The effect of regional nerve blockade on the incidence of trigemino cardiac reflex in TMJ surgeries due to use of bi-block prosthesis

RM Reyad¹, EG Saleh¹, AA Ghanem², RR El Beialy²

Abstract

Introduction

Ankylosis is a serious and handicapping problem and has been associated with a lot of hazards from chewing problems and malnutrition up to frank sleep apnoea syndrome (OSA) and life threatening upper airway complications during anaesthesia. On the other hand, trigemino cardiac reflex (TCR) consists of dysrhythmias, hypotension, apnoea and gastric hypermotility. Clinically, it is encountered in cranio-maxillo facial and ocular surgeries. In this study we try to study the incidence of TCR due to forcible mouth opening by bi-block prosthesis following TMJ procedures after regional nerve blocks of maxillary and mandibular nerves.

Materials and methods

100 patients enrolled for TMJ surgeries are grouped into 2 groups each containing 50 patients, control group (C-group) and nerve block group (NB-group) in which maxillary and mandibular nerves are blocked. Acrylic – bi-block prosthesis is inserted. The incidence of TCR (which is defined by a drop in both HR and MABP in > 20% of the baseline values), also lowest H.R, occurrence of dysrhythmias, hypotension, apnoea and laryngospasm.

Results

There is a significant drop of incidence of TCR in the NB group (9%) compared to the C-group (2/50 – 4%).

The lowest H.R. is insignificantly higher in the NB-group (49+3) than the C-group (44+2).

There was no haemodynamically significant hypotension, arrhythmias or laryngospasm.

Conclusion

Prophylactic nerve blockade at end of TMJ procedures and before bi-block prosthesis application is efficient to reduce the incidence of TCR.

Introduction

Different surgical procedures have been described for the temporomandibular joint (TMJ) including arthrocentesis¹, arthroscopy, and TMJ reconstruction for a variety of indications including ankylosis.

Ankylosis of the temporomandibular joint (TMJ) is an intracapsular union of the disc-condyle complex to the temporal articular surface of the cranium that restricts mouth opening².

TMJ ankylosis is mostly related to trauma (13-100%), local or systemic sepsis (10-49%) or multi-system disease (10%). TMJ ankylosis may also follow TMJ surgery³.

Ankylosis of the temporomandibular joint may be associated with difficulties in chewing, digestion, speech, and oral hygiene⁴. When this process occurs during childhood, it may alter the normal potential growth of the whole maxillofacial complex.

This in-turn may cause facial disfigurement and asymmetry (bird-face deformity), psychological sequelae together with airway obstruction, obstructive sleep opera (OSA) and cor-pulmonale⁵. Associated structural anomalies may compromise the upper airway leading to great hazards regarding ventilation, intubation and extubation⁶.

The trigeminal nerve is the largest cranial nerve and it supplies sensation to the face, scalp together with nasal and oral mucosa⁷. Stimulation of the trigeminal receptors in the nasal mucosa could initiate a trigemino respiratory reflex plus cardiac arrhythmias. This reflex has been studied in animals a long time ago and named Kratschmer’s reflex⁸. Now, it is re-named as the “Trigemino-cardiac reflex” which is defined as the sudden occurrence of parasympathetic dysrhythmia, sympathetic hypotension, apnoea or gastric hyper motility due to central or peripheral stimulation of any of the sensory branches of the trigeminal nerve⁹.

The incidence of TCR is greatly variable according to the type of surgical manoeuvre involving the sensory branches of the 5th nerve.

For example, ophthalmic surgery (especially strabismus and intra-orbital mass surgeries) may be associated with TCR in up to 90% of cases. The incidence is lower in craniofacial surgery (1-2%) such as Lefort-1 osteotomy, mid-face fractures reduction, elevation of complex zygomatic fractures and temporomandibular joint surgery including ankylosis. The incidence in skull base surgery is modest (8-18%), as in balloon-rhizotomy of the Gasserian ganglion, tumours in the cerebello pontine angle, pituitary fossa or falk¹⁰. Predisposing factors for intraoperative TCR include hypoxia, hypercarbia, light general anaesthesia and young age (high vagal tone), as well as long lasting stimulus and bilateral trigeminal stimulation¹¹. In addition, perioperative TCR has been reported during drainage surgery of subdural empyema or H2O2 immersion suggesting inflammatory and chemical predisposition¹².

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A history of transient ischemic attacks (TIA), 6 weeks prior to surgery, is an additional risk factor for intraoperative TCR. Furthermore, drugs, including potent narcotics (sufentanil and alfentanil), beta-blockers and calcium channel blockers, all exaggerate the occurrence of intraoperative TCR. 

In this prospective controlled study, we report the incidence of TCR due to the use of bi-block prosthesis at the end of TMJ procedures to maintain the initial improvement in mouth opening in the early post-operative period. Also, we suggest prophylactic nerve blockade or both the upper and lower jaws in an attempt to reduce the incidence of such TCR.

Materials and methods

In accordance with ethical Guidelines for research in humans, this study was designed as a prospective, randomized, and controlled clinical study from August 2009 into January 2013, in the Cairo University Dental Hospital, Maxillofacial Unit Ain Shams University. The study protocol was approved by the ethical committee of each and signed informed consent was obtained from all patients allocated in the study.

100 patients were involved in the study randomly selected and allocated for elective surgery. They met the following inclusion criteria:

1. Type of surgery: TMJ surgical procedures that includes - Surgeries for unilateral, bony ankylosis which is corrected by gap arthroplasty and acrylic bi-block prosthesis is used immediately at the postoperative period to prevent re-ankylosis. - TMJ arthroscopy, arthrocentesis, eminectomy, meniscectomy, conylotomy and condylectomy.
2. Age: 18-65 years.
3. ASA status I and II patients.

Exclusion criteria

1. ASA III and IV status.
2. Extreme of age: paediatric and geriatric patients.
3. Severe cardiovascular, pulmonary, endocrinial or rheumatological disorders.
4. Pregnancy and lactation.
5. Patients on regular drug therapy that may affect the haemodynamic variables measured in assessing the TCR e.g. beta blockers, Ca-channel blockers, anti-arrhythmic and anti-psychotic drugs.
6. Patients with known high vagal tone, for example those suffering from frequent vasovagal attacks or carotid sinus syndrome.

The selected patients were randomly allocated into 2 groups and each contained 50 patients:

1. Nerve block group (Group-NB): in which prophylactic nerve blockade of both upper and lower jaws were done by the same maxillofacial surgeon at the end of the surgery and before bi-block application and extubating the patients.
2. Control group (Group-C): in which, no nerve blockade has been done.

Anaesthetic technique

Meticulous assessment of the airway was done by the anaesthesiologist.

The patient was transferred to the operating theatre, ASA-basic monitors were applied to the patient [pulse – oxymetry – non-invasive blood pressure (NIBP)-3-leads ECG and capnography]. For all patients, non-apnoeic inhalational induction using sevoflurane was tried. Lidocaine 1-1.5mg/kg was given 2-3 minutes earlier to attenuate the pressure effect of airway manipulation. Intubation had been carried out using routine direct laryngoscopy and for difficult cases either the fibre optic technique with lidocaine spray 10% "spray where you go", or blind nasal intubation had been tried. After checking the position of ETT by chest auscultation and capnography, the ETT had been secured in place carefully. Thereafter, fentanyl 2-3mg/kg and atracurium besylate 0.5mg/kg I.V. are administrated to all patients.

Anesthesia was maintained using 100% O2 plus 1-1.5 MAC isoflurane and atracurium besylate 0.1mg/kg every 25 minutes. Analgesia was provided using top up doses of fentanyl 50-100mg I.V. according to the haemodynamic variants of the patient. Analgesia was augmented with a ketolac 30mg I.V drip plus a paracetamol 1gm I.V. drip.

At the end of the surgery, the volatile agent was discontinued, and we made sure that the patient was fully conscious, alert, oriented and could obey demands before extubation. Lidocaine 1-1.5mg/kg I.V. was given prior to extubation in order to ameliorate pressure response of airway assessment and reduce the incidence of laryngospasm following extubation.

At the end of surgical procedures of TMJ and before bi-block application, nerve blockade of the upper jaw (maxillary block) and lower jaw (mandibular block) had been carried out by the same maxillofacial surgeon using a lidocaine 1% plus bupivacaine 0.25% cocktail as follow: the technique of maxillary nerve block is performed intraorally via "The High Tuberosity technique". The target area is the region where the maxillary nerve enters the pterygopalatine fossa. The needle is inserted at the height of the mucobuccal fold above the distal aspect of the 2nd maxillary molar (guided by anatomical landmarks as the maxillary tuberosity and the zygomatic process of the maxilla). The needle advanced to the depth of 30mm and 1.8 ml of local anaesthetics was injected.

The technique used for mandibular nerve block is "the Akinosi technique" which is applicable for closed month states. The needle is directed medial to the coronoid process and via mucosal tissues till the depth of 25mm of the maxillary tuberosity, then, 1.8 ml of local anaesthetics is injected.

Then, the bi-block prosthesis (acrylic type) is inserted before patient extubation. The maximal tolerated size is applied and all patients were foretold that the prosthesis would be inserted for one week immediately postoperatively (as much as tolerated).

For each patient, HR and MABP recorded basically (before induction of anaesthesia) and after bi-block insertion (extending to 60 minutes after extubation until full patient...
recovery) together with the lowest H.R. were recorded. In addition, any adverse haemodynamic event such as asystole, ventricular ectopy, severe bradycardia (HR < 45 / min), severe hypotension or laryngospasm, all have been reported together with their management.

Statistical analysis
Data entry and analysis was done with IBM compatible computer using software (SPSS version). Data are expressed as mean (SD) and number (% of incidence).

The difference between the groups were tested using student’s T-test and X² test as appropriate. All p-values are considered significant at P < 0.05.

Results
Patients characteristics are given in table 1. There were no significant differences regarding age, sex, body weight or type of surgical procedures. TCR was reported in 2 patients (4%) of the control group and none (0%) in the nerve block group. The lowest mean H.R. after bi-block insertion was significantly higher in the NB group compared to the control group. The mean baseline HR was comparable in both groups.

In patients demonstrating bradycardia, HR increased after release of the bi-block fore sometime until haemodynamic stability had regained and atropine 0.6 mg I.V. was given if bradycardia <45/min persisted.

There were no other clinically significant arrhythmias (including ventricular ectopy and asystole). MAP was maintained within 20% of the preoperative values (apart from the 2 cases of the control group who expressed the manifest TCR and their MABP dropped > 20% of base line values, however, rapid recovery occurred on fluid administration.

No cases of laryngospasm have been reported (meticulous assessment for upper airway oedema prior to extubation plus fully awake – state extubation may played a role in that respect) (Table 2).

Discussion
In this prospective study, we described a unique predisposing manoeuvre for trigemino-cadiac reflex (TCR) which is the forcible mouth opening due to the "bi-block" appliance used at the end of TMJ surgery to prevent immediate re-ankylosis due to oedema, pain and early haematoma.

Trigemino-cardiac reflex is suggested to be a brainstem reflex and currently has been defined as a drop in the heart rate (HR) and mean arterial blood pressure (MABP) by more than 20% of the base line values of the patient due to surgical manipulation at any of the sensory branches of the 5th nerve (either centrally or peripherally)16. Other clinical presentations of TCR may range from sinus bradycardia, bradycardia ends in asystole, asystole without preceding bradycardia, apnoea and gastric hypermotility17. Its incidence in maxillofacial surgery including surgeries at the TMJ (as in ankylosis operations) is about 1-2% due to peripheral stimulation of sensory branches of the 2nd and 3rd divisions of the trigeminal nerve (may be termed the maxillo-mandibulo-cardiac reflex)18.

In addition, peripheral stimulation (anterior ethmoidal nerve in the nasal mucosa) co-activates the vagal nerve (resulting in bradycardia) and sympathetic nerves (resulting in hypertension)19. Conversely, central stimulation of TCR results in profound cardiac vagal activation and inferior cardiac sympathetic nerve suppression17.

TCR has been proven to be of great clinical significance as the accompanying hypotension may end in myocardial or cerebral infarction in those at risk.

It is also linked with worse outcomes following neurosurgical procedures. For example, the occurrence of intraoperative TCR is correlated with higher incidence of ipsilateral tinnitus in patients undergoing vestibular schwannoma surgery20. Gharabaghie et al.21 have attributed postoperative decline in auditory function in vestibular schwannom surgery to intraoperative occurrence of TCR. Cioly et al. studied the deterioration of brain auditory evoked potentials (BAEP) during surgery for cerebellopontine angle tumours and connected this deterioration to occurrence of TCR. A possible explanation is the reduced local vascular perfusion by TCR-induced hypotension of the already compromised local circulation due to surgical dissection22.

TCR must be considered as an oxygen-conserving neuroprotective reflex of the physiological role in preventing hypoxia and augment ischemic tolerance of the brain during stroke-states. This may be of great putative value in clinical neurology and cardiovascular therapy23. Regarding the predisposition for TCR, a variety of risk factors have been postulated "as mentioned before". In addition, due to advances in surgical manoeuvres and techniques, new predisposing factors for TCR have been described recently.

Table 1: Patients characteristics.

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Nerve block (NB) group N=50</th>
<th>Control group N=50</th>
<th>P value</th>
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<tr>
<td>Age (years)</td>
<td>44 ± 11.6</td>
<td>42±9.6</td>
<td>0.685</td>
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<tr>
<td>Sex (M:F)</td>
<td>22:28</td>
<td>20:30</td>
<td>0.312</td>
</tr>
<tr>
<td>Body weight (Kg)</td>
<td>62±8.6</td>
<td>64±7.2</td>
<td>0.114</td>
</tr>
<tr>
<td>Types of operations</td>
<td>Ankylosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other TMJ procedures</td>
<td>17</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>145±27</td>
<td>149±28</td>
<td>0.712</td>
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</table>

Competing interests: None declared.
TCR has been encountered during drainage surgery for subdural empyema due to sensitization of meningeal afferents of central TCR by inflammatory mediators. Another case report has been published recording central TCR in response to chemical irritation of the sensitized trigeminal-dural afferents by hydrogen peroxide (commonly used for hemostasis) during evacuation of subdural hematoma. In our study, similarly, we describe a new risk factor for TCR which is the 2nd and 3rd divisions stimulation by upper and lower jaw irritation through the use of bi-block prosthesis which might be considered as an exaggerated form of the previously described forcible mouth probing (or opening). The higher rate of TCR in our study (4%) compared to the general occurrence of maxillo-mandibular TCR (1-2%) may be attributed to relatively small sample size. In addition our work may support the idea that bradycardia and TCR during maxillofacial surgeries might occur much more common than published.

TMJ ankylosis is not uncommon and its management is difficult and challenging. There is no universal treatment and results are quite variable and often disappointing and unsatisfactory. The most frequent operations involve gap arthroplasty, inter positional arthroplasty and joint reconstruction with autogenous or alloplastic materials.

A major hazard following ankylosis surgery is re-ankylosis which could be reduced by meticulous resection of the ankylosic mass (fibrous or bony) together with aggressive post-operative physiotherapy.

After TMJ surgery, aggressive physiotherapy should be commenced immediately to prevent adhesions, soft tissues contraction, reduce pain & re-develop normal muscle function.

Some surgeons prefer to delay physiotherapy for a week to allow subsidence of pain and swelling & avoid the potential re-bleeding with early mandibular mobility and subsequent haematoma formation and organization and ossification. On the other hand, that delay may allow early phase of healing and increase the chance of re-ankylosis. In our study, we used the acrylic bi-block appliance (of maximal allowed intercinsal opening) which is applied immediately after surgical reconstruction and before extubation. It is then used for up to 6 months (on and off and mostly at night). In addition, intense postoperative physiotherapy is encouraged from the 2nd postoperative day.

In our study, we try to reduce the occurrence of perioperative TCR due to bi-block prosthesis use following unilateral TMJ surgery by prophylactic nerve blockade of the upper and lower jaws which is proven in our study by lower incidence in the NB group (0%) as compared to the C group (4%). This concept has widely been applied recently to block the afferent nervous pathway of the peripheral TCR. For example, peribulbar block with bupivacaine in retinal detachment patients has significantly reduced both the incidence and severity of TCR31. Gupta et al., proved the efficiency of peribulbar block in reflex prophylaxis in children undergoing strabismus surgery. The story is totally different for central TCR as central manipulation of the 5th nerve may lead to radiated traction of the brainstem or the nerve outlet resulting in central TCR activation. Peripheral blockade of the trigeminal nerve or any of its branches → in this case is ineffective to prevent the central TCR.

In our study we tried to combat the trigemino-cardiac reflex due to the use of bi-block prosthesis following TMJ surgery. The concept of prolonged or chronic variant of TCR in the post-operative state has been recently supported.

It was found that orbital and zygomatic fractures were associated with haemodynamic instability (in the form of BP alteration, bradycardia and extrasystoles) especially during sleep. This was explained by soft tissue swellings e.g. of extra ocular muscles in case of orbital fractures, that stimulate OCR (a sub type of TCR) during movement of the eye ball especially during states of high vagal tone during sleep particularly during REM sleep. This theory is more supported by absent underlying cardiac aberrations together with marked improvement with surgical stabilization of fractures.

This concept of chronic (or subacute) variant of TCR is now substituting the old concept of "vagal escape or occulocardiac reflex fatigue". Moreover, our technique of regional nerve blockade to combat such a chronic variant in the early postoperative period until haemodynamic stability of the patient is superior to the idea of prophylactic atropine administration.

The use of anticholinergic is associated with many disadvantages like its latency and higher incidence of ventricular ectopy and bigeminy dysrhythmia which extend longer than TCR itself.

### Table 2: the incidence of Trigeminocardiac reflex (TCR). Data are expressed as mean (SD) or number (% of incidence) plus H.R.

<table>
<thead>
<tr>
<th></th>
<th>(NB) group</th>
<th>Control group</th>
<th>P value</th>
</tr>
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<tbody>
<tr>
<td>Base line H.R. (beat/min)</td>
<td>74 ± 11</td>
<td>76±12</td>
<td>0.270</td>
</tr>
<tr>
<td>Lowest H.R.</td>
<td>49±3</td>
<td>44±2</td>
<td>0.052</td>
</tr>
<tr>
<td>Incidence of TCR</td>
<td>0(0%)</td>
<td>2(4%)</td>
<td>0.031</td>
</tr>
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</table>

### Conclusion

In this prospective, randomized controlled study, we suggested that the prophylactic regional nerve blockade in the form of maxillary and mandibular nerve blocks with local anaesthetics is proven to be effective in reducing the incidence of TCR due to the use of bi-block prosthesis.
block prosthesis following TMJ procedures.

We recommend the use of this simple, safe and effective manoeuvre of nerve blockade in the career of a maxillofacial surgeon to combat such lethal and hazardous TCR especially in high risk patients for example paediatric patients.

Limitations and recommendations
-The maxillofacial surgeon was not blinded with both groups of the study.
-Greater sample size is recommended.
-Prolonged post-operative hemodynamic monitoring for detecting the real incidence of the chronic variant of TCR is recommended.

References


