DOI: https://doi.org/10.54393/pjhs.v6i1.2221

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 01 (January 2025)

Original Article

OPEN ACCESS

Comparison of Open and Close Exposure with Orthodontic Traction of Impacted Maxillary Canine in Orthodontic Treatments

Muhammad Amjad Bari[1], Nadia Wajdan[2], Tariq[3*], Abid Hussain Kanju[4], Muhammad Azeem Khan[5] and Sahrish Liaquat[6]

[1]Department of Periodontology, Nishtar Institute of Dentistry, Multan, Pakistan
[2]Multan Medical and Dental College, Multan, Pakistan
[3]Department of Orthodontics, Bhittai Medical and Dental College, Mirpurkhas, Pakistan
[4]Department of Orthodontics, Nishtar Institute of Dentistry, Multan, Pakistan
[5]Department of Oral Medicine, Bakhtawar Amin Medical and Dental College, Multan, Pakistan
[6] Department of Oral Medicine, Nishtar Institute of Dentistry, Multan, Pakistan

ARTICLE INFO

Keywords:
Maxillary Canines, Impacted Teeth, Open Eruption, Closed Eruption, Orthodontic Traction

How to Cite:
Amjad Bari, M., Wajdan, N., Tariq, ., Kanju, A. H., Azeem Khan, M., & Liaquat, S. (2025). Comparison of Open and Close Exposure with Orthodontic Traction of Impacted Maxillary Canine in Orthodontic Treatments : Orthodontic Traction of Impacted Maxillary Canine. Pakistan Journal of Health Sciences, 6(1), 69–74. https://doi.org/10.54393/pjhs.v6i1.2221

***Corresponding Author:**
Tariq
Department of Orthodontics, Bhittai Medical and Dental College, Mirpurkhas, Pakistan
sharpeys_fiber@yahoo.com

Received Date: 25th September, 2024
Acceptance Date: 21st January, 2025
Publisehd Date: 31st January, 2025

ABSTRACT

Labial impactions make maxillary canines the most affected permanent teeth after third molars, at one third. Orthodontic advice is often needed for impacted canines. **Objective:** To compare the outcomes of open and close exposure with orthodontic traction of impacted maxillary canine in orthodontic treatments. **Methods:** In this comparative prospective cohort study 54 patients with labial impacted maxillary canine were included in this study. Study was conducted from Jan 2023 - Jun 2023. Non-consecutive sampling technique was used. 27 patients were managed with open technique in group I and 27 patients with closed eruption technique in group II. The evaluation encompassed a comparison of two surgical exposure methods (open and closed) mobility, vitality, periodontal health, amount of impaction, length of orthodontic therapy, and postoperative discomfort. **Results:** Compared to the close eruption approach, the postoperative recovery time for open eruption was significantly greater ($P<0.05$). Patients reported comparable levels of postoperative discomfort; but, the closed eruption approach resulted in a more rapid resolution of that pain. The open eruption approach required less time during surgery on average compared to the closed eruption technique ($P<0.05$). In a direct correlation with the amount of impaction, the overall length of orthodontic treatment was shown to be longer for deeper levels of impaction. Both methods produced canines with comparable levels of energy and movement. **Conclusions:** In this study, the closed eruption approach took longer but reduced postoperative pain faster. Orthodontic therapy took longer with deeper impaction. Closed eruption surgeries improve periodontal tissues surrounding guided erupted teeth.

INTRODUCTION

When it comes to the structure, appearance, and function of the dental arch, canines play a pivotal role [1]. Impaction affects 2% of the population, making them the most impacted tooth in dental patient after third molars [2]. They tend to be unilateral and most often seen in the palatal area; they are more prevalent in the maxilla [3]. Impaction of the upper canine can be caused by a variety of circumstances, however the specific reason is unknown [1]. In order to diagnose impaction and plan and execute the therapy appropriately, clinical and radiographic exams are conducted, along with the determination of the site [4-6]. The location, canine angulation with respect to neighboring teeth, and presence or absence of ankylosis are factors that determine treatment prognosis [7]. Possible treatments include canine extraction and premolar relocation, auto-transplantation, prosthetic rehabilitation for occlusal harmony, or a combination of surgical and orthodontic procedures to bring the tooth into proper alignment with the jaw, among others [8]. A lack of room in the dental arch is the primary cause of buccal impaction. The genetic and guidance hypotheses have both been put out as possible explanations for palatal

DOI: https://doi.org/10.54393/pjhs.v6i1.2221

impaction. Some dental abnormalities, including hypoplasia of the enamel, microdontia of the maxillary lateral incisor, and hypodontia of the second premolar, can coexist with the eruption anomaly of the maxillary canine, which, according to genetic theory, is the consequence of a developmental disruption of the dental lamina. There is evidence for this notion in gender differences, bilateral occurrences, and families [9]. As the maxillary canines glide along their roots during eruption, the root of the lateral incisors acts as a guide, according to the guiding theory. If the directed eruption is disrupted in any way, a palatal impaction might occur. So, palatal impaction can occur if this directed eruption is interrupted. The maxillary lateral incisor missing, extra teeth, odontomas, tooth bud displacement (transposition), and cystic or neoplastic development are all examples of disorders [10]. Early detection of impacted maxillary canines is critical for reducing treatment time, expense, and complexity [11]. Radiographic imaging and clinical examination (palpation and ocular inspection) can confirm the presence of impacted maxillary canines. The dental literature has documented several clinical signs of impaction, such as the delayed eruption of the permanent canine, distal tipping, abnormal migration of the lateral incisors, absence of a labial canine bulge, presence of a palatal bulge, prolonged retention of deciduous canines, or both [12]. Therefore, it is important to determine the normal eruption timing of teeth in the examined population [13]. When caught early, impacted teeth may be able to improve their position or even spontaneously erupt with the use of interceptive orthodontic therapy, such as space formation [14]. By utilizing an apically relocated gingival flap or by entirely removing the bone and soft tissue directly overlaying the affected canine, the crown can be surgically exposed in the open approach. The next step is to use a surgical pack to cover the incision. The canine can then be let to erupt on its own or orthodontic attachments can be bonded directly to the canine for direct traction. On the flip side, the modern closed approach entails bonding an attachment to the exposed canine crown after raising a complete mucoperiostal flap. Following the first healing period, the orthodontic traction is applied and the flap is moved again. This process continues until the canine emerges in the mouth and is then directed to the dental arch. Although both methods have been around for a while, are flexible, and can be adjusted to fit any situation, there has been conflicting information on how well they compare. Pain, periodontal health, aesthetics, recuperation time after surgery, and overall performance have all been the subject of several research [15].

Using two distinct surgical exposure procedures, this study aimed to examine the final orthodontic alignment of patients with labially impacted maxillary canines and evaluate the post-treatment effects.

METHODS

This comparative prospective cohort study was conducted at CIMS Dental College/CMH Multan after getting approval on 7th Dec 2022 with reference no.786/CDC/IRB/12-04. After getting informed written consent detailed demographics were recorded. Non-consecutive sampling technique was used. The calculated sample size was via Open epi sample size calculator by taking mean surgical time in open technique 22.31 ± 1.98 min and in closed 30.87 ± 2.38 min by taking 95% Confidence interval and 80% power of test, was 4 which was too small to perform statistical test. So, 54 patients (27 in each group) were taken [16]. The inclusion criteria were impacted maxillary canines with A2 (tooth angulation to the midline 16°- 45°), V1 (vertical height of the tooth crown above the cementoenamel junction but less than half the length of the root of the maxillary lateral incisor), and O3 (medial position of the canine crown of more than half but less than the entire root width of the lateral incisor). Exclusion criteria were the medical issues that affect tooth movement or ability to use the required mechanics, the patients had no associated syndrome, alveolar cleft and/or palate, or previous tooth loss due to trauma, caries, periodontal disease, or orthodontic extraction. Over the course of six months (Jan 2023- Jun 2023) participants were chosen from a pool of patients who needed orthodontic eruption or instruction for labially impacted maxillary canines. The surgical step involved comparing two methods of guided eruption, one open and one closed. Patients were equally divided in two groups. Minor differences exist in open technique as compared to closed. In this procedure, the canine tooth is surgically exposed, but instead of bonding an attachment, a tissue window is removed to expose it. Covering the exposed area with a dressing or 'pack' After 10 days, the dressing is removed. The tooth is either left to erupt naturally or aligned with the other teeth with an orthodontic attachment above the gum. The closed method includes surgically exposing the teeth and pasting a gold chain attachment. The chain exits the mucosa when the palatal flap is adjusted and sutured. While formerly hard in the surgical theater, new self-etch adhesive bonding solutions have simplified the bonding method. After surgery, an orthodontic brace gently moves the canine into the dental arch. After emerging through the mucosa, the canine positions itself. The research team advice an Orthopantamograph (OPG) measurement of the impacted tooth's distance from the alveolar edge as a means of categorizing affected maxillary canines. Level I was assigned to distances between 1 and 5 mm from the alveolar edge, Level II to distances between 5 and 7 mm, and Level III to distances more than 7 mm. Patients' perceptions of pain during and after surgery were evaluated using a visual analog scale. The analog scale was

DOI: https://doi.org/10.54393/pjhs.v6i1.2221

used to record the following levels of pain: severe (8-10), moderate (4-7), and mild (1-3). The evaluation encompassed a comparison of two surgical exposure methods (open and closed) in terms of pain, recovery time, complications and periodontal pocket depth. To ensure root resorption and lamina dura continuity, Radiovisiography (RVG) was performed on all instances at the end of therapy. In order to determine the periodontal status of the erupted canines, measured the pocket depth on each of the four sides of the guiding tooth. Data were entered and analyzed by SPSS version 25.0. All the qualitative variable was presented by frequencies and percentages and qualitative with mean ± SD. The comparison of two surgical exposure methods (open and closed) in terms of pain, recovery time was compared by independent sample t-test and complications and periodontal pocket depth with Chi-square test. P-value <0.05 was considered as significant.

RESULTS

There were 34 (63.8%) females and 20 (36.2%) males among all cases (Figure 1).

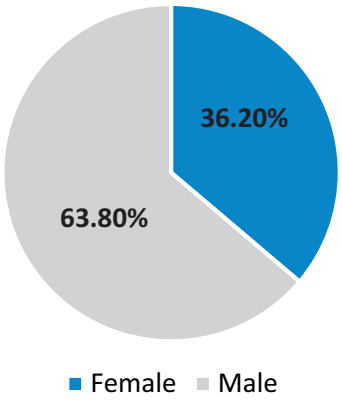

Figure 1: Gender Distribution of Presented Cases

Mean age of the cases in group I was 27.30 ± 5.75 years and in group II mean age was 25.17 ± 10.82 years. In group I right canine impaction was found in 12 (44.4%) cases and left canine in 14 (51.9%) cases while in group II right canine in 11 (40.7%) and left canine in 15 (55.6%) cases. Surgical mean time in group I was 23.17 ± 8.28 minutes and in group II mean time was 31.17 ± 10.42 minutes (Table 1).

Table 1: Demographics and Surgical Time of both Techniques (n=27)

Variables	Group I (Mean ± SD)	Group II (Mean ± SD)
Mean Age (Years)	27.30 ± 5.75	25.17 ± 10.82
Canine		
Right	12 (44.4%)	11 (40.7%)
Left	14 (51.9%)	15 (55.6%)
Bilateral	1 (3.7%)	1 (3.7%)
Surgical Time (Minutes)	23.17 ± 8.28	31.17 ± 10.42

The average pain rating for patients who underwent a closed eruption process was 3.1 ± 0.3, whereas for patients who underwent an open eruption method it was 3.12 ± 0.4, and there was no statistically significant difference (P = 0.12). The time required for recuperation following open eruption surgery was more than that of the close eruption method with p value <0.05. Post-operative, there was no any significant different was observed in complication between both groups (Table 2).

Table 2: Comparison of Pain and Recovery after Treatment (n=27)

Variables	Group I (Mean ± SD)	Group II (Mean ± SD)	p-value
Pain Score	3.1 ± 0.3	3.12 ± 0.4	0.12
Recovery Time (hour)	74.8 ± 6.18	49.04 ± 3.14	<0.05
Complications			
Yes	1 (3.7%)	2 (7.4%)	0.00
No	26 (96.3%)	25 (92.6%)	

No statistically significant difference was seen in the mobility and vitality of the guided canine between the two methods. Periodontal pocket depth evaluations revealed that closed method treated teeth exhibited superior periodontal health (Table 3).

Table 3: The Periodontal Pocket Depth

Variables	Open Technique (Mean ± SD)	Closed Technique (Mean ± SD)	p-value
Mesial (mm)	2.7 ± 1.5	2.4 ± 1.61	0.11
Distal (mm)	3.14 ± 2.12	2.3 ± 0.10	0.20
Buccal (mm)	1.9 ± 2.10	2.15 ± 10.6	0.13
Lingual (mm)	2.0 ± 0.55	2.18 ± 8.24	0.121

Independent T test was utilized

DISCUSSION

A tooth is considered impacted if it has lost its ability to erupt fully or partially into its proper location in the dental arch. The maxillary canine and third molars are among the permanent teeth that often go loose. Between one and two and a half percent of cases include the maxillary canine [17]. After a comprehensive clinical and radiographic assessment, the decision to keep or remove the impacted tooth is made. Although there is a common agreement on how to remove an impacted third molar tooth from the mandible or maxilla, a canine tooth requires a distinct approach. Because teeth are so important to the dentition, preserving them is the greatest way to keep the dental arch looking good and functioning well [18]. Collaboration is key when guiding the tooth into proper occlusion. A full-thickness mucoperiosteal incision is made and the affected tooth is exposed under local anesthetic during surgical extraction. There are two ways to accomplish this: the open technique and the closed method [19]. Re-exposure in the event of bonded connection failure is one of the key drawbacks of the closed approach, although faster healing and less aggressive bone removal are two of its primary benefits. Although the open approach has its benefits, such as the ability to easily rebound attachments

DOI: https://doi.org/10.54393/pjhs.v6i1.2221

in the event of bond failure, it also has certain drawbacks, including as the increased exposure of bone, the increased risk of infection, and the worsening of periodontal health. When all the teeth are erupted, orthodontic treatment of a malocclusion takes less time. The average pain rating for patients who underwent a closed eruption process was 3.1 ± 0.3, whereas for patients who underwent an open eruption method it was 3.12 ± 0.4, and there was no statistically significant difference (P = 0.12). Results were in line with studies conducted in past in post-operative pain score among both groups were insignificant [20-22]. The time required for recuperation following open eruption surgery was more than that of the close eruption method with p value <0.05. Post-operative, there was no any significant different was observed in complication between both groups. These were comparable to the study conducted in past [23]. In current study, surgical mean time in group I was 23.17 ± 8.28 minutes and in group II mean time was 31.17 ± 10.42 minutes. These results were agreed with previous studies conducted by Izadikhah I and Cassina C *et al* [14, 15]. However, when the maxillary canine is impacted, the process takes longer. Contrary to the findings of a previous study, which found that the time required by closed technique was significantly less than open technique, this study found that the open technique was the more time-consuming of the two surgical techniques [21]. The current study utilized MIP, which shortened the attachment bonding period. Various techniques for applying physiological pressure on impacted teeth in the upper jaw were detailed. Other supplementary mechanics enable the traction of an impacted maxillary canine into the dental arch, in addition to the standard golden chain and elastic techniques. Because the incisor is guided near to the resorptive follicle of the impacted canine and experiences a significant torque during conventional alignment, the surrounding lateral incisors may be at risk of resorption [22]. Preventing root resorptions of lateral incisors requires careful movement management of impacted maxillary canines. The temporary anchoring device described by past study can make this possible [24]. Another useful approach that may be employed both before and during the leveling process was published by Raghav *et al* [25]. The segmented arch technique's static mechanics allowed to claim an efficient and predictable output [26]. Using two distinct approaches, the initial stage of this investigation involved making enough room for the affected canine to be traced into its proper location in the arch. According to previous study,a simple biomechanical exercise can be used to tip the crown of an impacted maxillary canine into the proper position within the dental arch if its apex is in line with the arch in the buccopalatal and mesiodistal planes [27]. This study was able to include the same biomechanic because of the angulation, tilting, and vertical orientation inclusion criteria for the location of the impacted maxillary canine. In current study, no statistically significant difference was seen in the mobility and vitality of the guided canine between the two methods. Periodontal pocket depth evaluations revealed that closed method treated teeth exhibited superior periodontal health. When it comes to treating impacted canines, previously proposed that the open technique would yield better periodontal outcomes than the closed technique. This is because the former allows for better cleansability and causes less trauma to the periodontal tissue during the canine's natural eruption [28]. The results from this investigation show the opposite to be true. A Gingival Index (GI) score was used to quantify the results of a clinical assessment of gingiva color, size, and texture. The GI score was much greater in the open group compared to the closed surgical groups, indicating a worse result for the open group individuals. The dogs in the open group also showed a significantly higher plaque index compared to those in the closed group. One possible explanation for the contradictory findings is that the sample size is too small to draw any firm conclusions from the data we have collected thus far. No evidence found that participants in the open surgical group had better outcomes than those in the closed surgical group with respect to clinical attachment level. This agrees with previous study [29].

CONCLUSIONS

In this comparative study, the closed eruption approach took longer but reduced postoperative pain faster. Orthodontic therapy took longer with deeper impaction. Closed eruption surgeries improve periodontal tissues surrounding guided erupted teeth.

Authors Contribution

Conceptualization: NW
Methodology: MAB, T
Formal analysis: AHK
Writing, review and editing: MAK, SL

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

DOI: https://doi.org/10.54393/pjhs.v6i1.2221

REFERENCES

[1] Parkin NA, Almutairi S, Benson PE. Surgical exposure and orthodontic alignment of palatally displaced canines: can we shorten treatment time?. Journal of Orthodontics.2019 Jun; 46(1_suppl): 54-9. doi: 10.1177/1465312519841384.

[2] Sampaziotis D, Tsolakis IA, Bitsanis E, Tsolakis AI. Open versus closed surgical exposure of palatally impacted maxillary canines: comparison of the different treatment outcomes-a systematic review. European Journal of Orthodontics. 2018 Jan; 40(1): 11-22. doi: 10.1093/ejo/cjw077.

[3] Pakbaznejad Esmaeili E, Ilo AM, Waltimo-Sirén J, Ekholm M. Minimum size and positioning of imaging field for CBCT scans of impacted maxillary canines. Clinical Oral Investigations.2020 Feb; 24: 897-905. doi: 10.1007/s00784-019-02904-1.

[4] Dağsuyu İM, Kahraman F, Okşayan R. Three-dimensional evaluation of angular, linear, and resorption features of maxillary impacted canines on cone-beam computed tomography. Oral Radiology. 2018 Jan; 34: 66-72. doi: 10.1007/s11282-017-0289-5.

[5] Schroder AG, Guariza-Filho O, de Araujo CM, Ruellas AC, Tanaka OM, Porporatti AL. To what extent are impacted canines associated with root resorption of the adjacent tooth?: A systematic review with meta-analysis. The Journal of the American Dental Association.2018 Sep; 149(9): 765-77. doi:10.1016/j.adaj.2018.05.012.

[6] Mummolo S, Nota A, De Felice ME, Marcattili D, Tecco S, Marzo G. Periodontal status of buccally and palatally impacted maxillary canines after surgical-orthodontic treatment with open technique. Journal of Oral Science. 2018; 60(4): 552-6. doi: 10.2334/josnusd.17-0394.

[7] Björksved M, Arnrup K, Lindsten R, Magnusson A, Sundell AL, Gustafsson A *et al*. Closed vs open surgical exposure of palatally displaced canines: surgery time, postoperative complications, and patients' perceptions: a multicentre, randomized, controlled trial. European Journal of Orthodontics. 2018 Nov; 40(6): 626-35. doi: 10.1093/ejo/cjy070.

[8] Zabielskaite G, Varoneckaite M, Smailiene D. Evaluation of postoperative pain and discomfort in patients undergoing surgical exposure of impacted maxillary canines. Journal of Oral & Maxillofacial Research.2022 Apr; 13(2). doi.org/10 .5037/jomr .2022 .13202.

[9] Mousa MR, Hajeer MY, Burhan AS, Heshmeh O, Alam MK. The effectiveness of minimally-invasive corticotomy-assisted orthodontic treatment of palatally impacted canines compared to the traditional traction method in terms of treatment duration, velocity of traction movement and the associated dentoalveolar changes: A Randomized Controlled Trial. F1000Research.2023; 12. doi: 10.1 26 88/f1000research.135338.1.

[10] D'Silva E, Fraser D, Wang B, Barmak AB, Caton J, Tsigarida A. The association between gingival recession and buccal bone at maxillary anterior teeth. Journal of Periodontology.2020 Apr; 91(4): 484-92. doi: 10.1002/JPER.19-0375.

[11] Caprioglio A, Comaglio I, Siani L, Fastuca R. Effects of impaction severity of treated palatally displaced canines on periodontal outcomes: a retrospective study. Progress in Orthodontics. 2019 Dec; 20: 1-7. doi: 10.1186/s40510-018-0256-7.

[12] Luyten J, Grisar K, Opdebeeck H, Jacobs R, Politis C. A retrospective long-term pulpal, periodontal, and esthetic, follow-up of palatally impacted canines treated with an open or closed surgical exposure technique using the Maxillary Canine Aesthetic Index. American Journal of Orthodontics and Dentofacial Orthopedics.2020 Oct; 158(4): e29-36. doi: 10.1016/j.ajodo.2019.11.014.

[13] Fekonja A. Comparisons of Two Different Treatment Methods for Impacted Maxillary Canines: A Retrospective Study. Journal of Clinical Medicine. 2024 Apr; 13(8): 2374. doi: 10.3390/jcm13082374.

[14] Cassina C, Papageorgiou SN, Eliades T. Open versus closed surgical exposure for permanent impacted canines: a systematic review and meta-analyses. European Journal of Orthodontics. 2018 Jan; 40(1): 1-0. doi: 10.1093/ejo/cjx047.

[15] Sajnani AK and King NM. Success rates of different management techniques for impacted mandibular canines and associated complications in children and adolescents. Journal of Investigative and Clinical Dentistry.2015 Aug; 6(3): 228-33. doi: 10.111 1/jicd.12 084.

[16] Londhe SM, Kumar P, Datana S, Kotwal A, Saxena V. Guided tooth eruption: comparison of open and closed eruption techniques in labially impacted maxillary canines. Journal of Dental Research and Reviews. 2014 Dec; 1(3): 148-51. doi: 10.4103/2348-2915.146495.

[17] Garcovich D, Aiuto R, Serrano EL, Re D. and autonomous eruption of palatally impacted canines. European Journal of Paediatric Dentistry. 2018 Apr; 19: 300.

[18] Katiyar R, Tandon P, Singh GP, Agrawal A, Chaturvedi TP. Management of impacted all canines with surgical exposure and alignment by orthodontic treatment. Contemporary Clinical Dentistry. 2013 Jul; 4(3): 371-3. doi: 10.4103/0976-237X.118350.

DOI: https://doi.org/10.54393/pjhs.v6i1.2221

[19] Grisar K, Chaabouni D, Romero LP, Vandendriessche T, Politis C, Jacobs R. Autogenous transalveolar transplantation of maxillary canines: a systematic review and meta-analysis. European Journal of Orthodontics.2018 Nov; 40(6): 608-16. doi: 10.1093/ejo /cjy026.

[20] Smailiene D, Kavaliauskiene A, Pacauskiene I, Zasciurinskiene E, Bjerklin K. Palatally impacted maxillary canines: choice of surgical-orthodontic treatment method does not influence post-treatment periodontal status. A controlled prospective study. European Journal of Orthodontics. 2013 Dec; 35(6): 803-10. doi: 10.1093/ejo/cjs102.

[21] Lee JY, Choi YJ, Choi SH, Chung CJ, Yu HS, Kim KH. Labially impacted maxillary canines after the closed eruption technique and orthodontic traction: A split-mouth comparison of periodontal recession. Journal of Periodontology. 2019 Jan; 90(1): 35-43. doi: 10.1002/JPER.18-0034.

[22] Alyammahi AS, Kaklamanos EG, Athanasiou AE. Effectiveness of extraction of primary canines for interceptive management of palatally displaced permanent canines: a systematic review and meta-analysis. European Journal of Orthodontics. 2018 Apr; 40(2): 149-56. doi: 10.1093/ejo/cjx042.

[23] Naoumova J, Rahbar E, Hansen K. Glass-ionomer open exposure (GOPEX) versus closed exposure of palatally impacted canines: a retrospective study of treatment outcome and orthodontists' preferences. European Journal of Orthodontics. 2018 Nov; 40(6): 617-25. doi: 10.1093/ejo/cjy031.

[24] Grenga C, Guarnieri R, Grenga V, Bovi M, Bertoldo S, Galluccio G *et al.* Periodontal evaluation of palatally impacted maxillary canines treated by closed approach with ultrasonic surgery and orthodontic treatment: a retrospective pilot study. Scientific Reports. 2021 Feb; 11(1): 2843. doi: 10.1038/s41598-021-82510-y.

[25] Raghav P, Singh K, Reddy CM, Joshi D, Jain S. Treatment of maxillary impacted canine using ballista spring and orthodontic wire traction. International Journal of Clinical Pediatric Dentistry. 2017 Jul; 10(3): 313. doi: 10.5005/jp-journals-10005-1457.

[26] Otake Y, Nakamura M, Henmi A, Takahashi T, Sasano Y. Experimental comparison of the performance of cutting bone and soft tissue between piezosurgery and conventional rotary instruments. Scientific Reports. 2018 Nov; 8(1): 17154. doi: 10.1038/s41598-018-35295-6.

[27] Guarnieri R, Bertoldo S, Cassetta M, Altieri F, Grenga C, Vichi M *et al.* Periodontal results of different therapeutic approaches (open vs. closed technique) and timing evaluation (< 2 year vs.> 2 year) of palatal impacted canines: a systematic review. BioMed Central Oral Health. 2021 Dec; 21: 1-3. doi: 10.1186 /s12 903-021-01937-x.

[28] Sultan H AlAnazi, Ahmed A Aldeaij, Mufarah Y Assiri, Eman. M Saleh, Alkatheri Bayan. Orthodontic Considerations for Management of Bilateral Impacted Maxillary Canine Case Series and Review of Literature. International Clinical and Medical Case Reports Journal. 2023 Nov; 2(17): 1-16.

[29] Pua OA, Silva Júnior JP, Martins JH, Cavalcante BM, Almeida PP, Silva FL, Belém LC, Medeiros AM. Surgery traction canine of impacted in the maxillary: a case report. RGO-Revista Gaúcha de Odontologia. 2023 Oct; 71: e20230052. doi: 10.1590/1981-86372023 00522 0230009.