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Original Research Article

Physical Therapy in Temporomandibular Dysfunction Following Maxillo–Mandibular Fixation in Sub-Condylar Mandibular Fracture - A Single Case Study

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ABSTRACT

Background and objective: Mandibular Condyle fractures are one of the most common fractures which are managed with much controversy compared to any other fractures of mandible. Temporomandibular dysfunctions (TMD) following maxillomandibular fixation (MMF) are well documented however the role of Physical therapy interventions in TMD following MMF in sub-condylar mandibular fracture is uncertain. So the objective of this study was to find the effect of manual therapy, therapeutic exercise and home exercise program in TMD following MMF in sub-condylar mandibular fractureon levels of pain and disability and range of mouth opening and functioning of temporomandibular joint (TMJ).
Methods and Measures: The study consisted of baseline Phase A and intervention Phase B. Phase B consisted of manual therapy, therapeutic exercise, and home exercise program focusing on temporomandibular joint function. Numerical pain rating scale (NPRS), maximum mouth opening (MMO), TMD disability index (TDI), patient-specific functional scale (PSFS) data were obtained for analysis. Visual analysis and 2-SD band method of analysis were used to compare data.
Study Setting: Outpatient Musculoskeletal Physiotherapy department
Study Design: Single case A-B design study
Result: There was significant change in scores of NPRS, MMO, TDI and PSFS following intervention as compared to that at baseline.
Conclusion: The results of 16 treatment session over 5 week study proposed that physical therapy intervention which includes manual therapy, therapeutic exercise and home exercise program may be an effective strategy in management of TMD following MMF in sub condylar mandibular fracture.

Key Words: Mandibular condyle fracture, Maxillo-mandibular fixation, TMJ dysfunction, Physical therapy.

INTRODUCTION

Mandibular fractures are the most common among facial skeleton fractures. [1] The causes of mandibular fractures include falls, interpersonal violence, motor vehicle accidents, pathology and iatrogenic during

tooth removal. Assaults are the most common cause of isolated mandible fracture. [2] The available treatment strategies for mandibular sub condylar fracture are open or closed reduction with maxillomandibular fixation (MMF), conservative treatment that includes observation, analgesics, anti-inflammatory, soft diet and early physical therapy exercise. [3,4] Closed reduction of mandibular fracture with MMF can adversely affect bone, muscle, synovial joint and periarticular connective tissues. The changes in muscle of mastication system have been documented following immobilization of mandible. [5] The Cortical and trabecular thinning, vascular distention and increased osteoclastic activity have been described following joint immobilization. [6] Clinical bone union in adults occurs within 4 to 6 weeks. [2,3] But unwanted complications after close or open reduction with MMF in fracture mandible includes bony deformities, trigeminal nerve injury, facial nerve injury, TMJ ankylosis or decrease mouth opening, changes in musculature including muscle atrophy, change in length and function with dental occlusion affection or temporomandibular joint disorder. [1-3,7-9] Post fracture early Physical therapy rehabilitation is essential for achieving good outcomes that include restoration of pre occlusion, restoration of mouth opening, pain free mouth opening, full range of mandibular excursion, restoration of facial and mandibular symmetry. [3,4]

The literature has explained the possible mechanism of post traumatic restricted TMJ motion includes pseudoankylosis and true ankylosis. [4,7,10,11] Pseudoankylosis results from extracapsular causes and very common in condylar fracture. Condylar fractures leads to violation of articular space, inflammation and hemarthrosis which increases fibrous matrix formation and reduces mandibular movements. Adhesion of the coronoid process and hypertrophy aroundit, or fibrosis of the temporalis muscle, can be considered as other causes of pseudoankylosis. The true ankylosis which results from fibrous adhesions or bony fusionis also commonly caused by trauma. The mandibular movement limitations itself may lead to a changes in the synovial membrane and reduction in joint lubrication. The muscle weakness and fibrosis may leadto further jaw movement limitation and increased pain. [11]

TMD is a cluster of pathologies affecting the masticatory muscles, the TMJ, and related structures or both. [12] TMD is manifested by many symptoms including pain, click or popping of jaw, jaw movement limitation, tenderness, headache, ear pain, dizziness and cervical spine disorders. [3,7,12-19] Physical therapy interventions in TMD are intended to reduce inflammation and pain and to restore functions of oral motor. Numerous physical therapy interventions, including ultrasound, microwave, laser, electric stimulation, TENS, therapeutic exercise, home exercise and manual therapy techniques are used in TMD. [4,7,14,16] Manual therapy techniques are regularly used to control pain and restore joint mobility. Maitland joint mobilization and muscle energy techniques were used in this study to reduce pain and disability; and to maximize mobility and function of TMJ.

Several researchers have investigated the effectiveness of physical therapy in patients with TMD, [13,18, 20,21] but there is limited documentation on the effectiveness of physical therapy on TMD post MMF in mandibular sub condylar fracture. This limited documentation may also be due to inaccurate, improper or lack of diagnosis of TMD in post mandibular fracture. However, the importance of physical therapy in the management of TMD has been recommended by the American Academy of Craniomandibular Disorders and the

Minnesota Dental Association.[20] So, finding the effectiveness of physical therapy intervention may heighten the management strategy of TMD post MMF. Hence, the purpose of the study was to investigate the effect of manual therapy, therapeutic exercise and home exercise program in TMD following MMF in sub-condylar mandibular fracture on levels of pain and disability and range of mouth opening and functioning of TMJ. The study hypothesized that the physical therapy interventions would alter the levels of pain and functioning in this case.

METHODS

Before the initial assessment process, the subject was asked to volunteer the single-case design study. After the subject agreed to participate in the study, she reviewed and signed the consent form which was approved by the Institutional Scientific Review Board.

CASE REPORT

A 27 years old Gujarati woman with preferred chewing side right, BMI 23.87 kg/m^2, teacher by profession, from a lower socioeconomic status [22] had a fall on chin within the house. Immediately bleeding started from chin (impact area).Then, she was unable to eat and open her mouth due pain since the fall. On the same day she consulted a dentist and radiological examination (Ortho-panto-gram view) (Figure 1) confirmed the diagnosis of as having left side mandible sub-condylar fracture with displaced proximal segment. Although, MRI is an excellent tool in the diagnosis of TMJ and soft tissue dysfunctions, it was not available in this case. Two stitches were taken at bleeding site and surgery /conservative treatment of the fracture was advised but she refused it due to her low socioeconomic status and had to look after her 8 months old baby girl. One week after the fracture she was convinced for the fracture management and underwent closed reduction Inter MMF performed by an oral surgeon who has 8 years of experience in the field. Jaw immobilization was advised along with a course of antibiotic (5days) and NSAIDs until pain persist. After 5 weeks of immobilization, the fixation was removed and a new analgesic was advised to take on need basis. On her first oral surgeon follow-up after 15 days (7 weeks after MMF) she was advised for physical therapy treatment to improve mouth opening. At another follow-up after 15 days (9 weeks after MMF), the surgeon advised to discontinue medications and continue only physical therapy treatment.

Figure 1: Ortho-panto-gram (OPG) view in closed mouth position demonstrating mandibular sub-condyle fracture and reduce TMJ space left side.

After analysis of the case report (at 7 weeks after MMF), during the initial evaluation she reported unable to open the mouth to eat solid food, brushing the teeth, difficulty in talking, yawning, laughing, and pain on strenuous mouth opening at her left jaw and TMJ. She also reported occasional night pain especially while sleeping on the affected side, and pain behind the ear. She denied any positive history of musculoskeletal, neuromuscular, cardio-vascular, cardiopulmonary and systemic diseases. She was on liquid diet since the day of fracture.

Active maximum mouth opening was measured 3 mm, which also exacerbated her symptoms. Mandibular lateral deviation, protrusion and retraction range were severely affected. TMJ auscultation with a stethoscope during active motions did not reveal any joint clicking or popping sound. Joint play testing of the TMJ revealed considerable hypomobility in caudal distraction, anterior and lateral glide of the mandible bilaterally. Cervical active range of motion screening revealed no remarkable changes. Extra oral palpation revealed tenderness on affected sided masseter and TMJ line. Strength testing for muscle of mastication was performed using MMT and it was found to be non-functional which progressed to functional post intervention; however it was not included for analysis. The TMJ hypomobility and limited function in muscle of mastication as a result of post MMF was the initial working hypothesis for the treatment. The diagnostic criteria utilized to establish the hypothesis included (1) Limitation in mouth opening (3 mm) and all other movements, (2) X-ray confirmation of sub-condylar fracture and reduce left TMJ space, (3) prior history of MMF and (4) change in length and function in muscles of mastication.

Outcome Measures:

The outcome measures were recorded at baseline (day 1, 2, 3 and 4) and last visit of each week prior to intervention for one to four weeks. The 5th week Data was recorded at next day of the intervention. The numerical pain rating scale (NPRS), range of maximal mouth opening (MMO), patient specific functional scale (PSFS) and TMD disability index (TDI) were used as an outcome measure. The 11 point **NPRS** is a uni-dimensional measure of pain intensity in adults which provide an estimate of patients' pain intensity, easy to administer and score.[23] The NPRS ranging from "0" represent "no pain" to "10" the worst pain imaginable was utilized to quantify the patient's average pain in past 24 hours.[24] The NPRS is a sensitive and consistent compared to other pain measures.[25] ***Maximal mouth opening (MMO)***measured with10-cm ruler marked in millimeters while seated patient was asked to ''open the mouth as wide as possible devoid of pain or discomfort and inter incisors distance was measured in millimeters. Intra-tester reliability has proven acceptable when measuring MMO in millimeters.[26] MMO has been demonstrated as the only reliable measurement of TMJROM in patients with and without TMD.[27] ***TMD Disability Index (TDI)*** *comprises* ten questions concerning TMD disability, and score of each question is recorded from 0-4. Higher scores represent greater levels of disability.[28] However, validity and reliability of questionnaire has not been tested.[17] ***The patient specific functional scale*** investigates functional status of patient by asking their difficult activities based on their current condition. The functional limitation is rated on 0-10 scale for each activity, where 0 represent inability to perform the activity and 10 represent ability to perform the activity normally as before the onset of symptoms. [29] The PSFS has proven to be

valid, reliable and responsive for patients with various clinical conditions. [30-32] However, the PSFS has not been tested with TMD patients. [15]

Figure 2: MMO at 5th week (35 mm opening) measured with 10 cm ruler

Experimental Procedures:

The patient visited department 19 times over 39 day period during the study for either data collection or actual treatment. During the study period she went through nine phases of data collection within the A-B single-subject design. The first baseline phase (A) involved 4 visits, which included the day of the initial evaluation and 3additional visits for the purpose of data collection only. The treatment phases (B), initiated at the fourth visit, and consisted of 16 physical therapy treatment sessions in addition to data collection. In an attempt to control external variables, the patient was consistently scheduled at 11:00 AM for both data collection and treatment session.

Baseline (A) Phase:

The first 4 baseline measurements were collected over a 4-day period. During the first visit the initial evaluation was completed in 1 hour duration. No management program was implemented during this phase. Following visits consisted of data collection only (approximately 15 to 20 minutes each). The final baseline measurement was collected on fourth visit, just prior to the initiation of the intervention phase (B).

Treatment (B) Phase:

The patient received 16 treatment sessions in 35 days, approximately 45 minutes each (Table 1 & 2). Treatment was concentrated not only on TMJ but also on cervical spine, as changes in either of these joints would cause compensatory changes in the other. She was instructed to eat soft foods, cut foods into small pieces, evenly chew on both sides, relax jaw muscles, tongue positioning, maintain good head, neck, and shoulder posture. She was also advice to avoid chewing gum or eat hard food, caffeine; other oral habits and sleeping posture that strain neck or jaw. [7] Physical therapy intervention which includes manual therapy, therapeutic exercise and home exercise program focused on restoring TMJ arthrokinematics, normalization of soft tissue. The G.D. Maitland TMJ mobilization techniques was used for mandibular depression, caudal and transverse lateral glides, starting with II Grades, concentrating on pain and progressed to III and IV Grades, for condylar mobility.[17,33,34] Leon Chaitow's post-isometric relaxation (Isometric contraction) and reciprocal inhibition MET technique were used to restore the length of muscle of mouth opening, closing & lateral deviation (muscles of mastication).[17,35,36] Therapeutic exercises were also focused on strengthening the muscles of mastication with manual resistance.[15,17,19] Self-stretches exercise were incorporated into home program along with the graded sticks. Isometric exercise of mandible and the deep neck flexors were also incorporated to maximize TMJ stability.[4,7,15,17,19]

Table 1: Rehabilitation Program

Exercise	Description
1st Week (Five Treatment Session)	
Stretching exercise	Oral sub-mucosal, 10 stretch, 15 sec hold, one set bilateral
MET	Post-isometric relaxation (Isometric contraction) and reciprocal inhibition MET technique for muscle of mastication & lateral deviator in lying position, 5 repetition, 10 sec hold, 2 set
Maitland mobilization	Intra-oral, depression, protraction & retraction glide, grade-I & II, 20 oscillation, 3 sets each
Active ROM exercise	Mouth opening, deviations & protraction, 5 repetition, 3 sets each
Stick exercise	Mouth opening with 2 to 7 sticks for 5 min in supine position, pillow under shoulder blades
Isometric exercise	Supine lying, chin tuck exercise, 10 repetition, 10 sec hold, 2 sets
2nd Week (Five Treatment Session)	
Maitland mobilization	Intra-oral, depression, protraction & retraction glide, grade-II & III, 20 oscillation, 3 sets each
	Extra-oral, PA & transverse medial glide, grade-II , 20 oscillation, 3 sets
MET	Same as 1st week
Active ROM exercise	Mouth opening, deviation & protraction, 10 repetition, 3 sets each
Stick exercise	Mouth opening with 7 to11 sticks for 5 min in supine position, pillow under shoulder blades
Resistance exercise	Manual resistance mouth opening, deviation & protraction, 10 repetition, 5 sec hold, 3 sets each
Isometric exercise	Same as 1st week
3rd Week (Three Treatment Session)	
Maitland mobilization	Extra-oral, PA & transverse medial glide, grade-III, 20 oscillation, 3 sets
MET	Post-isometric relaxation (Isolytic contraction) and reciprocal inhibition technique MET for muscle of mastication & lateral deviator in lying position, 5 repetition, 10 sec hold, 2 set
Stick exercise	Mouth opening with 11 to 17 sticks for 5 min in supine position, pillow under shoulder blades
Resistance exercise	Same as 2nd week
Isometric exercise	Same as 2nd week
4th Week (Two Treatment Session)	
Maitland mobilization	Right side extra-oral, PA & transverse medial glide, grade-III & IV, 20 oscillation, 3 sets
Stick exercise	Mouth opening with 17 to 21 sticks for 5 min in supine position, pillow under shoulder blades
Resistance exercise	Manual resistance mouth opening, left deviation & protraction, 10 repetition, 10 sec hold, 3 sets each
Isometric exercise	Same as 3rd week
5th Week (One Treatment Session)	
Maitland mobilization	Right side extra-oral, PA & transverse medial glide, grade-III & IV, 20 oscillation, 3 sets
Stick exercise	Mouth opening with 21 to 23 sticks for 5 min in supine position, cervical spine in slight extension (pillow under shoulder blades)
Resistance exercise	Same as 4th week

Table 2: Home exercises program

Exercise	Description
Active ROM exercise	Mouth opening, deviation & protrusion, 10 repetition, 3 sets each in front of the mirror
Resistance exercise	Manual resistance mouth opening, deviation & protrusion, 10 repetition, 10 sec hold, 3 sets each in front of the mirror
Stick exercise	Mouth opening with sticks for 10-15 min twice/day in supine, pillow under shoulder blades
All the home exercise were perform twice a day, six day in a week, half an hour before the food in front of the mirror throughout the rehabilitation	

Data Analysis:

Visual analysis and statistical analysis were utilized to determine the effects of manual therapy, therapeutic exercise, and home exercise program in the management of TMD following maxilla-mandibular fixation in mandible sub-condylar fracture patient. The graphical characteristics and statistical tests were examined using the SYSTAT computer package 11 version. Visual analysis consists of the evaluation of variability, level, slope, and trend of data. Statistical analysis was performed utilizing the 2-Standard Deviation (2-SD) Band method (p=0.05). A significant change in status is inferred if at least 2successive data points fall outside the 2-SD range. [37]

RESULT:

Visual analysis of NPRS, MMO, TDI and PSFS data (Table 1) (Figure 3-6) demonstrated a reduction in the variability of data point from the A to B phase, suggesting the data points in the B phase were more stable. The change in level was noted between the last data point of A phase (NPRS=8, MMO=3mm, TDI=29, PSFS=0.6) to the first point in the B phase (NPRS=6, MMO=14mm, TDI=21, PSFS=5.8). The mean level of the data points in A phase (NPRS=7.75, MMO=2.75mm, TDI=28.5, PSFS=0.42) changes in B phase (NPRS=3, MMO=26mm, TDI=8.6, PSFS=7.84) suggesting a change in NPRS, MMO, TDI and PSFS score after implication of the intervention. There were change in the trend in NPRS (A=stable, B=decelerating), MMO (A=stable, B=accelerating), TDI (A=stable, B=decelerating), and PSFS (A=stable, B=accelerating) indicating greater rate of change in the treatment phase. The scores at the last session of B phase were NPRS=2, MMO=35mm, TDI=2 and PSFS=9.4 respectively. The 2-SD band method analysis of NPRS, MMO, TDI and PSFS revealed 5 successive data points in B phase fall outside the 2-SD line, suggesting a statistically significant reduction in pain and disability while maximized maximum mouth opening and function of TMJ were achieved after treatment phase (Table 3) (Figure 3-6).

Table 3: Baseline and treatment phase data for NPRS, MMO, TDI and PSFS.

Phase	Pain		Mouth Opening		Disability		Function	
	NPRS	Mean (SD)	MMO	Mean (SD)	TDI	Mean (SD)	PSFS	Mean (SD)
Day1(A)	8	7.75±0.43	3	3±0.63	28	28.5±1.11	0.2	0.42±0.14
Day4(A)	8		3		29		0.6	
Week1(B)	6	3±1.54	14	26±7.92	21	8.6±7.2	5.8	7.84±1.31
Week5(B)	2		35		2		9.4	

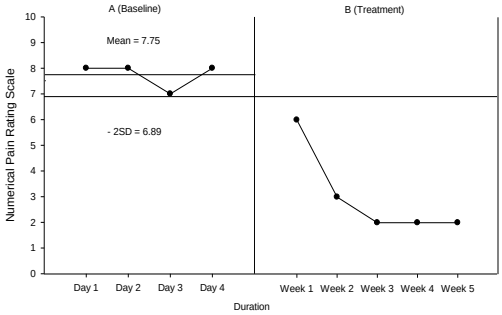

Figure 3: Average pain 24 hour data recorded with the 11 point NPRS were 0 representing ‘‘no pain’’ and 10 representing ‘‘the worst pain imaginable” and statistical analysis using 2-SD band method.

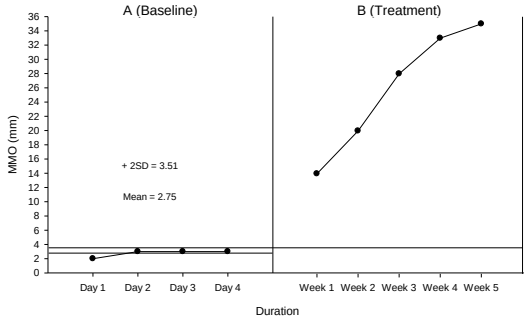

Figure 4:Maximal mouth opening (MMO) data recorded in millimeter and statistical analysis using 2-SD band method.

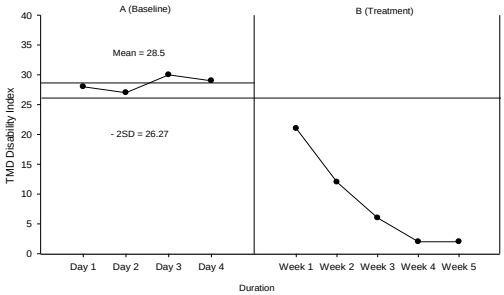

Figure 5: Disability data recorded with the TDIten questions concerning disability associated with TMD, and each question is scored from 0-4. Higher scores represent greater levels of disability and statistical analysis using 2-SD band method.

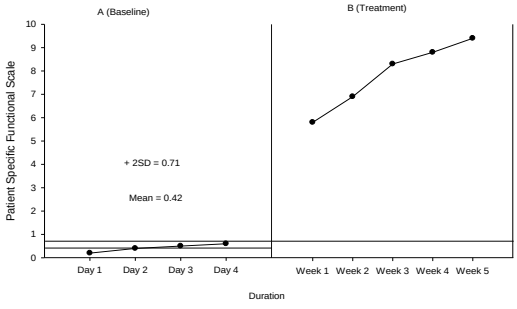

Figure 6: Functional limitation data recorded with the 11 point PSFS were 0 representing ‘‘unable to perform activity’’ and 10 representing ‘‘Able to perform activity at the same level as before injury or problem” and statistical analysis using 2-SDband method.

DISCUSSION

The result of this single-case experimental study shows that 16 treatment sessions over 5 weeks of physical therapy program was an effective management strategy of TMD post MMF in mandibular sub-condylar fracture to reduce pain and disability; and to improve mouth opening and functional capacity of TMJ. Although, the subject achieved normal range of mouth opening (35 mm); some residual pain (NPRS 2 point) on forceful mouth opening was present at the last assessment which is prevalent as chronic pain according to an earlier study. [38] The disability level on TDI questionnaire was also decreased to 2 point while improved functional status on PSFS to 9.4 points.

The visual analysis demonstrated a positive change in level of the NPRS, MMO, TDI and PSFS suggesting improvements in TMD symptoms immediately after the intervention program. The change from a stable line to decelerating trend in NPRS and TDI while a stable line to accelerating trend in MMO and PSFS during the intervention phase is again suggestive of the benefits of manual therapy, therapeutic exercise and home exercise program in this patient. It was hypothesized that Maitland joint mobilization techniques may have succeeded in releasing synovial and articular adhesions, [21] which led to better functioning of TMJ in the subject. The findings of this present study were in accordance to previous studies on TMD without subcondylar fracture. [15,17,18] The MET isometric muscle contraction stimulates the muscle proprioceptors which may produce pain relief via pain gate control theory. Immediately following an isometric contraction, a hypertonicmuscle can be passively lengthened to a new resting length and isotonic MET reduce hypertonicity in a shortened antagonist and increase strength of the agonist, [39] that helps to improve joint range of motion. These findings on effectiveness of MET were also similar to an earlier study on non-traumatic cause of TMD. [17,36] The therapeutic exercise against resistance along with home exercise program promotes reflex relaxation of the antagonistic muscles. This stimulates the maximum number of motor units within the lateral pterygoids during mouth opening and lateral mandibular movements and improves the functioning of TMJ. [13,17-19]

The study had certain limitations as other single case study designs. The study did not have reliable tools to measures disability, muscle strength and function of jaw. The observation period could have been longer to record the long-term benefits. The study cannot comment on change in TMJ joint space after the intervention as radiographic comparison was not done. The study being conducted on a single subject, its result can't be generalized for the management of TMD following MMF. Apart from certain limitation, the study provides the first evidence of the effectiveness of physical therapy intervention in the form of manual therapy, therapeutic exercise and home exercise program in TMD post MMF in mandibular sub-condylar fracture. Further studies are warranted in TMD diagnosed in post mandibular fracture, with larger sample size, longer period of observation using more reliable investigative methods (MRI) and measuring tools. Future randomized control studies are necessary to compare the effectiveness of different physical therapy intervention in TMD following MMF in sub-condylar fracture subjects.

CONCLUSION

The results of this single-case experimental design with 16 treatment session over five weeks study proposed that physical therapy intervention which includes manual therapy, therapeutic exercise, and

home exercise program may an effective strategy in management of TMD following MMF in sub-condylar fracture.

Conflict of Interest: There were no conflicts of interest during the course of study.

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REFERENCE

1. Adnan Ali Shah and Abdus Salam - Pattern and Management of Mandibular Fractures: A Study Conducted on 264 Patients. Pakistan Oral & Dental Journal. 2007:27(1); 103-5.
2. Ongole and BN Praveen. Textbook of Oral Medicine, Oral Diagnosis and Oral Radiology. India: Elsevier; 2009.
3. Mohammad Hosein Kalantar Motamedi. A textbook of advanced oral and maxillofacial surgery. Croatia. InTech; 2013.
4. Ministry of Health Malaysia. Clinical Practice Guidelines: Management of unilateral condoyle fracture of the Mandible. Malaysia. Ministry of Health Malaysia; Dec 2005.
5. Ellis E, Carlson DS. The effects of mandibular immobilization on the masticatory system. A review. ClinPlast Surg. 1989 Jan;16(1):133-46.
6. Geiser M, Trueta J. Muscle action, bone rarefaction and bone formation; an experimental study. J Bone Joint Surg Br. 1958 May;40-B(2):282-311.
7. Edward F. Wright. Manual of Temporomandibular Disorders. 2nd ed. USA. Wiley-Blackwell; 2010.
8. Kaplan A, Williams G Jr. The TMJ Book. Pharos books, New York, 1998.
9. Kang-Young Choi, Jung-Dug Yang, Ho-Yun Chung, Byung-Chae Cho. Current concepts in the mandibular condyle fracture management Part II: Open reduction versus closed reduction. Arch PlastSurg 2012 July;39(4):301-308.
10. Saghafi D, Curl DD. Chiropractic manipulation of anteriorly displaced temporomandibular disc with adhesion. J Manipulative Physiol Ther. Feb 1995; 18(2):98-104.
11. Hupp JR, Ellis E, Tucker MR. Contemporary oral and maxillofacial surgery. 5th ed. St. Louis, Mo: Mosby Elsevier. 2008.
12. McNeill C. Temporomandibular Disorders: Guidelines for Classification, Assessment, and Management. 2nd ed. Chicago, Ill: Quintessence Publishing Co; 1993.
13. Margaret L McNeely, Susan Armijo Olivo and David J Magee. A Systematic Review of the Effectiveness of Physical Therapy Interventions for Temporo-mandibular Disorders.PhysTher. 2006; 86(5):710-725.
14. Di Fabio RP. Physical therapy for patients with TMD: a descriptive study of treatment, disability, and health status. J Orofac Pain. 1998; 12(2):124–135.
15. Eric S. Furto, Joshua A. Cleland, Julie M. Whitman, Kenneth A. Olson. Manual Physical Therapy Interventions and Exercise for Patients with Temporomandibular Disorders. Cranio. 2006; 24(4):283-291.
16. Edward F. Wright and Sarah L. North. Management and Treatment of Temporomandibular Disorders: A

Clinical Perspective. J Man ManipTher. 2009; 17(4):247–254.
17. Jessica A. Palmer, Joshua A. Cleland. Effectiveness of manual physical therapy, therapeutic exercise, and patient education on bilateral disc displacement without reduction of the temporomandibular joint: A single-case design. J Orthop Sports PhysTher. sept 2004;34(9):535-548.
18. David Smékal, KristýnaVelebová, Dagmar Hanáková, Magdaléna Lepšíková. The effectiveness of specific physiotherapy in the treatment of temporomandibular disorders. Acta Univ. Palacki. Olomuc.,Gymn. Aug 2008; 38(2):45-53.
19. Carolyn Kisner and Lynn Allen Colby. Therapeutic Exercise Foundations and Techniques. 5th ed. USA. F. A. Davis Company; 2012.
20. Sturdivant J, Fricton JR. Physical therapy for temporomandibular disorders and orofacial pain. CurrOpin Dent. Aug 1991; 1(4):485-96.
21. Moses JJ, Topper DC. A functional approach to the treatment of temporomandibular joint internal derangement. J CraniomandibDisord. 1991 winter; 5(1):19-27.
22. Kumar N, Gupta N, Kishore J. Kuppuswamy's socioeconomic scale: Updating income ranges for the year 2012. Indian J Public Health 2012; 56(1):103-4.
23. Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain. Nov 2001; 94(2):149–58.
24. Dworkin RH, Turk DC, Farrar JT, Haythornthwaite JA, Jensen MP, Katz NP, et al. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. Pain 2005; 113(1-2):9–19.
25. Maria Alexandra Ferreira-Valente, José LuísPais-Ribeiro, Mark P. Jensen. Validity of four pain intensity rating scales. PAIN. Oct 2011; 152(10):2399–2404.
26. Dworkin SF, LeResche L, DeRouen T. Reliability of clinical measurement in temporomandibular disorders. Clin J Pain. 1988; 4(2):89-99.
27. Walker N, Bohannon RW, Cameron D. Discriminant validity of temporomandibular joint range of motion measurements obtained with a ruler. J Orthop Sports PhysTher. Aug 2000; 30(8):484-92.
28. Steigerwald DP, Maher JH. The Steigerwald/Maher TMD Disability Questionnaire. Today Chiro 1997;26:86-91.
29. Stratford P, Gill C, Westaway M, Binkley J: Assessing disability and change of individual patients: a report of a patient-specific measure. Physiother Can 1995; 47(4):258-263.
30. Westaway M, Stratford P, Binkley J: The Patient Specific Functional Scale: validation of its use in persons with neck dysfunction. J Orthop Sports PhysTher. May 1998; 27(5):331-338.
31. Chatman A, Neel J, Hyams S: The Patient Specific Functional Scale: measurement properties in patients with knee dysfunction. PhysTher. 1997; 77(8):820-829.
32. Hefford C, Abbott JH, Arnold R, Baxter GD. The patient-specific functional scale: validity, reliability, and responsiveness in patients with upper extremity musculoskeletal

problems. J Orthop Sports PhysTher. 2012 Feb; 42(2):56-65.
33. EllyHengeveld and Kevin Banks. Maitland's Peripheral Manipulation. 4th ed. USA. Elsevier; 2005.
34. Darlene Hertling and Randolph M Kessler. Management of common musculoskeletal disorder: physical therapy principles and methods, 3rd ed. New York: Lippincott, 1996.
35. Leon Chaitow. Muscle Energy Techniques. 3rd ed. UK: Elsevier Health Sciences; 2006.
36. ViswasRajadurai. The Effect of Muscle Energy Technique on Temporomandibular Joint Dysfunction: A Randomized Clinical Trial. Asian J. Sci. Res., 2011; 4(1): 71-77.
37. Mohammed Reza Nourbakhsh and Kenneth J Ottenbacher. The Statistical Analysis of Single-Subject Data: A Comparative Examination. PHYS THER. 1994; 74(8):768-776.
38. R H Haug and L AAssael. Outcomes of open versus closed treatment of mandibular subcondylar fractures.J Oral Maxillofac Surg. 2001 Apr; 59(4):370-5.
39. Lisa A. DeStefano. Greenman's Principles of Manual Medicine. 4th ed. Philadelphia. Lippincott Williams & Wilkins; 2011.

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