To Determine Effectiveness of Surgical Uprighting as an Alternative to Orthodontic Uprighting of Impacted Mandibular Second Molars

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ABSTRACT

Background: Impaction of the mandibular second molar is an uncommon disturbance that may cause periodontal defects, root resorption, occlusal discrepancies, and functional impairment. Orthodontic uprighting is the conventional treatment but requires prolonged treatment and patient compliance. Surgical uprighting offers immediate correction however, comparative clinical evidence remains limited.

Aim: To compare the clinical effectiveness of surgical and orthodontic uprighting in the management of impacted mandibular second molars.

Materials and Methods: A prospective experimental study was conducted in patients with impacted mandibular second molars. Following clinical and radiographic evaluation, patients underwent either surgical or orthodontic uprighting. Postoperative pain, maximum mouth opening, pulp vitality, external root resorption, and radiographic healing were assessed during follow-up. Statistical significance was set at $P < 0.05$.

Results: Both techniques achieved successful functional repositioning. Surgical uprighting demonstrated favourable postoperative recovery, preservation of pulp vitality, minimal external root resorption, satisfactory periodontal healing, with outcomes comparable to orthodontic uprighting.

Conclusion: Surgical uprighting is a predictable and biologically acceptable alternative for carefully selected impacted mandibular second molars, providing favourable clinical and radiographic outcomes with shorter treatment duration.

Keywords: Impacted mandibular second molar; Surgical uprighting; Orthodontic uprighting; Pulp vitality; External root resorption.

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INTRODUCTION

Eruption of teeth is defined as the axial movement of teeth from their developmental position within the jaw bones into the oral cavity[1]. Impaction is defined as a condition in which a tooth fails to erupt into its functional position within the expected developmental time frame due to obstruction by adjacent teeth, bone, or overlying soft tissue.[2] The impacted tooth may be completely or partially unerupted and is classified according to its anatomical position and orientation.[3] The most commonly impacted teeth are the mandibular third molars, followed by maxillary canines and mandibular second premolars however the incidence of impacted mandibular second molar is very minimal with an incidence of almost 0.06-0.3%[4]. The etiological factors associated with the impaction of the mandibular second molar include arch length deficiency, which may result from disturbances in mandibular growth, tooth development, or genetic influences[5] . The tooth bud of the mandibular second molar initially develops with a mesial inclination during normal development, this inclination undergoes spontaneous correction through physiological mandibular remodeling and adequate space for eruption is created by resorption of the anterior border of the mandibular ramus and mesial migration of the mandibular first molar into the leeway space during the transition from primary to permanent dentition. Any disruption in these processes may interfere with normal eruption and ultimately result in impaction of the mandibular second molar[5].

Arch length excess also lead to the impaction of the mandibular second molar due to excess space between the developing mandibular second molar crown and the roots of the mandibular first molars causing mandibular second molar to further incline mesially thereby becoming impacted under the mandibular first molar.It has also been postulated that eruption of mandibular second molar requires guidance by the distal root of mandibular first molar. Other etiologies for the impaction of the mandibular second molar is more mesially positioned third molar or any pathology of the jaw. Delayed eruption of the second mandibular premolars, ankylosis of primary teeth, untimely extraction of primary mandibular molars[5] .

The various options for management for impacted mandibular second molar is potentially multidisciplinary and careful case selection is vital for successful management.Surgical uprighting, Orthodontic assisted uprighting or a combination of both are the current available options.[6]

Orthodontic uprighting of impacted teeth include the use of deimpaction springs have shown to provide successful results in the uprighting of impacted second molars. The use of segmental copper nickel titanium arch wire in combination with ligature wire and a bonded brackets on the tooth surface has also been documented. Use of Ramus screw in combination with elastic chains anchored by the bone screws that are activated by connecting the opposite end of chain to the attachments bonded on the second molars have proven to be successful[7]

Before the surgical procedure is carried out the options of minimally invasive procedures must be discussed and their role in the movement of the tooth must be evaluated. Surgical uprighting of a partially impacted second molar is procedure that can be seen as an alternative to orthodontic uprighting of the impacted mandibular second molar. The procedure can be seen as a faster alternative procedure that will present with a better long term follow up of the same.The aim of the study is to determine the efficacy of surgical uprighting technique as an alternative to orthodontic uprighting of partially impacted mandibular second molars

Materials and methods

Study design

An experimental study was conducted among patients indicated for surgical or orthodontic uprighting of impacted mandibular second molars. Patients reporting to the Departments of Oral and Maxillofacial Surgery and Orthodontics and Dentofacial Orthopaedics from April 2024 to October 2025 were screened for eligibility.

Patients aged 1between 2–40 years diagnosed with an impacted mandibular second molar, indicated for uprighting of the impacted tooth, and willing to participate were included. Patients with dental caries involving the impacted mandibular second molar, underlying infection, systemic conditions that could potentially affect the study outcomes, or unwillingness to participate were excluded.

All eligible participants were informed about the nature and purpose of the study, and written informed consent was obtained prior to enrolment. For participants below 18 years of age, consent was obtained from the parent or legal guardian,

The study was approved by the Institutional Review Board (SRMDC/IRB/2023/MDS/No.407)

Sample size calculation: Sample size estimation was performed using G*Power software (Version 3.0) based on the effect size reported in the parent study[5]. Assuming an effect size of 0.95, a two-sided significance level (α) of 0.05, and a statistical power of 90% ($1-\beta = 0.90$), the required sample size was calculated to be 40 participants, comprising 20 participants in the surgical uprighting group and 20 participants in the orthodontic uprighting group.

Study methodology

Patient preoperative examination was performed and necessary radiographic investigations such as Intraoral periapical xrays ,Orthopantomogram(OPG) a Cone Beam computed tomography(CBCT) were taken.Patients were allocated into study group (Surgical Uprighting) and the control group(Orthodontic uprighting) based on the recommendation of the orthodontist.The surgical procedure was carried out under local anesthesia with standard surgical procedure performed by a single surgeon.

Procedure:

STUDY GROUP

Under aseptic conditions local anesthesia was administered through

Inferior alveolar nerve and Long buccal nerve block.A crevicular incision with an anterior and distal release was placed in the region of interest and a full thickness mucoperiosteal flap was reflected.Extraction of the impacted mandibular third molar was performed.Following which exposure of the impacted mandibular second molar was done. Bone guttering when indicated was then continued from the mesial to the distal aspect on the buccal surface to create space.A straight elevator was used to upright the impacted teeth and the tooth was brought into occlusion.After verification of the position the tooth was stabilised. Placement of xenograft (Bio-Oss® ,Geistlich Pharma AG, Wolhusen, Switzerland) was done around the teeth and closure was carried out using 3-0 Vicryl®(Polyglactin 910), Ethicon, Inc.Splinting of the teeth was done using flowable composite material and ligature wire .Patient were discharged with standard post operative medications. Patients were reviewed post operatively on days 3 and 7 and imaging was done using an orthopantamogram for position verification Parameters evaluated included pain score depicted on the VAS scale and measurement of mouth opening. An Electric pulp tester was used to assess the pulpal vitality and incidence of external root resorption was done based on the CBCT at the end of three months

CONTROL GROUP

The treatment plan for each case was determined by the severity of impaction, molar angulation, the position of adjacent first and third molars, and patient compliance. Correction time for orthodontic uprighting of impacted mandibular second molars varies based on angulation severity, method, age.

1. **Use of Temporary anchorage Devices (TAD's) ;** A chain was bonded to the exposed surface. When the attachment is placed on the buccal cusp, an extrusive pulling force was applied from mini-screw anchorage. This occlusal offset creates a tip-back moment facilitating distal crown movement into occlusion. Activation with TADs generates a clockwise rotation of the molar.

2. **Use of Copper Nickel Titanium (NiTi) sectional wires**: These provide light, continuous, superelastic forces suitable for uprighting impacted second molars. A 10–12 mm segment of 0.016 × 0.016-inch or 0.016 × 0.025-inch Copper NiTi wire was positioned between the distal/occlusal surface of the first molar and the exposed cusp or fossa of the impacted second molar. Upon engagement, the wire attempts to return to its original straight form, generating a clockwise tip-back moment and an extrusive force on the second molar while exerting an intrusive effect on the first molar. Bite turbos are placed on the first molar help prevent occlusal interference during treatment.

Parameters evaluvated

Pain,mouth opening and pulp vitality were evaluated by clinical evaluation on post op day 1,3 & 7. Presence or Absence of external root resorption was evaluated at the end of 3 month follow up by radiographs.P ulp vitality was

also evaluated at the end of the three month followup.

Results:

The Normality tests Kolmogorov-Smirnov and Shapiro-Wilks tests results reveal that values follow Normal distribution. Therefore, to analyse the data, Parametric was applied. Descriptive statistics was expressed using mean and standard deviation. Inferential statistics was done using independent sample t test. To analyse the data SPSS (IBM SPSS Statistics for Windows, Version 26.0, Armonk, NY: IBM Corp. Released 2019) is used. Significance level is fixed as 5% ($\alpha = 0.05$). P-value <0.05 is considered to be statistically significant.

VARIABLES	CASE STUDY				CONTROL GROUP			
	VAS SCORE DAY 0	VAS SCORE DAY 1	VAS SCORE DAY 3	VAS SCORE DAY 7	VAS SCORE DAY 0	VAS SCORE DAY 1	VAS SCORE DAY 3	VAS SCORE DAY 7
Mean	.0000	3.4000	2.7000	1.1000	.0000	.2000	.0000	.0000
Std. Error of Mean	.00000	.61824	.44845	.45826	.00000	.13333	.00000	.00000
Std. Deviation	.00000	1.15505	1.21814	1.04914	.00000	.42164	.00000	.00000
Range	.00	6.00	4.00	4.00	.00	1.00	.00	.00

Table 1 shows the descriptive statistics of pain intensity recorded using the Visual Analog Scale (VAS) at different time intervals (Day 0, Day 1, Day 3, and Day 7) among the case and control groups. At baseline, it was shown that both groups reported a VAS score of zero, indicating no preoperative pain. In the case group, the mean VAS score increased on Day 1 (3.4 ± 1.15), followed by a gradual reduction on Day 3 (2.7 ± 1.21) and Day 7 (1.1 ± 1.05), demonstrating a progressive decrease in pain intensity over time. In contrast, the control group revealed minimal postoperative pain, with a mean VAS score of 0.2 ± 0.42 on Day 1 and complete absence of pain on Days 3 and 7

VISUAL ANALOG SCALE	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
VAS SCORE DAY 1	3.20000	2.14994	.67987	1.66203	4.73797	4.707	9	.001*
VAS SCORE DAY 3	2.70000	1.41814	.44845	1.68553	3.71447	6.021	9	.001*
VAS SCORE DAY 7	1.10000	1.44914	.45826	.06335	2.13665	2.400	9	.040*

Table 2 shows the intergroup comparison of VAS scores at different postoperative intervals. A statistically significant difference was observed between the case and control groups on Day 1 ($t = 4.707$, $p = 0.001$), Day 3 ($t = 6.021$, $p = 0.001$), and Day 7 ($t = 2.400$, $p = 0.040$). The mean difference in VAS scores indicates that pain levels were consistently higher in the case group compared to the control group across all postoperative time points. These findings confirm a significant reduction in pain intensity over time in the case group while maintaining minimal pain levels in the control group.

VARIABLES	CASE STUDY				CONTROL GROUP			
	MOUTH OPENING PREOP	MOUTH OPENING DAY 1	MOUTH OPENING DAY 3	MOUTH OPENING DAY 7	MOUTH OPENING PREOP	MOUTH OPENING DAY 1	MOUTH OPENING DAY 3	MOUTH OPENING DAY 7
Mean	35.8000	29.6000	31.1000	33.2000	36.0000	36.0000	36.0000	36.0000
Std. Error of Mean	.69602	1.02415	.72188	.92856	1.21106	1.21106	1.21106	1.21106
Std. Deviation	2.20101	3.23866	2.28279	2.93636	2.96648	2.96648	2.96648	2.96648
Range	7.00	9.00	8.00	10.00	9.00	9.00	9.00	9.00

Table 3 shows the descriptive statistics of mouth opening measurements recorded pre operatively and on Days 1, 3, and 7 post operatively. In the case group, the mean preoperative mouth opening was 35.8 ± 2.20 mm, which

reduced to 29.6 ± 3.24 mm on Day 1, followed by gradual improvement on Day 3 (31.1 ± 2.28 mm) and Day 7 (33.2 ± 2.94 mm). The control group maintained a stable mean mouth opening of 36.0 ± 2.96 mm across all time intervals, indicating the absence of postoperative restriction.

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
MOUTH OPENING PREOP -	33.80000	2.20101	.69602	32.22549	35.37451	48.562	9	.001*
MOUTH OPENING DAY 1 -	-6.40000	4.52647	1.43139	-9.63804	-3.16196	-4.471	9	.002*
MOUTH OPENING DAY 3 -	-4.90000	3.92853	1.24231	-7.71030	-2.08970	-3.944	9	.003*
MOUTH OPENING DAY 7 -	-2.80000	4.31535	1.36463	-5.88701	.28701	-2.052	9	.070*

Table 4 shows the comparison of mouth opening values between the case and control groups. A statistically significant difference was observed pre operatively (p = 0.001), on Day 1 (p = 0.002), and on Day 3 (p = 0.003). However, by Day 7, the difference was not statistically significant (p = 0.070), indicating functional recovery in the case group. These results propose that although the case group experienced significant postoperative limitation in mouth opening initially, gradual improvement was observed, and near-normal mouth opening was achieved by the seventh postoperative day.

OPTIONS	TOOTH VITALITY PREOP		TOOTH VITALITY 3 DAY		TOOTH VITALITY 7 DAY		TOOTH VITALITY 1 MONTH		TOOTH VITALITY 3 MONTH	
	CASE GROUP	CONTROL GROUP	CASE GROUP	CONTROL GROUP	CASE GROUP	CONTROL GROUP	CASE GROUP	CONTROL GROUP	CASE GROUP	CONTROL GROUP
N/A	6	0	0	0	0	0	0	0	0	0
NON - VITAL	0	0	2	0	2	0	2	0	2	0
VITAL	14	20	18	20	18	20	18	20	18	20

Table 5 depicts the distribution of tooth vitality status at different follow-up intervals. Pre operatively, all teeth in both groups were vital. In the case group, a minor number of teeth exhibited non-vital status from Day 3 onward, with two cases showing non-vitality at Day 3, Day 7, one month, and three months. In contrast, all teeth in the control group remained vital throughout the follow-up period. Despite these findings, the majority of teeth in the case group retained vitality, suggesting that the intervention had minimal adverse effect on pulpal health.

No cases of external root resorption were observed in either the case or control groups. All participants were evaluated and the absence of radiographic evidence of root resorption during the study period was noted..

Discussion;

Mandibular second molars play a critical role in maintaining occlusal harmony, masticatory efficiency, and overall arch integrity. Failure of eruption or incomplete eruption predisposes patients to food impaction, distal caries in first molars, periodontal defects with discrepancies in the occlusion. Diagnosis along with timely intervention are therefore essential for preservation of natural dentition and maintenance of long-term oral health. Although impaction of mandibular second molars is relatively uncommon, its clinical implications can be significant. Orthodontic uprighting is generally considered the first-line approach; however, it requires prolonged treatment duration, complex biomechanics, patient compliance, and adequate posterior anchorage. Deeply

impacted teeth or those with severe mesial angulation may not be amenable to orthodontic correction alone. In such cases, surgical uprighting offers a time-efficient alternative, allowing immediate correction of tooth angulation and occlusal alignment. The biological rationale for surgical uprighting is centered on preservation of the periodontal ligament and maintenance of pulpal vitality while repositioning the tooth within the alveolus. When performed atraumatically, the procedure enables reattachment of periodontal fibers and subsequent bone remodeling around the repositioned tooth. The present study aimed to evaluate the effectiveness of surgical uprighting as an alternative to orthodontic uprighting in cases of impacted mandibular second molars. Postoperative pain, functional limitation in mouth opening, pulpal vitality, and the incidence of external root resorption were assessed.

Postoperative pain following dentoalveolar surgery is primarily attributed to surgical trauma and the inflammatory response.Tissue injury causes the release of inflammatory mediators such as prostaglandins, bradykinin, and histamine, which sensitize peripheral nociceptors and produce pain perception. In the present study, the case group demonstrated higher VAS scores in the early postoperative period, with a gradual reduction from Day 1 to Day 7. This pattern reflects the natural progression of acute inflammation followed by resolution and tissue healing. A statistically significant intergroup difference in pain scores was observed at all postoperative intervals, indicating that surgical management results in greater initial discomfort compared to conventional orthodontic uprighting.

However, the progressive decline in VAS scores confirms that this discomfort is transient. These findings are consistent with previous literature McAboy et al reported mild to moderate postoperative discomfort following surgical uprighting, with symptoms subsiding within a short duration [8]. Terry and Hegtvedt similarly described temporary postoperative discomfort without long-term sequelae [9].

The present study supports the concept that although surgical uprighting is invasive, when performed atraumatically and supported with appropriate analgesic management, it is associated with favorable recovery and minimal long-term morbidity. Restriction in mouth opening is a common postoperative finding following mandibular surgical procedures. Trismus is generally related to inflammation of the masticatory muscles, in addition to edema in adjacent soft tissues. In the present study, the case group exhibited a significant reduction in mouth opening on postoperative Day 1, with gradual improvement by Day 7. In contrast, the control group demonstrated stable mouth opening throughout the observation period. The statistically significant reduction in the early postoperative phase indicates a transient functional limitation associated with surgical manipulation. Boynton and Lieblich reported similar transient trismus following mandibular surgical procedures,with recovery

typically occurring within one to two weeks [10] . McAboy et al. also documented short-term postoperative limitation in jaw movement without persistent functional impairment [8].
Pogrel did not report long-term functional deficits following surgical uprighting procedures.[11] The present findings are therefore consistent with existing evidence demonstrating gradual return to normal function. Early mobilization, patient compliance, minimal surgical trauma, and adequate postoperative care likely contribute to accelerated functional recovery.
Pulpal vitality is a critical determinant of long -term success in surgically repositioned teeth. Disruption of the apical neurovascular bundle during manipulation may compromise pulpal blood supply, potentially leading to ischemia or necrosis. In the present study, the majority of teeth in the surgical group remained vital during the follow-up period. A small number of cases demonstrated non -vital responses, with increased angulation and deeper impaction appearing to correlate with higher incidence of vitality loss. These findings suggest that the degree of surgical manipulation and initial tooth angulation may influence pulpal outcomes. However, pulpal changes do not necessarily indicate irreversible pathology.

McCabe and Dummer explained that pulp canal obliteration may represent a reparative response following trauma rather than true degenerative change. Calcific metamorphosis is often a defensive mechanism triggered by transient vascular compromise, leading to tertiary dentin deposition while maintaining functional integrity.[12] The overall high rate of vitality retention in the present study supports the premise that, when performed carefully, surgical uprighting does not significantly compromise pulpal health. Teeth that demonstrated non-vital responses were managed appropriately to preserve long-term function. Nevertheless, longer follow-up periods are necessary to determine the stability of pulpal outcomes.

External root resorption is a potential complication associated with both orthodontic and surgical interventions. It may result from periodontal ligament trauma, cementoblastic damage, or inflammatory activation of osteoclastic cells. In the present study, cases of external root resorption was not observed in both groups.This favorable outcome may be attributed to controlled surgical manipulation and preservation of periodontal ligament (PDL) integrity. In contrast, Padwa et al. reported a small incidence (5.3%) of root resorption following surgical uprighting [5]. Similarly, Shipper and Thomadakis documented rare cases of root resorption after surgical repositioning, though most remained clinically stable[13]. Terry and Hegtvedt also reported low complication rates with minimal pathological root changes. [9] The absence of root resorption in the present study supports the biological compatibility of the procedure. However, long -term radiographic evaluation is essential to confirm sustained root integrity.

Bone regeneration and periodontal healing are fundamental for long-term stability of surgically repositioned teeth. Although extensive radiographic bone formation could not be conclusively appreciated within the limited duration of this study. Preservation of the periodontium facilitates reattachment of PDL with alveolar bone remodeling. Vitality of PDL cells plays a crucial role in osteogenic stimulation and re-establishment of functional attachment

The use of Xenograft materials may further enhance regenerative potential by providing an osteoconductive scaffold for bone formation. However, longer follow-up and advanced imaging modalities are required to definitively assess the extent of periodontal regeneration and stability.

The present study demonstrates that surgical uprighting can achieve functional correction within a relatively short time frame while maintaining acceptable biological outcomes. Although associated with transient postoperative discomfort and temporary functional limitation, the procedure exhibits high pulp vitality retention and minimal complications. These findings are consistent with previous reports indicating high success rates and predictable outcomes when appropriate case selection is performed. The study however has certain limitations. The sample size was limited, potentially affecting statistical power. The follow-up period was relatively short for definitive assessment of long -term pulpal and periodontal outcomes. Radiographic evaluation beyond three months would provide more comprehensive evidence of bone regeneration and root integrity. Additionally, allocation based on orthodontist recommendation rather than randomization may introduce selection bias.

Future research with larger sample sizes, randomized study designs, and extended follow-up periods is recommended to further validate these findings. Comparative long -term studies between surgical and orthodontic uprighting would provide clearer guidelines for treatment planning

CONCLUSION

Surgical uprighting can be a reliable and an acceptable alternative to orthodontic uprighting in selected cases of impacted mandibular second molars. When performed with careful case selection and atraumatic technique, the procedure demonstrates transient postoperative discomfort, temporary functional limitation, high pulp vitality retention, and minimal risk of root resorption. These findings support the continued role of tooth -preserving surgical approaches in contemporary oral and maxillofacial practice.

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FIGURE 1; ARMAMENTARIUM

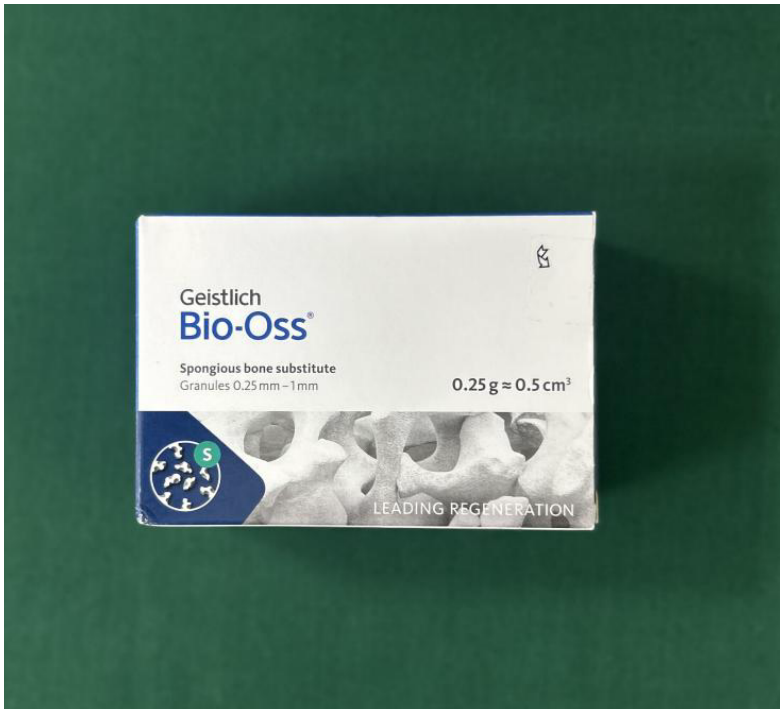

FIGURE 2;XENOGRAFT USED

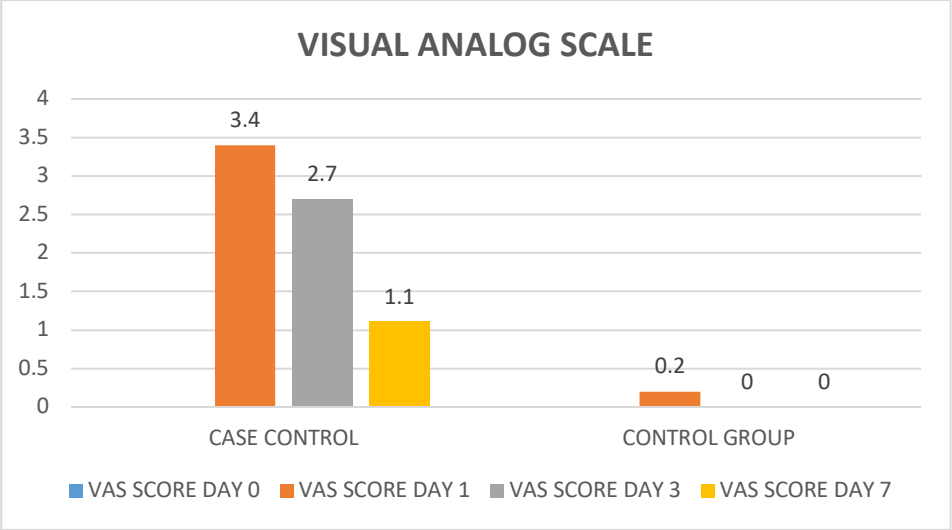

Figure 3; Graphical representation of comparison between the study and control group

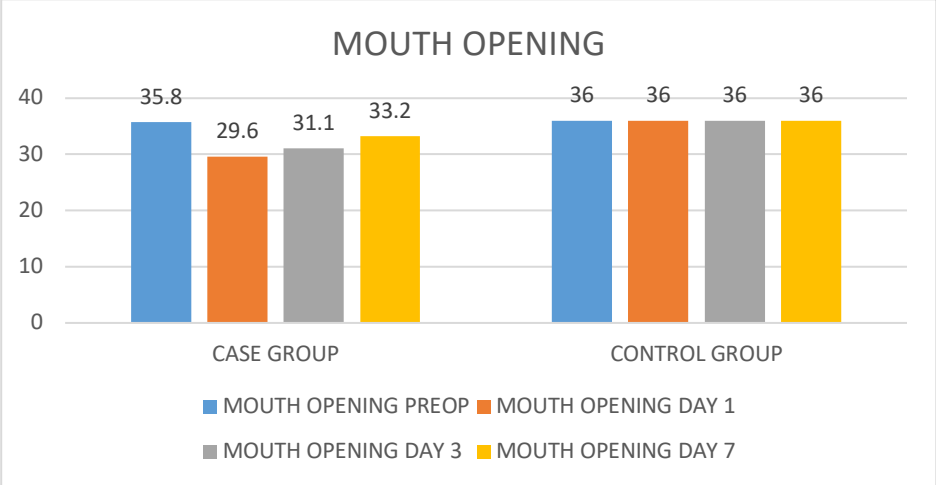

Figure 4 graphical representation of comparison of mouth opening between the study and control

Figure 5;A)Preop Occlusion B) Extraction of Impacted Mandibular Third molar C) Uprighting of Impacted 47 D)Stabilistion of 47 done E)Preop OPG F) 3 Month follow up OPG

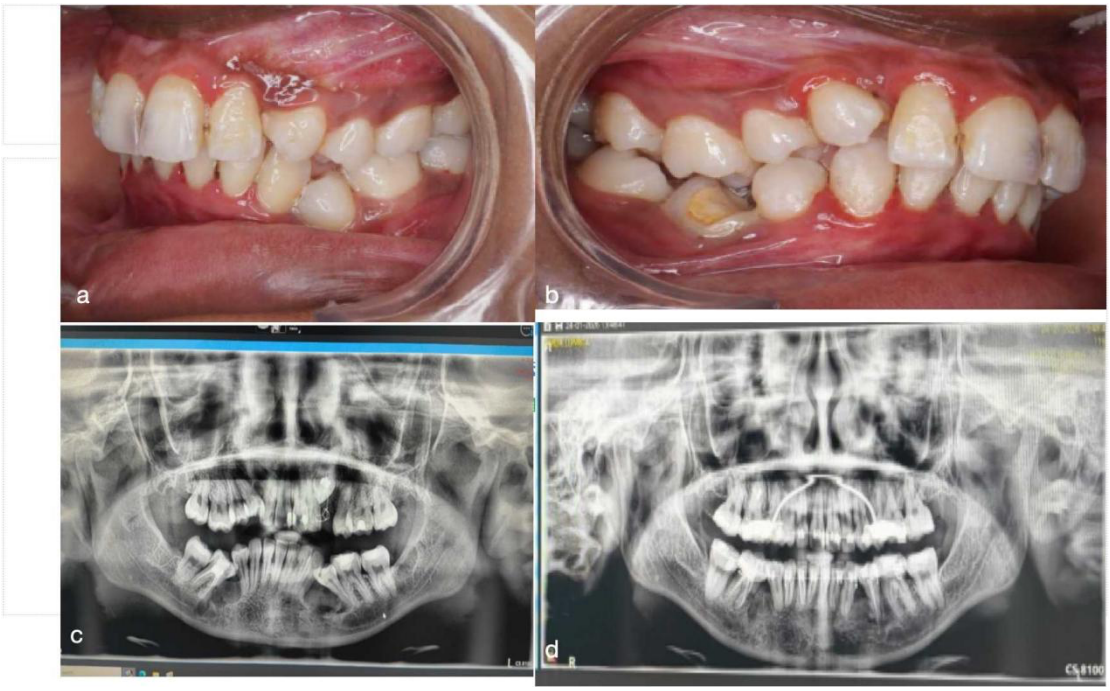

Figure 6: a and b) Preop Occlusion c) Preop OPG d) Post op OPG