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**Research Article**

# QUALITATIVE AND QUANTITATIVE ASSESSMENT OF BENEFIT OF FIBEROPTIC INTUBATION OVER BLIND NASAL INTUBATION IN LIMITED MOUTH OPENING SCENARIO OF MAXILLOFACIAL SURGERY. OUR SIMPLIFIED APPROACH IN AIRWAY MANAGEMENT

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**A B S T R A C T**

**Introduction:** Maxillofacial surgeries with limited mouth opening, poses an airway challenge to the attending anesthetist during surgery. This study retrospectively reviewed the anaesthesia assessment concepts related to airway evaluation invarious clinical conditions of difficult intubation patients and morbidity of different techniques of nasal intubation and present our approach for airway management in such patients to overcome adverse complications.

**Methodology:** An 4-year retrospective study of 32 cases treated in our institution in the year of January 2016 to March 2020 was carried out. Data collected included demographic variables and clinical data, predictors of difficult airway, complications, patient comfort and satisfaction during intubation techniques. Descriptive analysis of data was performed for the entire qualitative and quantitative variables of Blind Naso-tracheal Intubation and Fiber optic Intubation. The Mann- Whitney U test was used at 0.05 level and significance to compare the parameters of the study.

**Results:** Males are more commonly affected than females with a ratio of2:1 with ameanage group of 30 years. The pathological conditions include Temporomandibular ankylosis (25%), Oral submucous fibrosis (18.75%), Bilateral Parasymphysis Fracture (37.5%), Ludwigs angina (3.1%), Carcinoma of Retromolar trigone (3.1%), Massetric space infection (12.5%) reported. The mouth opening was less <2cms in all cases with an average of 5mm interincisor gap. We have managed difficult airway by blind nasal intubation (mean time 16.51±3.07 minutes), compared to fibreoptic intubation with (mean time 8.54±1.36 minutes). Patient satisfaction was excellent with less complications in fibreoptic compared to blind nasal intubation. P value <0.05 and was statistically significant.

**Discussion:** Fiber optic intubation with deep sedation is still considered as the gold standard for difficult intubation cases. We have highlighted its role in limited mouth opening patients of bilateral Temporomandibular ankylos is with minimal risk. We have established our guidelines or algorithm depending on the expertise in the field and the facility available in our institution. The treatment protocol followed and predictors assessed for difficult airway is applicable to all limited mouth open ingscenarioin maxillofacial surgery to overcome life threatening complications associated with intubation techniques.



## INTRODUCTION

A difficulty airway can be a challenging situation for anaesthesiologist in limited mouth opening or near total trismus. The Maxillofacial pathology or conditions which predispose an individual to limited mouth opening include Temporomandibular ankylosis, Oral submucous fibrosis, Fractur of mandible, Zygomatic arch fracture, ludwigs angina, carcinoma of retromolar trigone, myositis ossificans traumatic and Massetric space infection.[1] As per practice guidelines, a difficult airway can be defined as the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both. The difficult airway depends on a complex interaction between patient factors which includes precise collection and

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communication of data, the clinical setting, and also the skills of the anaesthestist. The life threatening adverse outcomes associated with the difficult airway include (but are not limited to) death, brain injury, cardiopulmonary arrest.[2]

In a patient with nil or limited mouth opening, intubation choices are blind nasal intubation, retrograde intubation technique via cricothyroid puncture or fiberoptic intubation and tracheostomy. [3]. Nasal route intubation is more favourable, as thesepatients require surgical procedures either intra oral, extra oral, or both.Blind nasal intubation can fail and repeated attempts may injure the involved structures resulting in complications like bleeding due to laceration of mucosa and airway obstruction. Use of fiberoptic laryngoscope may be the method of choice in difficult airway.[4]

We have conducted a study to evaluate different nasal intubation techniques and morbidity or complications associated and standardise the guidelines in managing airway challenges of patients who underwent surgical intervention. Based on the data available we have established an algorithm depending on facility and expertise available to be followed in our institution while intubating difficult airway cases with limited mouth opening. While fiberoptic intubation is conclusively proven to be superior, there is a need to evaluate the different levels of patient comfort and complications of the techniques, which will validate the adaption of new treatment protocol.

***Methodology***

A 4 year retrospective evaluation of airway management which was conducted on 32 patients of Maxillofacial pathology and Trauma, who underwent surgical intervention in our institution in the year January 2016 to March 2020 were analysed. Inclusion criteria in the study were as follows: (a)Patients with limited mouth opening <2cm and(b) nasalintubation suitable for surgical procedure. Exclusion criteria were as follows: (a) Patients required more invasive and surgical techniques for securing the airway, (b) significantly deviated nasal septum and previous nasal surgery, (c) local infection in nose (d)sensitivity to amide local anaesthetics, or coagulation disorders.

The pre-operative medical assessment included routine surgical profile, electrocardiogram, and chest X-ray followed by preanesthetic evaluation with a standard proforma which included previous anaesthetic problem, general appearance of face, neck, maxilla and mandible, jaw movement, head extension and movement, teeth and oropharynx, nasal obstruction or deviated nasal septum, soft tissues of the neck, thyroid enlargement, recent cervical spine radiographs, and for any gross anatomical distortion. The difficulty of intubation was evaluated based on LEMON (Look-Evaluate-Mallampatti-Obstruction-Neck mobility) assessment and recorded.[5]. Previous history of surgeries under general anaesthesia, difficulty in intubation and complication during surgery was collected.

Data collected include demographic variables and clinical data. Airway predictive Variables considered in the study include - Thyromental distance, sternohyoid distance, man dibulohyoid distance and interincisal distance to measure the risk factors of difficult airway intubation. As mouth opening of patient was very limited, Mallampatti score and Cormac Lehane grading was not applicable in the study which are based on glottic view of direct laryngoscopy. The institutional ethics committee approved the protocol.

Patients were told about the need of awake blind nasotracheal intubation, its complications the type of airway anaesthesia and need of any airway intervention in emergency. After detailed explanation about the technique, the active participation of the cooperative patients in the process of intubation was sought. The patients were instructed to follow the protocols to assist in smooth intubation like taking deep breaths, maintaining the head position, and swallowing secretion as and when required. On the night before surgery, pantoprazole 40 mg and metoclopramide 5 mg orally were given to prevent acid reflux and aspiration. Patients were keptnilperorally6hoursbefore surgery. Onthemorning of surgery, premedication was given 1 hour before the procedure which included antibiotics , injection dexamethasone 8 mg (steroid), injection ondansetron 4 mg (antiemetic), injection pantoprazole40mg (antacid),injection glycopyrrolate0.2mg (antisialagogue),and anasal decongestant (xylometazoline2%). The patient was then asked to gargle 10mL of lignocaine viscous 4% without swallowing. Transmucosal topical anaesthesia of the nasal passages performed by gentle insertion of two cotton tipped applicator sticks soaked in lidocaine 2% with epinephrine 1: 200,000 into each nostril. Bilateral superior laryngeal nerve block and transtracheal injection of the local anaesthetic was given. A proper size (30 or 32) of nasopharyngeal airway lubricated with 2% lidocaine jelly was inserted smoothly, which helps in guiding tube through nasal passages with dilation of the nares just before blind awake intubation. Deepsedation with Injpropofol50µg/kg/minorInjketamine1-2mg/kg was given along with preanesthetic medication in fiber optic intubationcases.

Patient is placed in sniffing position, after inhalation of 100% oxygen for duration of 3 minutes, a proper size (6.5 or 7mm) cuffed, well coated endotracheal tube(ETT) was advanced through the wider and more patent nostril into the oropharynx. The distance from then ostrilto theoropharynx was measured by placing the tracheal tube against the side of the patient's face while planning forintubation.

In group (I) the ETT was then advanced gently until slight resistance was felt. Once the thetipmade contact with the vocalcords, breath sounds are heard on auscultation. Patient is asked to take deep breath, protruding tongue, then ETT was advanced gently into the trachea. If breath sounds disappeared, the ETT was then withdrawn until breat sounds could beheard, and asecond attempt was made. In group(II),the tipoff the fiber opticbronchoscope was defogged and introduced through the lumen of ETT, advanced until the glottic aperture seen and then through the vocal cords till carina was visualized. The fiberoptic scope was fixed in same position and the endotracheal tube was advanced. The fibro scope was withdrawn, and endotracheal tube placement was confirmed with capnography. All patients were intubated by an anesthesiologist familiar with both intubation techniques.

Number of intubation attempts were recorded in both groups. Time taken to intubate the trachea was measured in minutes from the moment the tube being placed in the nasal cavity,till its correct placement was detected by capnography included in the ventilator. The intra operative and post-operative complications were recorded. Patient satisfaction (excellent, good, and fair) were noted and patient comfort during

procedure (Grade I - no movement observed, GradeII-coughing observed, GradeIII-extremity movement observed, and Grade IV - violent movement observed), were analysed. The mean time of intubation in both the techniques with number of attempts in both the groups were also noted in the study. Descriptive analysis of data was performed for the entire qualitative and quantitative variables of Blind Naso-tracheal Intubation and Fiber optic Intubation. The Mann-Whitney U test was used at 0.05 level and significance to compare the parameters of the study. All analysis was performed using SPSS 20 version (SPSS Inc., IBM Corporation, USA).

***Results***

A total of 32 patients (n) were enrolled over a study for 4 years and fulfilled the inclusion criteria. Males (n=22) are more commonly affected than females(n=10) with M: F of 2:1 in all parameters. On clinical examination, the pathological conditions include Temporomandibular ankylosis (25%), Oral submucous fibrosis (18.75% ), Fracture of mandible ( 37.5%), Ludwig's angina (3.1%), Carcinoma of Retromolar trigone (3.1%), Massetric space infection ( 12.5%) reported. Table 1. The predictors of difficulty airway, depicted in Table 2 showed that Thyromental distance less than 6 cms, sternomental distance less than 12.5 cms and mandibulohyoid distance was <4cm considered prognostic of problematic laryngoscopy, as a result of which conventional direct laryngoscopy intubation was ruled out in our cases.

**Table 1** Type of intubation in following clinical conditions

| Clinical conditions | No of patients | Type of intubation done | |
|---|---|---|---|
| | | Blind nasal intubation | Fibreoptic intubation |
| TMJ Ankylosis | 8 | 3 | 5 |
| Oral Submucous Fibrosis | 6 | 3 | 4 |
| Fracture of Mandible | 12 | 7 | 4 |
| Carcinoma of Retromolar trigone | 1 | 0 | 1 |
| Ludwigs angina | 1 | 0 | 1 |
| Massetric Space infection | 4 | 1 | 3 |

**Table 2** Predictors of airway assessment

| Sl no | Indices | No of patients |
|---|---|---|
| 1 | Interincisor gap | |
| | <4 cm | 32 |
| | >4 cm | |
| 2 | Sternomental distance | |
| | <12.5cm | 29 |
| | >12.5 | 3 |
| 3 | Thyromental distance | |
| | <6.5 | 29 |
| | >6.5 | 3 |
| 4 | Mandibulo hyoid distance | |
| | <4 | 32 |
| | >4 | 0 |
| 5 | Mallampatti score | Not applicable |

Blind nasal intubation was performed successfully on (n=14) 43.75%cooperative patients and Fiberoptic intubation was performed successfully on (n=18) 56.25 % patients. Graph 1. The number of intubation attempts were statistically significant between both groups. Blind Naso-tracheal Intubation group (I) showed statistically significant (P<0.05) higher time and maximum of 3 attempts taken for intubation when compared to that of Fiberoptic Intubation, group (II) which was completed successfully by first and second attempt with less time. The mean time required for successful intubation was significantly less in group (II) (8.54±1.36 minutes) minutes than in group (I) (16.51±3.07) minutes. Table 3.

**Table 3** Comparison of time taken for the Incubation in Blind Naso-tracheal Intubation and Fibre optic Intubation (In mins)

| | Mean time of Incubation | | |
|---|---|---|---|
| | Group | Mean Rank | P Value |
| **First Attempt** | Blind Naso-tracheal Intubation | 25.5 | **0.001*** |
| | Fibre optic Intubation | 9.5 | |
| **Second Attempt** | Blind Naso-tracheal Intubation | 24.68 | **0.001*** |
| | Fibre optic Intubation | 10.14 | |
| **Third Attempt** | Blind Naso-tracheal Intubation | 20.36 | **0.041*** |
| | Fibre optic Intubation | 13.5 | |

*Statistical significance set at 0.05

No major complications occurred to our patients except for minor bleeding from the nose which stopped spontaneously. The minor intra operative complications include laceration of mucosa in 5 patients group I and 2 patients in group II. Bleeding occurred in 4 patients and esophageal intubation in 3 patients in group I respectively. During postoperative period, patients complained of nose pain in 5 patients in group I and 2 patients in group II. Anterior neck region pain and sore throat were more common in group I patients which resolved gradually as all patients were under intravenous antibiotics and intramuscular analgesics for 3 days. The Mann-Whitney Utest showing statistically significant higher intra and post-operative complications among Blind Naso-tracheal Intubation compared to Fiber optic Intubation (p<0.05). Table 4.

**Table 4** Comparison of intra and post-operative complications in Blind Naso-tracheal Intubation and Fibre optic Intubation

PiscalculatedbyManuWhitneyUtest. Group I: blind nasal intubation. Group II: fibreopticintubation.

| **INTRAOPERATIVE COMPLICATIONS** | | | | |
|---|---|---|---|---|
| | Groups | N | Mean Rank | P Value |
| **Laceration of nasal mucosa** | Fibreoptic intubation | 18 | 10.67 | **0.001*** |
| | Blind nasal intubation | 14 | 24 | |
| **Bleeding** | Fibreoptic intubation | 18 | 12 | **0.002*** |
| | Blind nasal intubation | 18 | 12 | |
| | | 14 | 22.29 | |
| | Fibreoptic intubation | 18 | 13.5 | **0.041*** |
| | Blind nasal intubation | 14 | 20.36 | |

| POSTOPERATIVE COMPLICATIONS | | | | |
|---|---|---|---|---|
| | Fibreoptic intubation | 17 | 10.24 | |
| **Nose pain** | Blind nasal intubation | 14 | 23 | **0.001*** |
| **Anterior neck region pain** | Fibreoptic intubation | 18 | 11.5 | **0.001*** |
| | Blind nasal intubation | 14 | 22.93 | |
| **Sore throat** | Fibreoptic intubation | 18 | 11 | **0.001*** |
| Blind nasal intubation | | | 14 | 23.57 |

*Statistical significance set at 0.05

Most of the patients (n = 32) in both the groups had difficulty in manipulation of the tip and showed Grade 2,3 and 4 patient comfort which was most common in group I patients compared to group II where grade 1 patient comfort was observed respectively, The Mann- Whitney U test display statistically significant higher patient Comfort among Fiber optic Intubation compared to Blind Naso-tracheal Intubation ($p<0.05$). Patients satisfaction was fair in group I compared to excellentin group II cases. The Mann-Whitney U test display statistically significant higher Patient Satisfaction among Fiber optic Intubation compared to Blind Naso-tracheal Intubation ($p<0.05$). Table 5.

**Table 5** Comparison of Patient Satisfaction and Patient Comforts in Blind Naso-tracheal Intubation and Fibre optic Intubation

Piscalculated by Manu Whitney U test. Group I: blind nasal intubation. Group II: fibreopticintubation.

| | **Satisfaction Interpretation** | **N** | **Mean Rank** | **P Value** |
|---|---|---|---|---|
| **Blind Naso tracheal Intubation** | Fair | 14 | | |
| | Good | 0 | 7.5 | |
| | Excellent | 0 | | |
| **Fibre optic Intubation** | Fair | 0 | | **0.001*** |
| | Good | 5 | 23.5 | |
| | Excellent | 13 | | |
| | **Comforts Interpretation** | **N** | **Mean Rank** | **P Value** |
| **Blind Naso tracheal Intubation** | Grade 1 | 0 | | |
| | Grade 2 | 7 | | |
| | Grade 3 | 5 | 9.5 | |
| | Grade 4 | 2 | | |
| **Fibre optic Intubation** | Grade 1 | 18 | | **0.001*** |
| | Grade 2 | 0 | | |
| | Grade 3 | 0 | 25.5 | |
| | Grade 4 | 0 | | |

Statistical significance set at 0.05

Based on above findings, we have adopted the protocol or an algorithm dependingon facility and expertise available to manage airway obstruction in patients with limited mouth opening or zero inter incisor gap treated in our institution. Table6.

## DISCUSSION

Trismus or Restricted mouth opening is the most commonly faced problem in the oral and Maxillofacial surgical practice. Limited mouth opening is found to be multi factorial, but the difficult intubation in airway management is yet challenging situation to be faced in day to day practice of anaesthesia during surgery.

The patients with Maxillofacial pathology and trauma presents serious challenges for the anaesthetist, as airway management in these patients can be complicated by their pathology and injury. Ankylosis of Temporomandibular Joint (TMJ) basically impairs the movement between the mandibular condyle and the temporal bone. [1]. TMJ ankylosis can be congenital or idiopathic due to trauma and infective pathology. Poor oral intake resulting in nutritional deficiency, becomes an indication for surgical intervention. Patients planned for maxillofacial surgical procedures with limited mouth opening may be a challenge to the attending anesthetist, due to hypotonicity of the soft tissues and associated mandibular or maxillary hypoplasia, complicating the airway management during surgery.[6],[7]. In children with TMJ ankylosis, the incidence of difficult airway is between 1.2% and 9%. [8]

Maxillofacial trauma requires to address type and nature of trauma to achieve safe management of airway. According to Hutchinson et al, A bilateral fracture of the anterior mandible may cause the fractured symphysis and the tongue to slide posteriorly and block the oropharynx in the supine patient.[9]. Oral submucous fibrosis is a chronic, insidious scarring disease of the oral cavity characterized by progressive restricted mouth opening, reduced movement and depapillation of the tongue, with blanching and leathery texture of the oral mucosa. These patients present difficulty in laryngoscopy and intubation by causingtrismus[10]. Ludwig's angina is an infection of the submandibular space, sublingual space and sub mental space, represents as an difficult entity to manage due to the rapid progression and difficulty in maintaining airway patency, resulting in asphyxia and death[11]. Carcinoma of Retromolar trigone involves ulceroproliferative growth infiltrating medial pterygoid muscle and masticator space presenting trismus poses airway challenge during surgery. .[12]

This study is anaesthetic review, as well as the anaesthetic chart of the 32 patients managed at our institution. The pathological conditions include Temporomandibular ankylosis(25%), Oral submucous fibrosis(18.75%),Fracture of Mandible(37.5%), Ludwigs angina (3.1%), Carcinoma of Retromolar trigone (3.1%), Massetric space infection ( 12.5%) reported. Majority of the patients presented in their second and third decade of life.

The prediction of difficult airway maintenance plays a vital role in patient safety and the prevention of complications. Mallampati scores, thyromental mandibular hyoid and sternomental distances were among the tests employed for assessment and airway management. As mouth opening was very less or nil in these patients, the assessment of Mallampati scoring was not possible in this study. As per literature Mallampati score alone has a low sensitivity and should therefore be combined with other tests such as thyromental and sternomental distances. In our study, thyromental distance was less than 6 cm, sternomental distance less than 12.5cm and mandibulohyoid distance was <4cm in bilateral TMJ ankylosis, suggestive of difficult intubation. [5].

Anaesthetic management in surgery of TMJ ankylosis presents critical challenge to the Anaesthesiologist in maintenance of airway patency. It depends on various factors like patients age, clinical symptoms , cooperation, expertise and availability of equipment in the set up. Inability to open mouth makes direct laryngoscopy impossible. Therefore, the intubation has to be done either by Blind nasal technique or with the help of a Fiberoptic bronchoscope.[13] The main drawback of Blind nasal technique is that it needs repeated attempts, guided by external palpation of the glottis by the contralateral hand and confirmation by end- tidal carbon dioxide trace. As there can be misses, repeated attempts may lead to bleeding and laryngeal oedema and further airway complications.[5]
Flexible fiberoptic bronchoscope is the gold standard of choice for coping with difficult tracheal intubations. The drawback of fiberoptic intubation is expensive and need expertise to perform the procedure. Other options include retro grade tracheal intubation which is again a invasive procedure with limited complications.[14]

When the expertise for these techniques are not available, only option left is tracheostomy, for securing the airway. Tracheostomy is an invasive procedure with a high post-operative morbidity and so it was reserved for emergency or failed attempts of intubation.[15]

In our study we performed blind nasotracheal intubation for cooperative patients, remaining uncooperative patients were successfully managed by fiberoptic intubation. Tracheostomy was not done in our patients, which was kept as last resort of airway management in failed intubation cases. We have observed intraoperative complications like lacerationofnasalmucosa, epistaxis and rarely oesophagealintu bation in patients undergoing blind nasal intubation due to repeated attempts of intubation, which were comparatively very less in fibre optic intubation.

When the initial attempt at intubation fails, mask ventilation should be resumed to maintain oxygenation, this avoids the chances of rising emergency situation for airway management. Head position and laryngoscopy technique may be resumed again during the next attempt.[16] Awake intubation and spontaneous ventilation are the safest techniques for securing anticipated difficult airway, as these patients should not be given muscle relaxants till the control of airway is achieved. Awake intubation needs patients co-operation, local blocks for nerves of larynx and topical anaesthesia for upper airway management. Topical anaesthesia and vasoconstrictors prevents bleeding and facilitates intubation through nasal passages. Nebulisation with 10% Lignocaine provides topical anaesthesia, anticholinergic agents reduce secretions, and prolongs the duration of induced general anaesthesia without using muscle relaxants.

In our study, we have administered transtracheal local anaesthesia prior to intubation, which had reduced the incidence of vocal cord spasm and reflex cardiac arrhythmia. Prophylactic IV administration of a tropineorglycopyrrolate be fore performing the procedure, helps to prevent the reflex bradycardia. Glycopyrrolate was given in our study since it produces less stimulatory effects on the central nervous system and heart rate by reducing secretions during the procedure.

In present study, patient undergoing blind intubation had fair satisfaction due to repeated attempts, coughing and traumatizednasalpassages compared to fiberoptic technique where they had excellent satisfaction as procedure was done under deep sedation, and less attempts have reduced the trauma to the mucosa and improved patient comfort during the procedure. During recovery period, patient had nose pain, anterior neck region pain and sore throat, more common in blind intubation, which can be overcome by flexible fiberoptic intubation.

Difficult airway management in TMJ Ankylosis is very challenging which requires expertise and good planning with initial preparation for managing any complication arising due to the attempted intubation such as bleeding, trauma, laryngospasm, and hypoxemia. Sometimes the situation can deteriorate into “cannot intubate and cannot ventilate” scenario. It is basically the planning, coordinations among the anaesthesia team members will result in favourable outcome in terms of morbidity associated with the procedure.[17]

In our study, some patients were not cooperative for awake intubation. In such cases

We need to go for fiber opticintubation under deep sedation with maintenance of spontaneous ventilation. All patients were successfully intubated with the help of fiber opticendo scope. We did not have to make our patients to undergo tracheostomy, which has reduced postoperative airway complications associated with the procedure. However, adequate preoperative evaluation, intra operative monitoring which includes. ECG, NIBP, SpO2, Et CO2) positioning, and a coordinated team of anaestheticcare, are the key elements for successful outcome of any surgical procedure.

Limitations of the study is that it didn’t addressinvasiveair way intubation techniques like sub mental intubation, Retromolar intubation and Tracheostomy in relation to limited mouth opening conditions seen in Maxillofacial surgery. Though the protocol of air way assessment and management remains the same, followed in the study. Further studies are needed to elaborate on invasive intubation technique versus noninvasive intubation techniques of difficulty airways seen in Maxillofacial field by considering the basis of parameters used in our study.

## CONCLUSION

We have highlighted the importance of meticulous preoperative evaluation and anaesthetic preparation in managing difficult airway intubation in Maxillofacial surgery. We have also comparatively evaluated the technique sensitivity, complications and patients satisfaction and comfort during the procedure associated with the both blind nasal intubation and fiberopticintubation technique. Based on the analysis of above data, Fiberopticintubation under sedation or inhalational agents with spontaneous respiration is considered as the safest approach among these patients. Blind nasal intubation can still be used in institutions where the facilities for fiberoptic intubation is unavailable.

The mainstay of difficult airway management remains always flexible fiberoptic intubation. We have established our guidelines or algorithm specific to our institution depending on the expertise and the facility available in managing difficult airway conditions undergoing surgical intervention. The aetiology of limited mouth opening is multifactorial which includes secondary to trauma, infection, inflammatory or

rheumatologic conditions, radiation therapy. Successful treatment necessitates an understanding of the underlying disorder, anaesthetic preparation and interaction and opinions between Maxillofacial consultants and anaesthetists is required for favourable outcome. Findings of this study is relevant to consider in other limited mouth opening scenarios, like myositis ossificans traumatica which can be reproduced by conducting similar studies.

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