exercise; rather it is flexion of the head on the cervical spine. During this exercise distraction of the upper cervical spine causing alleviation of mechanical Compressions, allowing the posterior cervical muscles to elongate.
d. Axial extension of the neck	The subject was instructed to perform all the following motions simultaneously; "nod your head, glide the neck backward and stretch the head upward." The patient was instructed to think of the chin being comfortably closer to the neck. During this exercises distraction of the cervical vertebrae, allows tension reduction in the supra- and infrahyoid muscles and enhance the ability of the masticatory muscles to relax. With this exercise, the sternocleidomastoids muscle takes a normal posterior angulation which reduces the stress and the unnecessary muscle activity of these muscles to maintain the position.
e. Controlled TMJ rotation	Reduction of initiating jaw movements with translatory component (ie, protrusive movement in opening, talking or chewing), therefore reducing masticator muscle activity and joint overload. The subject was asked to put the anterior 1/3 of the tongue against roof of mouth with slight pressure as if the subject is trying to make a "cluck" sound with the tongue and monitor TMJ by placing both the index fingers over the joints. The subject was further instructed to open and close the mouth until the patient feels the condyle (balls) of the joint moving forward against the fingers. subject was asked not to leave the tongue from the palate and do the action of chewing in this shortened range

f. Rhythmic stabilization technique	There is induction of muscle relaxation through the principle of reciprocal inhibition. When a muscle is actively contracted, its antagonists are consequently relaxed. Rhythmic stabilization also promotes the proper jaw rest position through proprioception. The subject was instructed to position the tongue against the palate in the correct position as explained above and grasp the chin by placing the index fingers over the chin and thumbs under the chin. Further the subject is asked to apply gentle resistance sideways to the right and then to the left. There after the subject was further instructed to apply gentle resistance to mouth opening and closing. The subject was been given a special instruction that the patient is not supposed to apply excessive force and as the jaw is not to be moved, rather it is to be kept stable and unmoved.
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Figure-1: TMJ non-trust manipulation and TMJ ROM measurement



Conventional TMJ exercises: Gentle isometric tension exercises against resistance, guided opening and closing movements was performed by the patients.³ These exercises were done by the subjects one session under supervision and 5 session at home in a day for 6 days in a week for 2 weeks. Each exercise was performed six repetitions per session.

Instructions to Subjects to perform at home: Patients were instructed to perform Rocabado's exercises for five more times in a day with adequate rest time in-between the sessions. All exercises were performed for six repetitions in every session.

Procedure of Intervention for Control Group: Subjects in this group received only Conventional TMJ Exercises as explained in study group.

Outcome Measurements: The subjective outcome measures such as TMJ dysfunction symptoms, Intensity of TMJ pain, Jaw Functional limitation, and the objective measurement such as TMJ ROM (Mouth opening

range of motion ROM) were measured before and after 2 weeks of intervention.

1. TMJ dysfunction symptoms were measured by Fonseca's questionnaire. It provides scores and information on symptoms with which patients with TMJ disorders. It composed of 10 questions, which included checking for the presence of pain in temporo- mandibular joint, head, back, and while chewing, para-functional habits, movement limitations, joint clicking, perception of malocclusion, and sensation of emotional stress. The Fonseca's questionnaire has reliability and validity of 0.7044%¹⁴ and is a valid source for evaluating the jaw function.
2. Intensity of TMJ pain was measured by 10 cm Visual analogue scale. It describes patients perceived level of pain intensity. The score was determined by measuring the distance on the 10-cm line between the "no pain" and the "worst possible pain".¹⁵ The visual analogue scale has the reliability and validity of 0.96 % to 0.98 %.¹⁶
3. Functional limitations of the TMJ was measured by Jaw function limitation scale. It provides scores and information on many of the disabilities of patients with TMJ disorder. It composed of 20 activities for each item patient had to grade the disability between 0 to 10. The scale has validity and reliability of 0.77% to 0.97%¹⁷ and is a valid scale for measuring jaw function limitation.
4. Mobility of the TMJ (Mouth opening range of motion ROM) (figure-1) was measured by a measuring scale. The mouth opening was measured using a standardized protocol. The subjects were asked to open their mouth maximally till no further opening was possible. The distance from the incisal edge of the upper incisor teeth to the incisal edge of the lower incisor teeth was measured using a calibrated metal ruler and the mobility was recorded in ranges of cm with a ruler that gives readings in centimetres and millimetres.^{18,19}

STATISTICAL METHODS

Descriptive statistical analysis was carried out in the present study. Out Come measurements

analyzed are presented as mean \pm SD. Significance is assessed at 5 % level of significance with p value was set at 0.05 less than this is considered as statistically significant difference. Paired 't' test as a parametric and Wilcoxon signed rank test as a non-parametric test have been used to analysis the variables pre-intervention to post-intervention with calculation of percentage of change. Independent't' test as a parametric and Mann Whitney U test as a non-parametric test have been used to compare the means of variables between two groups with calculation of percentage of difference between the means. The Statistical software namely SPSS 16.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

The study was completed by total of 30 subjects. In Study Group there were 15 subjects with mean age of 31.13 years and there were 6 males 9 females were included in the study. In Control Group there were 15 subjects with mean age 31.53 years and there were 5 males 10 females were included in the

study. There is no significant difference in mean ages between the groups (table-2).

Analysis of means within the Study Group and control group found that there is a statistically significant change ($p < 0.005$) in means of Visual analogue score, TMJ ROM, Fonseca's Questionnaire Rating and Jaw and Function Limitation Scale Score when means were analyzed from pre intervention to post intervention with negative percentage of change showing that there is decrease in the post means. There is clinical significant improvement with large effect size (table-3 & 4).

When the pre intervention means of Visual analog scale score, TMJ ROM, Fonseca's Questionnaire Rating and Jaw and Function Limitation Scale Score were compared there is no statistically significant difference between the groups. There is no clinical significant difference in pre means with small effect size. When post intervention means were compared there is a statistically significant difference between the groups. There is a clinical significant difference in post means with Medium to large effect size (table-5 & 6).

Table 2: Basic Characteristics of the subjects studied

Basic Characteristics of the subjects		Study Group	Control Group	Significance ^a
Number of subjects (n)		15	15	--
Age in years (Mean \pm SD)		31.13 \pm 7.22 (20-40)	31.53 \pm 6.11 (21-40)	p = 0.226 (NS)
Gender	Males	6	5	--
	Females	9	10	

a - Pearson Chi-Square

Table 3: Analysis of pain, TMJ ROM, TMJ dysfunction symptoms, Functional limitations within Study Group (Pre to post test analysis)

Study Group	Pre intervention (Mean ± SD) min-max	Post intervention (Mean ± SD) min-max	Percent age of change	Z value ^b (Non parametric significance)	t value a (Paramet ric)	Parametric Significance P value	95% Confidence interval of the difference		Effect Size (r)
							Lower	Upper	
VAS score in cm	7.04 ± 2.24 (0.24- 9.1)	2.32 ± 1.46 (0.0-5.4)	- 67.04%	-3.352 P = 0.001**	8.761	P < 0.000**	3.56	5.88	+ 0.78 (Large)
ROM in cm	2.63 ± 0.57 (1.8 - 3.5)	3.78 ± 0.22 (3.2 -4.0)	43.72%	-3.414 P = 0.001**	-10.102	P < 0.000**	-1.39	-.908	+ 0.79 (Large)
Fonseca's Questionnaire Rating	68.00 ± 16.34 (25 - 95)	17.00 ± 8.40 (5 - 40)	-75%	-3.415 P = 0.001**	13.942	P < 0.000**	43.15	58.84	+ 0.89 (Large)
Jaw and Function Limitation Scale Score	87.60 ± 17.14 (52 - 126)	22.47 ± 8.07 (8 - 36)	- 74.34%	-3.409 P = 0.001**	17.148	P < 0.000**	56.98	73.28	+ 0.92 (Large)

** Statistically Significant difference p < 0.05; NS- Not significant; a. Pared t test. b. Wilcoxon Signed Ranks Test

Table 4: Analysis of pain, TMJ ROM, TMJ dysfunction symptoms, Functional limitations within Control Group (Pre to post test analysis)

Control Group	Pre intervention (Mean ± SD) min-max	Post intervention (Mean ± SD) min-max	Percenta ge of change	Z value ^b (Non parametric significance)	t value ^a (Paramet ric)	Parametric Significance P value	95% Confidence interval of the difference		Effect Size (r)
							Lower	Upper	
Visual analog scale score in cm	7.48 ± 1.56 (3.9 - 9.3)	3.98 ± 1.97 (0.5 - 6.9)	-46.79%	-3.409 P = 0.001**	10.436	P < 0.000**	2.77	4.21	+ 0.702 (Large)
ROM in cm	2.89 ± 0.51 (1.7 - 4.0)	3.55 ± 0.36 (2.8 - 4.0)	22.83%	-3.328 P = 0.001**	-8.154	P < 0.000**	-.833	-.486	+ 0.599 (Large)
Fonseca's Questionnaire Rating	60.33 ± 18.94 (20 - 985)	29.33 ± 20.43 (10 - 65)	-51.38%	-3.413 P = 0.001**	8.793	P < 0.000**	23.43	38.56	+ 0.618 (Large)
Jaw and Function Limitation Scale Score	83.40 ± 21.61 (38 - 122)	45.53 ± 23.11 (11 - 78)	-45.40%	-3.409 P = 0.001**	9.650	P < 0.000**	29.45	46.28	+ 0.646 (Large)

** Statistically Significant difference p < 0.05; NS- Not significant; a. Pared t test. b. Wilcoxon Signed Ranks Test

Table 5: Comparison of means of pain, TMJ ROM, TMJ dysfunction symptoms, Functional limitations between Study Group and Control Groups (PRE INTERVENTION COMPARISION)

Pre-intervention	Study Group (Mean ± SD) min-max	Control Groups (Mean ± SD) min-max	Percentage of difference	Z value ^b (Non parametric)	t value ^a (Parame tric)	Signific-ance P value	95% Confidence interval of the difference		Effect Size r
							Lower	Upper	
Visual analog scale score in cm	7.04 ± 2.24 (0.24- 9.1)	7.48 ± 1.56 (3.9- 9.3)	6.06%	Z = -0.353 P = 0.744	-0.614	P = 0.544 (NS)	-1.879	1.012	+ 0.113 (Small)
ROM in cm	2.63 ± 0.57 (1.8 - 3.5)	2.89 ± 0.51 (1.7 - 4.0)	9.42%	Z = -1.041 P = 0.298	-1.308	P = 0.202 (NS)	-0.667	0.147	+ 0.234 (Small)
Fonseca's Questionnaire Rating	68.00 ± 16.34 (25 - 95)	60.33 ± 18.94 (20 - 985)	-11.95%	Z = -1.301 P = 0.193	1.187	P = 0.245 (NS)	-5.566	20.89	+ 0.212 (Small)
Jaw and Function Limitation Scale Score	87.60 ± 17.14 (52 - 126)	83.40 ± 21.61 (38 - 122)	-4.91%	Z = -0.582 P = 0.561	0.590	P = 0.560 (NS)	-10.391	18.791	+ 0.107 (Small)

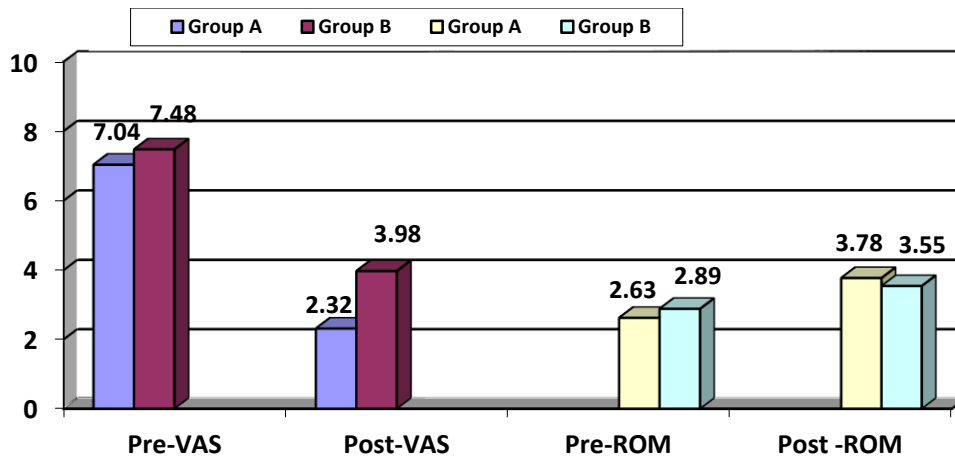
** Statistically Significant difference p < 0.05; NS- Not significant a. Independent t test b. Mann-Whitney Test

Table 6: Comparison of means of pain and Range of Motion between Study Group and Control Groups (POST INTERVENTION COMPARISION)

Post-intervention	Study Group (Mean ± SD) min-max	Control Groups (Mean ± SD) min-max	Percentage of difference	Z value ^b (Non parametric)	t value ^a (Parame tric)	Significance p value	95% Confidence interval of the difference		Effect Size r
							Lower	Upper	
Visual analog scale score in cm	2.32 ± 1.46 (0.0-5.4)	3.98 ± 1.97 (0.5-6.9)	52.95%	Z = -2.490 P = 0.011 **	-2.627	P = 0.014 **	-2.96	-0.367	+ 0.43 (Medium)
ROM in cm	3.78 ± 0.22 (3.2 -4.0)	3.55 ± 0.36 (2.8-4.0)	-6.27%	Z = -1.823 P = 0.068	2.132	P = 0.042 **	0.009	0.457	+ 0.360 (Medium)
Fonseca's Questionnaire Rating	17.00 ± 8.40 (5 - 40)	29.33 ± 20.43 (10- 65)	47.12%	Z = -1.566 P = 0.117	-2.162	P = 0.039 **	-24.01	-0.648	+ 0.367 (Medium)
Jaw and Function Limitation Scale Score	22.47 ± 8.07 (8 - 36)	45.53 ± 23.11 (11 - 78)	67.82%	Z = -3.095 P = 0.002	-3.649	P = 0.001 **	-36.01	-10.11	+ 0.554 (Large)

** Statistically Significant difference p < 0.05; NS- Not significant a. Independent t test b. Mann-Whitney Test

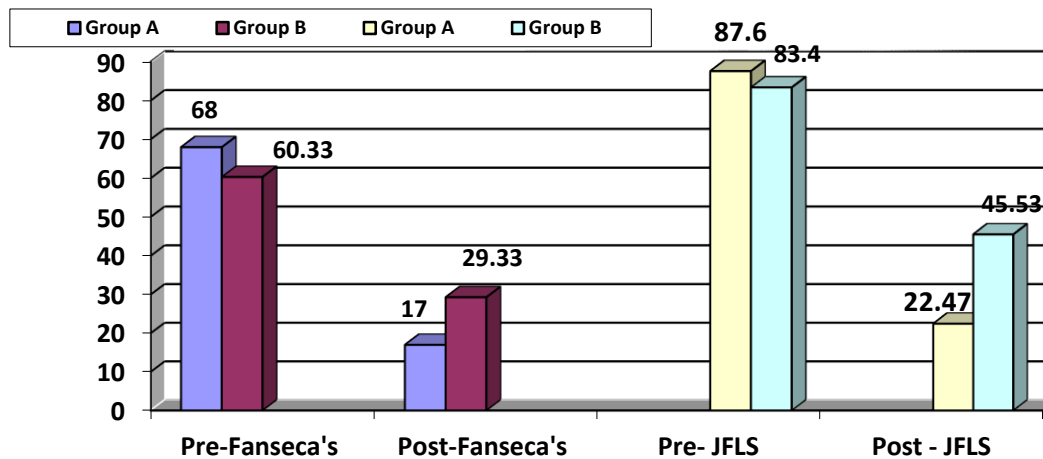
Graph -1: Comparison of pre and post means of pain and TMJ ROM between Study and Control Group (Pre and post comparative analysis)



The graph-1 shows that when pre-intervention and post intervention means VAS score and TMJ ROM was compared there is a statistically significant

difference between Study Group and Control Group.

Graph - 2: Comparison of pre and post means of Fonseca's Questionnaire Rating and Jaw and Function Limitation Scale Score between Study and Control Group (Pre to post test analysis)



The graph-2 shows that when post intervention means of Fonseca's Questionnaire Rating Score, and Jaw Function Limitation Scale Score were compared there is a statistically significant difference between the groups.

DISCUSSION

It is found from the analysis that the both the groups subjects, the group subjects who received two weeks of Rocabado's technique along with conventional TMJ exercises; and the group who received only conventional TMJ exercises have shown statistically and clinically significant effect on improving TMD symptoms, pain, TMJ ROM and jaw function in subjects with Temporomandibular joint dysfunction. However, the greater percentage of improvement is found in the study group who received Rocabado's technique with conventional TMJ exercises than only conventional TMJ exercises.

In the study group, the improvement in TMD symptoms, pain, TMJ ROM and jaw function could

be because of Rocabado's non-thrust TMJ manipulation, Rocabado's exercises along with conventional TMJ exercises. The objective of the Rocabado TMJ manipulation is to normalize the ROM, relieve pain, relieve soft tissue tension in the entire region of the jaw, neck and head. TMJ manipulation found to be effective by biomechanical and neurophysiological mechanism. Joint manipulation stimulates mechanoreceptors to reduce pain by pain modulation occurs by the pain gate theory and also by descending pathway inhibition.⁶ It increases awareness of joint position and motion because of afferent nerve impulses. The small gliding movements that occur in the joint during manipulation cause the synovial fluid movement to improve nutrient exchange, improves mobility of the hypomobile joints by loosening the adhesions, maintains the extensibility and tensile strength of articular tissues¹⁹ and causes soft tissue relaxation.

Rocabado proposes that 6 x 6 exercise program shown to have effect in decreasing pain and improving function of the masticator muscles, and correct forward head posture.²⁰ These exercises are designed to improve muscular co-ordination, relax tense muscles, increase TMJ ROM, alter the jaw closure pattern and muscle strength.²¹ The Rocabado's postural exercises restore and optimize the alignment of TMJ¹⁰ reduce the abnormal compressive forces on the temporomandibular joint. The resting position of the tongue explained in the Rocabado's exercises help in maintaining normal posture of the mandible, axial spine and reduction of bruxism.²⁵ TMJ rhythmic stabilization exercises promote the neuro-muscular relaxation of primary closing muscles of the mandible through the reciprocal inhibition.²⁵ These exercises also strengthen the jaw muscles and balance the strength and function of right and left temporomandibular joint. It also controls the excessive translation of the joint and establishes a normal jaw opening at rest and during mouth opening. Rocabado's exercises are also helpful in relieving the painful clicking of the joint that is caused by the displaced articular disc.²² It also strengthens the neck extensors and shoulder retractors, thereby improving the movement pattern of TMJ.²³ Theoretically, during exercises the muscles of mastication are recruited to apply a compressive force to the disk, thereby improving the condylar-disk-eminence congruency and ultimately improving function.⁸ These effects had been evident by previous studies that found to restore neuro-muscular control during activities involving extreme mouth opening, improve TMJ mobility, improve motor control with the patient's self-limitation in mouth opening, improve cervical spine, shoulders and upper back posture to improve mandibular neuromuscular control and prevent subsequent episode of open lock.⁸

In the control group, the improvement could be because the TMJ exercises are aimed to decrease TMJ pain by increasing the local circulation to the joint. These exercises re-establish the synchronism of the jaw movements, improve flexibility and hinder TMD relapse by strengthening the jaw musculature.²⁴ TMJ isometric exercises increase the intra-muscular pressure in proportion to the muscle tension, which helps the muscle to relax. There is also an increase in the synthesis of actin and myosin of the muscle, leading to an increase in cellular ATP which in turn increases the muscle metabolism and muscle strength while washing out the metabolites and increasing the blood flow to the muscles, further this leads to muscle relaxation.²⁴ The isometric exercises are designed for the group

of muscles and not for a single or isolated muscle; hence, contraction of one muscle group automatically causes its antagonist muscle group to stretch, leading to pain reduction by reciprocal inhibition.

When the effects of the study group compared with control group, the study group found to have greater percentage of improvement in outcome measurements with large effect size than control group. This could be due to added effect of Rocabado technique along with conventional TMJ exercise. Rocabado has developed a pragmatic approach incorporating the intricate relationships between the cervical spine and mandible and temporomandibular function. Rocabado technique demonstrates that the centric position can only be achieved when there is a balance between the position and movement patterns of the sub-cranial region, the mid and lower cervical spine the hyoid and the mandible. These effects may be lacking with conventional TMJ exercises. The Rocabado technique conventionally needs to be carried for duration of 6 week. However in the present study the findings are based on 2 weeks of duration. This duration might have influenced the finding of the results.

Therefore, from the finding it found that there is a statistically and clinically significant effect with greater percentage of improvement in TMD symptoms, pain, TMJ ROM and jaw function in the study group who received Rocabado's technique in comparison with the control group who received TMJ exercises. Hence, the present study rejects the null hypothesis.

The procedure in the study was standardized by blinding the subjects to avoid the placebo effects, and the exercise was performed by the subjects one session under supervision. Despite, the study is with several limitations. The mobilization glides was not uniform for all the subjects, and the intervention was carried only on subjects who had TMD with mouth opening difficulty. TMD is also affected by psychological and psychosocial factors which produce a sensation of pain that is unique and specific to each individual. The influence of psychological status, the stress and depression levels of an individual were not considered in the study. Long term effects of the Rocabado technique was not studied. Long term results of this multimodal program may be beneficial as evidenced by restoration of normal mouth activities, abolishment of pain, and lack of recurrence.

Recommendation for Future Research: Further study is needed to develop the appropriate protocol

on dosage of non-trust manipulation. Studies are needed to rule out the effect of Rocabado technique influenced by psychological and psychosocial factors affecting the TMD. Randomized controlled trial are needed to find the long term effect of the Rocabado technique on specific type of TMD.

CONCLUSION

It is concluded that Rocabado's technique found to have statistically and clinically significant added effect with conventional TMJ exercises shown greater percentage of improvements obtained in reducing TMJ dysfunction symptoms, pain, jaw functional limitation and increasing TMJ ROM comparing with only conventional TMJ exercises in subjects with Temporomandibular joint dysfunction with restricted mouth opening mobility. Implementation of Rocabado's technique along with the conventional techniques in rehabilitation of Temporomandibular Joint dysfunction is recommended if treatment is aiming to address the TMJ pain, TMJ mobility, Functional limitation and restore normal muscle length, strength, function, and coordination.

ACKNOWLEDGEMENT

Authors were expressing their sense of gratitude's to the people who helped and encouraged them for the guidance and completion of this study. I Ms. Niha Siraj Mulla forever grateful for love and support of my Parents & my Brother Khalid Mulla who has been by me always.

Conflicts of interest: None

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Citation

Niha Siraj Mulla, Vinod Babu. K, Sai Kumar. N, Syed Rais Rizvi. (2015). EFFECTIVENESS OF ROCABADO'S TECHNIQUE FOR SUBJECTS WITH TEMPOROMANDIBULAR JOINT DYSFUNCTION- A SINGLE BLIND STUDY. *International Journal of Physiotherapy*, 2(1), 365-375.