



REVIEW

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Evaluation of the mechanism and principles of management of temporomandibular joint dislocation. Systematic review of literature and a proposed new classification of temporomandibular joint dislocation

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Abstract

Background: Virtually all the articles in literature addressed only a specific type of dislocation. The aim of this review was to project a comprehensive understanding of the pathologic processes and management of all types of dislodgement of the head of the mandibular condyle from its normal position in the glenoid fossa. In addition, a new classification of temporomandibular joint dislocation was also proposed.

Method and materials: A thorough computer literature search was done using the Medline, Cochrane library and Embase database. Key words like *temporo-mandibular joint dislocation* were used for the search. Additional manual search was done by going through published home-based and foreign articles. Case reports/series, and original articles that documented the type of dislocation, number of cases treated in the series and original articles. Treatment done and outcome of treatment were included in the study.

Result: A total of 128 articles were reviewed out of which 79 were found relevant. Of these, 26 were case reports, 17 were case series and 36 were original articles. 79 cases were acute dislocations, 35 cases were chronic protracted TMJ dislocations and 311 cases were chronic recurrent TMJ dislocations. Etiology was predominantly trauma in 60% of cases and other causes contributed about 40%. Of all the cases reviewed, only 4 were unilateral dislocation. Various treatment modalities are outlined in this report as indicated for each type of dislocation.

Conclusion: The more complex and invasive method of treatment may not necessarily offer the best option and outcome of treatment, therefore conservative approaches should be exhausted and utilized appropriately before adopting the more invasive surgical techniques.

Introduction

The mechanism of temporomandibular joint dislocation varies depending on the type of dislocation which may be acute, chronic protracted or chronic recurrent dislocation [1]. This mechanics is closely related to the structure and function of the temporomandibular joint as well as the dynamics of the masticatory system [1]. The capsule of the joint is the most important structure which stabilizes the joint reinforced by the lateral ligaments [2,3].

However displacement of the head of the condyle out of the glenoid fossa is also greatly influenced by the morphology of the condyle, glenoid fossa, articular eminence, zygomatic arch and squamotympanic fissure [1,3-5]. The afore-mentioned factors mainly determine the type and direction of dislocation. In addition, age, dentition, cause and duration of the dislocation as well as the function of the masticatory muscles contribute significantly in the mechanism and management of temporomandibular joint dislocation [4-7]. The outcome of T.M.J dislocation, especially the chronic recurrent and chronic protracted are not very predictable and this depend on thorough

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evaluation, treatment planning and compliance of the patient [3-9].

The aim of this article is to review, analyze and update the mechanisms and various management options available for the different types of T.M.J dislocation in literature.

Methods and materials

A thorough computer literature search was done using the Medline, Cochrane library and Embase database. Key words like *temporo-mandibular joint dislocation* were used for the search. Additional manual search was done by going through published home-based and foreign articles. Relevance of article for inclusion into the study was assessed based on the title, abstract and contents of the full article. The reference list of the reviewed articles was also searched from Medline and Embase database as well as the Thomson Reuters, Wolters Kluwer, Lippincott Williams and Wilkins search engines for Cited and Related literature search based on the relevant title. Case reports/series, and original articles that documented the type of dislocation, number of cases treated in the series and original articles. Treatment done and outcome of treatment were included in the study. Total number of each type of dislocation reported was recorded and the treatment options for each type was analyzed based on the clinical and radiological outcome (presence/absence of pain, occlusion derangement, inter-incisal distance, deviation of the mandible and masticatory function, as well as position of the condylar head in the glenoid fossa). A new classification was proposed for Temporomandibular joint dislocation based on the position of the condylar head in relation to the articular eminence.

Results

A total of 128 articles were reviewed out which 79 were found relevant. Of these, 26 were case reports, 17 were case series and 36 were original articles. 79 cases were acute dislocations, 35 cases were chronic longstanding TMJ dislocations and 311 cases were chronic recurrent TMJ dislocations (Table 1). Etiology was predominantly trauma in 60% of cases and this include fall, road traffic accident, domestic accidents, interpersonal violence; other causes like excessive mouth opening from yawning, laughing, singing, prolonged mouth opening from oral and ENT procedures, forceful mouth opening from anaesthetic and endoscopic procedures contributed about 40%.

Of all the cases reviewed, only 4 were unilateral dislocation. Prognatism of the lower jaw, anterior cross bite and open bite were the classical features in the bilateral cases while deviation of the mandible, shift in the midline to the unaffected side and cross bite on that side were predominant in the unilateral cases.

Table 1 Distribution of the articles reviewed and type of dislocation

Parameter	Frequency
No. of articles reviewed	128
No. of relevant articles	79
Type of articles	
Case reports	26
Case series	17
Original articles	36
Type of dislocation	
Acute	79
Chronic	35
Recurrent	311
Superior	8
Medial	11
Lateral	2
Bilateral	421
Unilateral	4

Acute dislocation was treated by manual reduction in 63 cases without any form of anaesthesia while 2 cases were treated under IV analgesia and sedatives, and manual reduction was achieved in 14 cases under general anaesthesia, 3 cases were reduced with gag reflex (Table 2).

Chronic protracted TMJ dislocations were treated by manual Hippocratic method under G.A in 13 cases, a hook was used to apply traction on the sigmoid notch in 1 case, external elastic traction with arch bars and elastic bands was used in 1 case while assisted open reduction with Bristow's elevator was done in one case (Table 3). Vertical-oblique ramus osteotomy was used to correct prognatism and anterior open/cross bite in 9 cases, inverted L osteotomy was used in 1 case and sagittal split osteotomy was used in 1 case (Table 3contd).

The number of cases treated by chemical capsuloraphy using sclerosing agents and platelet rich plasma could not be ascertained, 9 cases were treated with autologous blood in the superior joint space and 9 cases with injection into the space and pericapsular tissues. Also, number of cases of chronic recurrent dislocation that received surgical capsuloraphy and placcation for lax capsule and ligaments was not obtained. Closed low

Table 2 Treatments useful for Acute dislocation

Treatment	No. of patients
Manual reduction without anaesthesia	63
Manual reduction with Local Anaesthesia (LA)+ sedation	2
Reduction with gag reflex	3
Manual reduction with General Anaesthesia (GA)	13
Assisted (open) reduction with General Anaesthesia	1

Table 3 Treatments Useful for Chronic protracted dislocation

Conservative Treatment of Chronic protracted dislocation	No. of patients
<i>Manual reduction without anaesthesia</i>	0
<i>Manual reduction with Local Anaesthesia (L.A)+ sedation</i>	1
<i>Manual reduction with L.A + sedation + nerve block</i>	1
<i>Manual reduction with General Anaesthesia (GA)</i>	13
<i>Assisted (open) reduction with General Anaesthesia</i>	1
<i>Elastic traction with Intermaxillary fixation</i>	1
<i>Traction with bone hook</i>	1
<i>Mandibular guidance therapy</i>	1
To reposition condyle in fossa (There was much restriction of movement)	
<i>Temporalis Myotomy</i>	4
<i>High Condylotomy</i>	?
To correct fusion and restore the joint (There was complete restriction of movement)	
<i>Low Condylotomy</i>	?
<i>Condylectomy (for chronic lateral dislocation)</i>	2
<i>Gap Arthroplasty (for superior dislocation)</i>	8
To maintain new joint and correct occlusion (There was little restriction of movement)	
<i>Horizontal subsigmoid osteotomy</i>	?
<i>Vertical/Oblique Osteotomy</i>	9
<i>Inverted L Shaped Osteotomy</i>	1
<i>Bilateral Sagittal Split Osteotomy</i>	1
<i>Midline Mandibulotomy</i>	1

level condylotomy to allow free movement was done in 2 cases while 4 cases received open condylotomy. Fifteen cases were treated with lateral pterygoid myotomy via intraoral approach (Table 4contd).

Also, 101 cases of chronic recurrent dislocation were treated with eminectomy to shorten the articular eminence and allow unrestricted movement/spontaneous reduction of the condylar head. Eminoplasty using mini-plates was done in 24 patients and screws was used in 3 cases (Table 4contd).

There were problems of severe pain and resorption of condylar head and eminence in 20% of cases with screws. Augmentation of the height of eminence by eminoplasty using bone grafts was done on some patients, 4 patients received interpositional (inlay) eminoplasty without need for wiring or plating while 60 received eminoplasty with onlay grafts wired to the articular eminence. Modified mini-invasive eminectomy and relocation of the lateral pterygoid muscle was done in 1 case.

Similar procedure was done for both sides in each bilateral case of chronic protracted and recurrent dislocation. Majority of the cases were adequately followed up for a period of 2-5 years and complications were mainly found in the patients that did eminoplasty with

screws. Patients with autologous blood injected around the pericapsular tissues and into the superior joint space had less recurrence rate than those injected into the space alone.

Discussion

Aetio-pathogenesis of Temporomandibular Joint Dislocation

Dislocation of the temporomandibular joint is the dislodgement of the head of the condyle from its normal position in the glenoid fossa located in the squamo-temporal portion of the cranial base. It can be partial (subluxation) or complete (luxation), bilateral or unilateral, acute, chronic protracted or chronic recurrent [7-29]. Also, it can be anterior-medial, superior, medial, lateral or posterior dislocation and the cause is either spontaneous or induced by trauma, [30-80] forceful mouth opening from endotracheal intubation with laryngeal mask or tracheal tube, ENT/Dental procedures, endoscopy, excessive mouth opening from yawning, laughing, vomiting and also during seizures [81-84,94,96-111]. Altered structural components include a lax capsule, weak ligaments, small/short and atrophic condyle, atrophic articular eminence, elongated articular eminence, hypoplastic zygomatic arch and small, poorly grooved glenoid fossa. Predisposing factors include epilepsy, severe vomiting, Ehlers-Danlos syndrome and Marfan's syndrome and dystonic movements from the effect of major tranquilizers/neuroleptics used for neuro-psychiatric diseases [5,28,46,51,68,116].

Anterior dislocations are the most common and occur due to displacement of the condyle anterior to the articular eminence of the temporal bone. Anterior dislocations are usually secondary to an interruption in the normal sequence of muscle action when the mouth closes from extreme opening [30]. The masseter and temporalis muscles elevate the mandible before the lateral pterygoid muscle relaxes resulting in the mandibular condyle being pulled out of the glenoid fossa and anterior to the bony eminence. Spasm of the masseter, temporalis and pterygoid muscles causes trismus and keeps the condyle from returning into the glenoid fossa [30].

Posterior dislocations typically occur secondary to a direct blow to the chin. The mandibular condyle is pushed posteriorly toward the mastoid [34]. Injury to the external auditory canal from the condylar head may occur from this type of injury.

Superior dislocations, also referred to as central dislocations, can occur from a direct blow to a partially opened mouth. The angle of the mandible in this position and small rounded margined condyle head predisposes to upward migration of the condyle. This can result in fracture of the glenoid fossa with mandibular

Table 4 Treatments useful for Chronic Recurrent Dislocation

Conservative Treatment of Recurrent dislocation	No. of patients
<i>Chemical Capsuloraphy</i>	?
<i>Alcohol</i>	
<i>Rivanol(aethedicaïne)</i>	
<i>Sodium monoruate</i>	
<i>Sodium psyliate (Sylnasol)</i>	
<i>Sodium tetradecyl sulphate</i>	
<i>Autologous blood capsuloraphy</i>	18
<i>Platelet rich plasma capsuloraphy</i>	?
<i>Botulinium toxin A toxin muscle injection</i>	2
To restrict condylar movement	
<i>Surgical capsuloraphy/Restitution of ligaments</i>	?
<i>Use of Mersilene or fascia lata around condylar neck</i>	?
<i>Internal Lateral pterygoid myotomy</i>	15
<i>External Lateral pterygoid myotomy</i>	1
<i>Open Condylotomy</i>	4
<i>Closed Condylotomy</i>	2
To recreate mechanical obstruction along condylar path	
<i>Anterior reposition/forward placement of disc</i>	?
<i>Downward and inward fracture of zygomatic bone</i>	?
<i>Eminoplasty with screws or L shaped pins</i>	3
<i>Eminoplasty with plates, mini-anchors</i>	24
<i>Eminoplasty with inlay bone grafts (Norman procedure)</i>	4
<i>Eminoplasty with onlay bone gafts (Dautery procedure)</i>	60
To remove mechanical obstacle along condylar path	
<i>Eminectomy (Standard)</i>	95
<i>Eminectomy (Modified)</i>	1
<i>Arthroscopic eminectomy</i>	5

? (Questionable)-signify that the number of cases treated by the treatment method could not be obtained.

condyle dislocation into the middle skull base [26,35,52,109]. Further injuries from this type of dislocation can range from facial nerve injury, to intracranial hematomas, cerebral contusion, leakage of cerebrospinal fluid, and damage to the eighth cranial nerve resulting in deafness. Medial dislocations are second to anterior dislocations. Avrahami et al. [110] documented 11 cases of medial dislocation and stated that they occur due to the sustained pull of the lateral pterygoid muscle on the condyle of the affected side.

Lateral dislocation is usually associated with mandible fractures. It could be type I (subluxation) or type II (luxation). Type II has been further sub-classified into three, depending on the duration and management applicable. The condylar head migrates laterally and superiorly and can often be palpated in the temporal space [8,9,61].

Acute dislocation presents within 2 weeks and it is readily reducible by the Hippocratic maneuver. After 2 weeks, spasms and shortening of the temporalis and

masseter muscles occur and reduction becomes difficult to achieve manually. This leads to the commencement of chronic protracted dislocation. Also, elongated articular eminence may prevent the sliding back of the head of the condyle into the normal position in the glenoid fossa, in this case, a chronic protracted dislocation with formation of a new pseudojoint with varying degree of movement sets in and such patients have problems with difficulty in closing the mouth (open lock) and deranged occlusion in which there is prognathism of the mandible with anterior cross bite [70].

In cases due to trauma, fibrous and bony consolidation occur anterior to the articular eminence following the sustained pull of lateral pterygoid and head of condyle resulting in ankylosis and deranged occlusion [31,34,63].

Chronic recurrent dislocations which include those due to habitual wide mouth opening are usually spontaneous and self reducible depending on the degree of alteration of the morphology of the temporomandibular joint and the contiguous structures. When the articular eminence is long, the dislocation will not be easily self reducible. It occurs commonly in patients with hypoplastic eminence, narrow fossa, lax capsule, collagen disorders, small condyle, hypermobility syndromes, oromandibular dystonias and use of neuroleptic drugs [17,18]

Plain T.M.J views especially the transcranio-oblique views, plain and contrast CT scans, i-CAT scans and MRI, linear and rotational plain digital tomograms, are joint arthroscopy are useful to assess the position of the head of the condyle and meniscus in relation to the glenoid fossa, mastoid process, tympanic plate and articular eminence. Recent imaging tools include the Dolphin imaging system which imports 2D facial photographs (facial wrap) on 3D stereographic images to enhance treatment simulation [40,41,55].

Newly Proposed Classification of TMJ Dislocation based on the position of the head of the condyle to the articular eminence

The author has classified dislocation based on relationship of the head of mandibular condyle to the articular eminence seen on clinico-radiological evaluation into three types (I-III).

Type I - the head of condyle is directly below the tip of the eminence

Type II - the head of condyle is in front of the tip of the eminence

Type III - the head of condyle is high up in front of the base of the eminence.

Conservative and Surgical Interventions in TMJ Dislocations

Cases of acute antero-medial, medial, lateral, or posterior dislocation can be reduced manually under local or

general anaesthesia, analgesic control with or without sedation. Other methods that have been used in literature include the wrist-pivot technique by Lowery et al. 2004, [30] combined ipsilateral staggering technique by Thomas et al. 2006, [97] the extraoral technique by Chen et al. 2007 [43]. Awang et al. 1987 [71] also described the gag reflex procedure in which the soft palate is rubbed across with a dental probe to initiate relaxation of the lateral pterygoid muscle and spontaneous reduction and closure of the mouth. However, Hippocratic maneuver still has the highest success rate.

Acute or chronic superior dislocation is better treated by gap arthroplasty, the impacted condylar head in the middle cranial fossa must be left in place to avoid bleeding, cerebrospinal fluid leakage and infection [26,35, 52,64].

Condylectomy is done for prolonged type II (complete/luxation) lateral dislocations, while treatment of type I and early type II is achieved by closed reduction of both dislocation and associated mandibular fractures, and intermaxillary fixation using arch bars, stainless steel ligature and tie wires for 4-6 weeks [9,61]. When there is bilateral condylar extracapsular fracture, open reduction and internal fixation of the condylar segment is indicated in addition to intermaxillary fixation with elastic bands for 2-4 weeks [8,9,61].

For chronic protracted dislocation, it is usually in the proposed type III position, the Hippocratic maneuver is usually unsuccessful without general anaesthesia and muscle relaxants and even with that, failure rate is high. Conservative methods like elastic rubber traction with arch bars and ligature wires/IMF with elastic bands are useful to achieve reduction in chronic protracted dislocation. Prior to the use of elastic bands, acrylic blocks or impression compound spacer can be placed in between upper and lower teeth to depress the mandible and open up the bite posteriorly, this helps displace the condyle downwards, the elastic bands that are applied front backwards helps to push the mandible/condyle backwards into the fossa after removing the spacer in about 72 hrs to 1 week. Extrusion of the teeth has been reported and it is corrected with bite plane [15,103].

Bone hook has also been used to apply traction via the sigmoid notch [15] Traction with wires is also possible through holes drilled in the angle of the mandible [15].

Manual reduction under local anaesthesia/deep temporal and masseteric nerve blocks [83], conscious sedation and general anesthesia or have also been described and these should be done first, but most cases are mainly amenable to surgical procedures.

In 1981, Lewis et al. [84] used Bristow's elevator to push the condyle into position via the Gillie's temporal approach for zygomatic bone elevation, the incision was

extended to the preauricular region. This is the assisted reduction under general anaesthesia.

When surgery is indicated for chronic protracted/prolonged dislocation (CPD) especially cases with longer duration, the goal may be to reposition the condyle in the glenoid fossa and restore movement; or if there is movement in the new position, the goal will be to set back the protruded mandible and correct occlusion. When temporalis is short and spastic, Laskin proposed an intraoral surgical approach to the muscle via a coronoid incision to do a temporalis myotomy [100]. Where access is difficult, when there is fibrosis or adhesions of muscle and cases where reunion of the muscles may occur, coronoidotomy with or without condylotomy is advocated [15].

Gotlieb advocated condylectomy and coronoidectomy in cases where there is ankylosis but there is possibility of entering the base of the skull and excessive bleeding from pterygoid plexus, internal maxillary and middle meningeal vessels [112].

Vertical and oblique ramus osteotomies have therefore, been described by many authors but these have the disadvantages of less bone contact, and impingement/impaction of the coronoid process on the condyle and the new joint, causing restrictions of movement [20,23,77,112,113].

Inverted L-shaped ramus osteotomy has been described by Adekeye in 1976 [112] to ensure maximal bone contact which is necessary for stability and healing.

Bilateral sagittal split technique offers a better outcome for correction of occlusion because there is no extraoral scar, risk of damage to inferior alveolar bundle is reduced in experienced hands and there is improved bone contact. Also, there is less post-operative bleeding and swelling from muscular detachment [20,112].

Chronic recurrent dislocation can be approached by conservative procedures of injecting sclerosing agents, autologous blood or platelet rich plasma into the lax pericapsular tissue and superior joint space weekly over a period of 6 weeks, [11-13,65,113] the sclerosing agents include sodium psyllate or sodium tetradecyl sulphate. Other workers have injected steroids into and around the capsule. The action of these injections is to induce fibrosis.

Moore and Wood [73,99] as well as some other workers have also injected Botulinium A toxin into the lateral pterygoid muscle, it is a protein catalyst, which prevents release of acetylcholine at the neuromuscular junction. It reversibly inactivate the protein that binds synaptic vesicles with the cell membrane. This is particularly useful when chronic recurrent dislocation is due to tardive dyskinesia and dystonias. It causes dysarthria, nasal speech, nasal regurgitation, painful chewing and swallowing, myasthenia gravis-like syndrome when it

spreads to adjacent tissues and it is contraindicated in pregnancy and lactating mothers.

Chronic recurrent dislocations not due to oromandibular dystonia respond better to surgical approaches especially when chemical capsuloraphy fails. These include surgical capsuloraphy in which a wedge of the capsule is excised and the tissue repaired (capsular placcation) with the goal of restituting and reinforcing the lax capsule, in situations where the eminence is low, it can be augmented or reconstructed with screws, plates or implants to improve the height.

Depending on the predisposing factor or morphology of the temporomandibular joint, the surgical procedures used to treat chronic recurrent dislocation may be directed towards restricting the condylar movement, creating a mechanical obstacle along the path of condylar translation or removing the mechanical obstacle in the condylar path.

Many surgeons have enhanced self reduction of chronic recurrent dislocation that cannot be easily self reduced due to elongated articular eminence by performing total eminectomy described by Myraugh in 1951 [104] to remove the eminence which serve as an obstruction [1,4,27,66,69,79,104,105,107]. Others have utilized the concept of restriction of condylar movement by detachment of lateral pterygoid tendon via internal or external approach or by doing an open or closed condylotomy below the attachment of lateral pterygoid [17,24,25,59,60,87,100]. Closed surgery reduces scarring but access is poor and increased damage to nerves and vessels in unskilled hands. The chance of recurrence due to fibrosis or re-union after surgery is higher for myotomy than condylotomy. Fascia lata, Mersilene tapes (Dacron) anchored around the zygomatic arch and passed around the condyle have also been used to restrict its movement [103]. Fascia lata can be readily harvested and treatment is cheaper but accompanied with post-operative pain, swelling, minor gait disturbance and movement of the lower limb [103].

Dautery and his colleagues in other to create mechanical obstacle along the condylar path, performed an osteotomy of the zygomatic arch and displaced the anterior segment downwards and inward to serve as a stop to the forward and upward movement of the condyle head [103]. This cannot be done in elderly patients because of the brittleness of the bone. Other materials like silicone wedge blocks and coralline hydroxyapatite blocks have been used [114]. Looseness, displacement and immune reactions are some of the adverse effects, especially for silicones.

Norman and his colleagues used interpositional eminoplasty in which bone grafts from the iliac or calvaria was sandwiched in the gap created in the middle of the articular eminence [5]. They did not use wires or plates

fix the segments. On the other hand, Dautery also performed an onlay eminoplasty by adapting a graft (fixed with wires) directly on the eminence to increase the height [78]. Both procedures also served to create mechanical obstruction. The grafts must extend medially to prevent medial escape.

Although procedures on the articular eminence seems to be gaining much popularity in recent times, eminectomy whose validity has been demonstrated by several authors, removes the bony obstacle, preventing condylar locking, but, these procedures does not address the uncoordinated muscle activity and the lax capsule or ligament, and this made some surgeons to adopt a modified mini-invasive eminectomy and relocation of the lateral pterygoid muscle or redirection of the temporalis muscle which aims to act on both the obstacle and the cause with respect to restoration of TMJ biomechanical constraints [1,75,103,115]. However, about 95% success rate have been recorded after use of eminectomy and metallic implants on the articular eminence.

Meniscoplasties and menisectomies are relevant procedures done when altered disc morphology and position cause dislocation or prevent self reduction. Total joint replacements should be considered when all appropriate treatments fail in chronic protracted and chronic recurrent dislocations, especially those with associated degenerative joint diseases [4,14,18,28,103,107].

Conclusion

The difficulty index assesses the ease of the manual reduction method to achieve a reduction of the condyle into its normal position in acute or chronic protracted dislocation and it is directly related to the position of the condylar head and the height of the articular eminence. Also, the frequency of recurrent dislocation and the self reducibility can be inversely linked to the height of the articular eminence.

The more complex and invasive method of treatment may not necessarily offer the best option and outcome of treatment, therefore conservative approaches should be exhausted and utilized appropriately before adopting the more invasive surgical techniques which should be done after thorough assessment and treatment planning [103]. Surgical treatment must therefore be based on the type, mechanism, aetio-pathogenesis and predisposing factor/morphology of the joint, age, availability of materials and skilled manpower.

Competing interests

The author declares that they have no competing interests.

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