

# Perioperative trigeminocardiac reflex in patients undergoing surgical treatment of temporomandibular joint ankylosis: A study

## ABSTRACT

**Purpose:** The behavior of trigeminocardiac reflex (TCR) is limited to few case reports only in maxillofacial surgery, especially for temporomandibular joint (TMJ) ankylosis cases. The present study aims to find out the incidence of bradycardia due to TCR during intraoperative forceful mouth opening in TMJ ankylosis patients.

**Materials and Methods:** A prospective, unicentric observational study was conducted selecting those patients who were planned for osteoarthrectomy with interpositional gap arthroplasty under general anesthesia. Sixty cases of TMJ ankylosis were randomly selected from December 2018 to March 2020. Predictor variables were patient age, gender, and type of ankylosis, and outcome variables were pulse rate, mean arterial blood pressure (MABP), and oxygen saturation level (SPO<sub>2</sub>). Data were recorded at baseline and during intraoperative mouth opening via heister jaw stretcher. A Chi-square test was used for testing the association between variables. *P* values were considered statistically significant at <0.05.

**Results:** The sample size of 60 subjects has been divided into two age groups (10–19) years and (20–40) years. The mean standard deviation age of the patients was 18.32 ± 6.81 years. About 63.3% were male. Out of 60 cases, 14 patients developed bradycardia. The frequency of bradycardia was found 23.3%. According to logistic regression analysis, age and type of ankylosis were the significant predictors of bradycardia.

**Conclusion:** We conclude that bradycardia due to TCR in TMJ ankylosis patients is not an uncommon entity. Incidences are more prevalent in the age group of 10–19 years and type IV bony ankylosis. Male had a high incidence of bradycardia though *P* value was nonsignificant.

**Keywords:** Maxillofacial surgery, temporomandibular joint ankylosis, trigeminocardiac reflex

## INTRODUCTION

Trigeminocardiac reflex (TCR) reflex has gained less attention in maxillofacial surgeries till now due to less reported data and literature although in neurosurgical procedures and ocular surgeries, a lot of clinical studies have been reported. Surgical procedures performed in the region supplied by cranial nerve areas, especially of the V<sup>th</sup> nerve that is the trigeminal nerve, can cause vagally induced bradycardia. This phenomenon is called trigeminocardiac reflex, similar to the “oculocardiac reflex” encountered during ophthalmic surgery. Oculocardiac reflex occurs in 32%–90% of strabismus surgeries,<sup>[1]</sup> but there are not much-documented data regarding TCR in temporomandibular joint (TMJ) ankylosis surgeries. Abdel-Hameed Elsayed *et al.*<sup>[2]</sup> conducted a

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retrospective study in 55 samples of TMJ ankylosis cases and reported a TCR incidence of 12.7% during gap arthroplasty.

TCR reflex is defined as a sudden decrease in pulse rate with or without mean arterial blood pressure (MABP) that may result in asystole and even cardiac arrest. TCR is characterized by an acute change in MABP, cardiac arrhythmia, ectopic beats, bradycardia (>20% of baseline value), syncope, vomiting, asystole, drop in oxygen saturation (SPO<sub>2</sub>) level, and gastric changes (gastric hypermotility).<sup>13,41</sup>

### Classification of trigeminocardiac reflex

1. Peripheral
2. Gasserian ganglion
3. Central.

The traditional classification of trigeminocardiac reflex depends upon the location of the trigger point. A central TCR is triggered by the stimulation of the intracranial part of the trigeminal nerve as in neurosurgical procedures. Peripheral TCR is therefore triggered by the extracranial course of the nerve. Gasserian ganglion subtype is defined as a reaction to direct stimulation around the ganglion, clinically present as a change in heart rate or MABP or decreasing in both parameters [Figure 1]. Peripheral TCR is further divided according to a branch of the affected trigeminal nerve into oculocardiac reflex V<sub>1</sub> and the maxilla–mandibular reflex V<sub>2</sub>, V<sub>3</sub>. All subtypes present slow down in heart rate, i.e. bradycardia. In the central TCR, a decrease in MABP is always seen while it is not necessary for peripheral type.

Various oral and maxillofacial surgical procedures can trigger this response, causing a severe or moderate decrease in the heart rate and sinus rhythms, its incidence during intraoperative mouth opening in TMJ ankylosis patients is still controversial.

The purpose of the present study was to estimate the prevalence of TCR during intraoperative mouth opening, among patients undergoing operative management of TMJ ankylosis. Hence, maxillofacial surgeon should be aware of the phenomenon of TCR intraoperatively and should inform the patient during postoperative physiotherapy for being cautious. Careful monitoring should be done to prevent any shocking events like bradycardia, sinus arrest, and arrhythmia.

### MATERIALS AND METHODS

A prospective randomized study was designed and conducted over all those TMJ ankylosis patients visiting oral and maxillofacial surgery outpatient department from the

period of December 2018 to March 2020, fulfilling inclusion criteria. The study population included 60 patients of either sex (American Society of Anesthesiologists Grade I and II) after obtaining informed and written consent from the patient itself or the guardian if the patient is minor. Age distribution of the patients was done in two groups (10–19) years and (20–40) years. The medical history of all patients was recorded and diagnosed based on clinical and radiographic examination. A routine blood investigation was done. Ethical clearance was approved by the Ethics Committee of University by the reference number 103 ECM II B-Thesis/P22.

### Inclusion criteria

- Age group between 10 and 40 years
- Patients having clinical signs and symptoms of TMJ ankylosis undergoing general anesthesia.

### Exclusion criteria

- Patients suffering from any systemic diseases (cardiac, respiratory, hepatorenal diseases, and any endocrine diseases)
- Patients with cardiac arrhythmic disorder
- TMJ disorders, other than ankylosis
- Patients on beta-blocker therapy and any antiarrhythmic drug therapy.

### Study variables

In the present study, the primary predictor variables included patient age and gender and type of ankylosis, and the primary outcome variable was >20% reduction of heart rate from its baseline value, lowering of MABP, and change in SPO<sub>2</sub> level.

### Surgical procedures

In the present study, all included patients were fulfilling our inclusion criteria and provisionally fit for general anesthesia as examined in preanesthetic checkup by the anesthesia resident. All patients were kept nil per oral for 8–10 h.

Premedication with injection fentanyl (2 µg/kg body weight) and glycopyrrolate (0.04 mg/kg body weight) and 1 mg midazolam was given before fiberoptic intubation to allay anxiety. Once the position of the endotracheal tube was confirmed by EtCO<sub>2</sub>, anesthesia was an endeavor with propofol (2 mg/kg body weight) loading. Anesthesia was maintained by 40% O<sub>2</sub> + 60% N<sub>2</sub>O + sevoflurane + vecuronium. A deeper plane of anesthesia was done by using train of four (TOF) for neuromuscular monitoring intraoperatively in all cases.

Exposure of TMJ was done using the standard ALKAYAT and BRAMLEY approach. After exposure and identification of the ankylotic chunk, gap arthroplasty was done by aggressive excision of the fibrous or bony mass, carried out by burs or

chisel mallet until at least a gap of 1–1.5 cm has been achieved between glenoid fossa and mandible. Heister mouth stretcher was applied to check the target mouth opening, i.e. 3–4.5 cm has been achieved or not.

During application of heister, heart rate and blood pressure (BP) were continuously monitored to check if there is any bradycardia or fall in SPO<sub>2</sub> level due to trigeminal cardiac reflex. If there is severe bradycardia (heart rate <40 beats/min/20% or more decrease in heart rate from baseline values), heister was removed till heart rate comes to baseline values. MABP, SPO<sub>2</sub>, and BP were measured. In refractory bradycardia, injection atropine 0.6 mg intravenous (IV) bolus was given as adjuvant after the stoppage of surgery.

**RESULTS**

In the present study, male were 38 (63.3%) and the female were 22 (36.7%) in number. Forty-three cases were in the age group of 10–19 years (71.7%) and 17 cases were in 20–40 years age group (28.3%). Out of 60 cases, bradycardia was detected in 14 subjects (23.3%) [Table 1]. The type of ankylotic chunk was as follows (Sawhney’s classification):

Type I in 75%, Type II in 89.5%, Type III in 84%, and Type IV in 41.7%. During analysis of the type of bony ankylosis using a Chi-square test, a statistically significant result was found in the incidence of TCR with Type IV bony ankylosis [*P* < 0.05; Table 1 and Figure 2].

In the present study, the incidence of bradycardia due to TCR was found in 23.3% of cases during intraoperative forceful mouth opening. None of the patients developed asystole or any adverse event. Although two patients developed, severe bradycardia by heart rate dropped up to 45 beats/min from their baseline value of 70–73 beats/min. In those patients, the procedure was immediately stopped, within 1 min heart rate reached to basal line. In addition, two cases had bradycardia and a slight change in MABP but maintaining mean arterial pressure (>65 mmHg). SPO<sub>2</sub> value was maintained in the range of (99%–100%) throughout the procedure in all cases. Reported bradycardia in 14 cases, 10 were male and 4 were female, but the result was nonsignificant [*P* = 0.612; Table 2

**Table 1: Assosiation of bradycardia with type of ankylosis**

Type of ankylosis	No of bradycardia		Bradycardia		Chi sq.	P
	No.	%	No	%		
Type I	3	75.0	1	25.0	10.717	0.013
Type II	17	89.5	2	10.5		
Type III	21	84.0	4	16.0		
Type IV	5	41.7	7	58.3		
Total	46	76.7	14	23.3		

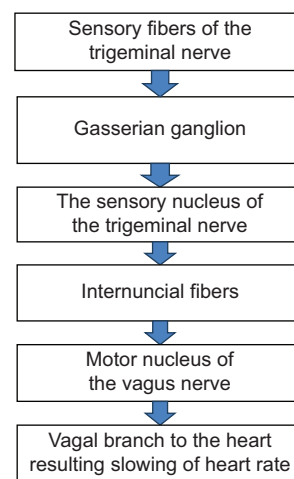
and Figure 3]. In this proposed prospective study, 43 cases were in the age group of 10–19 years and 17 cases were in the 20–40 years of age group. Younger age group patients experienced more incidence of bradycardia (27.9%) in comparison to elderly patients’ age group (11.8%) [Figure 4].

According to the logistic regression analysis model, age and type of ankylosis were the significant predictors of bradycardia [Table 3].

In the present study, bradycardia is predicted by the model in 7 cases out of which it was truly getting in 6 cases, so one case of false positive was found. On the other hand, bradycardia was not predicted by the model in 53 cases out of which it was truly absent in 45 cases so 8 cases of false negative were found. The overall accuracy of the model thus appeared to be 85%.

**DISCUSSION**

After the release of ankylosis, intraoperative forceful mouth opening is required. In this study, it has been observed that



**Figure 1: Trigemino-cardiac reflex is summarized in a flowchart**

**Table 2: Summary of relationship between age, gender, type of ankylosis and bradycardia**

	Total	Bradycardia	Chi sq.	P
Gender				
Male	38 63.3%	10 26.3%	1.775	0.612
Female	22 36.7%	4 18.2%		
Age group				
10-19 years	43 71.7%	12 27.9%	1.775	0.183
20-40 years	17 28.3%	2 11.8%		
Types of ankylosis				
I	4 6.7%	1 25%	10.7	0.013
II	19 31.7%	2 10.5%		
III	25 41.7%	4 16%		
IV	12 20%	7 58.3%		

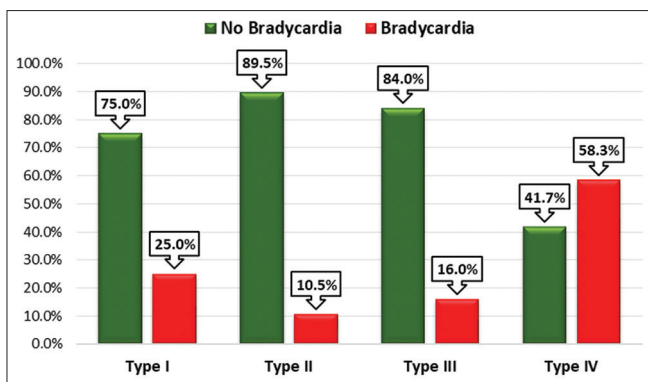


Figure 2: Association of bradycardia with type of ankylosis

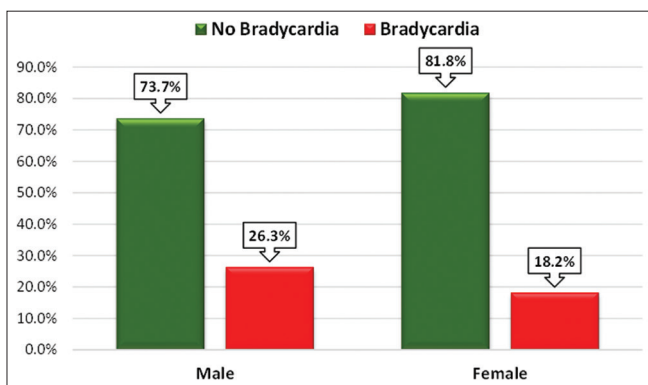


Figure 3: Association of bradycardia with gender

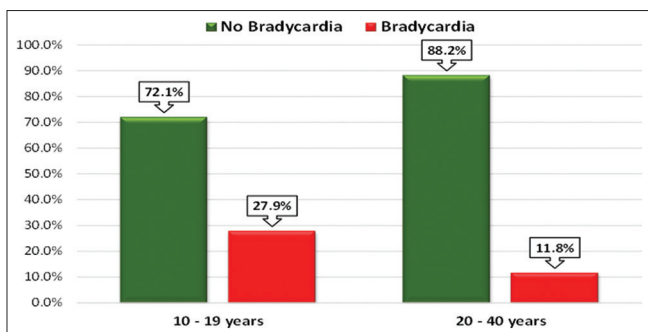


Figure 4: Association of bradycardia with age group

in some patients, during forceful mouth opening, there is a lowering of heart rate from baseline values. The initiation of the reflex is basically by pain and proprioception.<sup>[5]</sup> From animal models, it has been found that approximately two-third of the sensory trigeminal nerve is composed of unmyelinated C-fibers and A-delta fibers involved in the conduction of nociceptive pathway and tooth pulp is innervated by A-beta fibers.<sup>[3]</sup> The key findings of this study are bradycardia observed in 23.3% of cases. In addition, the incidence of bradycardia was more prevalent in the age group of 10–19 years (27.9%) than the 20–40 year age group (11.8%), male had high incidence (26.3%) than females (18.2%). In this study, the proportion of males and females is 19:11 (1.7:1). According to Potdar et al<sup>6</sup> they included a total of 17 patients

Table 3: Incidence of bradycardia with respect to Demographic data and type of Ankylosis

	B	SE	P	Exp(B)
Age (10-19) years	3.33	1.38	0.016	27.93
Gender				
Male	0.81	0.90	0.370	2.24
Type of ankylosis			0.024	
Type I	-0.83	1.69	0.622	0.44
Type II	-4.17	1.41	0.003	0.02
Type III	-3.62	1.32	0.006	0.03

SE: Standard error

in their study, the male: female ratio was 2:1, it showed that male had a high incidence of TMJ ankylosis than female. Mean age was 17 years and highest percentage group of ankylosis from 7 to 14 years, which coincides to our study. The etiology of TMJ ankylosis broadly includes trauma and infection. Isolated mandibular fractures represent the most common type of pediatric maxillofacial fractures. Trauma is the major cause of ankylosis in India, while a high percentage of congenital TMJ skeletal disorders are reported from the West. We hypothesized that this was the reason for more number of younger age group patients, specifically male in our study. TCR mainly serves as a protective phenomenon, but under some conditions, this reflex becomes exaggerated and puts the patient at risk. According to Lubbers *et al.*,<sup>[7]</sup> Bhargava *et al.*,<sup>[8]</sup> and Devakumari and Vijhayapriya,<sup>[9]</sup> predisposing and risk factors for TCR are children, male, hypoxemia, hypercarbia, light anesthesia, beta-adrenergic blockers, strength and duration of stimuli, and halothane.

In our study, the incidence of bradycardia was more in the age group of 10–19 years and male. We hypothesized that the age group of 10–19 years and males are more active in outdoor playing activities and report more maxillofacial trauma in comparison to females. According to the literature, the most common cause of TMJ ankylosis is maxillofacial trauma and poorly managed or undiagnosed condylar fracture.

- TCR reflex is more pronounced in children because of higher resting vagal tone
- TCR reflex is considered as “oxygen conserving reflex,” same as diving reflex, for vital organs such as heart and brain. From experiments, it has been suggested that trigeminocardiac reflex represents an expression of a central neurogenic reflex leading to rapid cerebrovascular vasodilatation to prevent from any serious hypoxic damage like ischemia of brain.<sup>[3]</sup> Both hypoxia and hypercarbia can be excluded throughout the intraoperative phase as all patients were on controlled mode ventilation
- The depth of anesthesia should be adequate, as the deeper planes obviate the cardiovascular depressive

responses by restricting the stimulation of the trigeminal nerve.<sup>[10]</sup> In our study, this is also ruled out because the anesthetist used TOF, maintaining a deeper plane of anesthesia in all cases during the intraoperative period

- Beta-blockers reduce the sympathetic response of the heart and by so doing, augment the vagal cardiac response resulting in bradycardia, but in our study, patients on beta-blockers or any antiarrhythmic drugs were already excluded so this is also ruled out
- The use of halothane during general anesthesia in dental surgery has been reported to increase the occurrence of arrhythmia. As halothane affects myocardial conduction, but in our study, anesthesia was maintained on sevoflurane rather than halothane that was not so commonly used nowadays due to its arrhythmogenic property. Hence, this is also ruled out<sup>[11]</sup>
- Kayıkçioğlu *et al.*<sup>[12]</sup> mentioned that a minimum period of 15–20 s of stimulation is necessary to elicit the reflex leading to at least 20% or more reduction in heart rate. Abrupt and sustained traction is more likely to evoke the TCR than smooth and gentle manipulation.<sup>[2,8]</sup> The reason behind smooth traction is, there is excessive overcompensation by the parasympathetic system occurs in an attempt to balance sudden sympathetic stimulation.

After the release of the ankylosed chunk, the next step is forceful mouth opening by application of Heister jaw stretcher, there is mechanical stimulation of mandibular branch of the trigeminal nerve which sends vagal reflex to the heart causing bradycardia. This statement is proved by Bohluli *et al.*<sup>[13]</sup> study design, they took 20 patients with the 2 sides of the mandibles, one side as a case and another side as control, and concluded that there was a statistically significant association between blocking the mandibular division of trigeminal nerve and decreased presentation of TCR.

Reflex bradycardia due to TCR resulted from distracting the mandibular condyle. The sensory supply of TMJ is by an auriculotemporal, a branch of the mandibular nerve. In ankylosis patients, during forceful mouth opening, nerve stimulation occurs, causing bradycardia.<sup>[14]</sup>

In the present study, all cases received glycopyrrolate through IV route in premedication, but during the intraoperative phase at the time of mechanical stimulus, no cases received atropine/glycopyrrolate at the time of bradycardia because reflex reverts back spontaneously after removing Heister. IV anticholinergics (atropine or glycopyrrolate) are effective in preventing this reflex if given in adequate doses within 30 min of surgery, but its effect is worn off by the time intraoperatively.<sup>[1]</sup>

Type I ankylosis was the least prevalent (25%) for bradycardia, while Type IV was most prevalent (58.3%). Abdel-Hameed Elsayed *et al.*<sup>[2]</sup> conducted a study in which the incidence of bradycardia was more pronounced in Type IV ankylosis during the surgical release of the bony chunk. Type IV bony ankylosis is characterized by severe bony bulge with complete fusion and absence of any safe cleavage line for osteotomy; this causes more difficulty in performing surgery, causing movement of the ankylosed chunk to the more medial direction; in addition, there is a need to increase the gap space between the mandibular stump and the temporal bone more than Type I, II, and III. They also found that the incidence of bradycardia was more pronounced in recurrent cases of TMJ ankylosis. The scope of this study is limited to the prevalence of TCR with age group and type of ankylosis, and thus, the issue concerning the duration of ankylosis having any effect on the prevalence of TCR has not been considered. However, this particular issue requires more research and analysis as only limited studies have been found to date.

In the central subtype of trigeminocardiac reflex, Dominguez *et al.*<sup>[15]</sup> commented that patients who received lower doses of anesthetic and analgesic agents developed tachycardia, which could be related to pain and secondary sympathetic stimulation resulting from incomplete analgesia. Heister is used for forceful MO in many other indications without any anesthesia, for example, in trismus. Arakeri and Arali stated about “dento-cardiac reflex” similar to TCR.<sup>[16]</sup> We can postulate by their medical hypothesis that there is low severity of TCR reflex in forceful mouth opening without anesthesia due to active sympathetic reflexes. TCR reflex is usually seen under general anesthesia where all sympathetic reflexes are blunted and increased vagal activity due to stimulation of trigeminal nerve branches. However it needs future research to conclude.

The main limitation of this study is having a fewer number of cases. We need to include more cases and an adequate male: female ratio, to find any association of gender and duration of ankylosis with TCR.

## CONCLUSION

Bradycardia was noted during intraoperative forceful mouth opening in TMJ ankylosis cases due to trigeminocardiac reflex. The incidence was more prevalent in the age group of 10–19 years and Type IV TMJ ankylosis having male preponderance. These findings should alert oral and maxillofacial surgeons and make them more aware of this risk. The patient should be monitored properly during intraoperative mouth opening and postoperative physiotherapy, especially in children and young adults

due to high resting vagal tone. Preventive measures and management procedures are seemingly the most important aspects of the TCR for oral and maxillofacial surgeons.

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#### Conflicts of interest

There are no conflicts of interest.

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