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Original Article

Evaluation of the Difference in the Rate of Canine Retraction Assisted by Piezocision and Discission in Human Subjects: A Preliminary Parallel-Arm Prospective Clinical Study

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Main Points

- This study evaluated the rate of canine retraction assisted by piezocision and dissection in a split mouth clinical study design with the opposite side serving as the control.
- Both corticotomy techniques doubled the rate of tooth movement compared to conventional retraction mechanics, while no difference was observed in the rate of tooth movement between peizocision and decision.
- Discision, although a cost-effective alternative, poses technical difficulties in practice.
- Although patients reported overall satisfaction with the procedure, mild pain and disturbance during the first 24 h was reported with decision.

ABSTRACT

Objective: The objective of the study was to evaluate the rate of orthodontic tooth movement assisted by piezocision and discission in extraction cases.

Methods: Twelve adults (20-35 years) requiring upper premolar extraction for orthodontic treatment were included in this preliminary parallel-arm clinical study. Participants (randomly allocated) in Groups A and B received piezocision and discision-assisted corticotomy cuts at the premolar extraction site, respectively, contralateral side served as the control. Canine retraction was started bilaterally using closed coil NiTi (Nickel titanium) springs. A schedule of fortnightly activation was followed for 3 months. Stage models were made monthly (M0, M1, M2, M3). Models were scanned using a 3-shape intraoral scanner, and the displacement of the canine was measured bilaterally in the stage models. A self-designed questionnaire was used to assess patients pain and satisfaction levels on a visual analogue scale.

Results: The rate of canine retraction at the piezocision site was twice that at the control site in group A (p=0.007). The rate of canine retraction at the dissection site was twice that at the control site in group B (p=0.012). However, there was no significant difference in the rate of retraction between the two surgical techniques. Pain and disturbance were noticed in the discission group at 50 and 67% respectively.

Conclusion: Discision is comparable to piezocision for accelerating orthodontic tooth movement. Although dissection can speed orthodontic treatment, it should be used with caution as it could pose technical and clinical difficulties, particularly in the posterior buccal region of the oral cavity.

Keywords: Corticotomy, piezocision, discision, regional acceleratory phenomenon

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INTRODUCTION

Accelerated orthodontic tooth movement can be achieved by enhancing the expression of specific inflammatory factors.[1] Several methods have been proposed to achieve accelerated orthodontic tooth movement, including physical or mechanical stimulation, medications, and surgical techniques.[1-4]

Wilcko et al.[5] explained that accelerated rate of tooth movement with periodontally accelerated osteogenic orthodontics is due to a transient catabolic and anabolic phase, which is an attribute of regional acceleratory phenomenon (RAP) as described by Frost in 1983. Vercellotti and Podesta[6] introduced corticotomy assisted by piezosurgical device in conjunction with mucoperiosteal flap elevation. Although, these corticotomies that effectively accelerate orthodontic tooth movement (OTM) are inherently invasive due to the requirement for significant flap elevation. This may potentially lead to postoperative pain, avascular necrosis, and a low patient's acceptance rate.[5-8] Some studies have also reported periodontal problems, such as increased tooth mobility and bone dehiscence, immediately following full-thickness flap elevation.[8-10]

In contrast to previous methods involving cortical resection and flap elevation, the concept of a minimally invasive corticotomy is to activate the inflammatory cascade in the cortical bone by creating an osteoporotic environment conducive to accelerating OTM.[11]

The use of ultrasonic devices is associated with minimal postoperative pain and discomfort because they are less traumatic to the hard and soft tissues. Piezoelectric instruments, which allow for more favorable osseous repair and regeneration, have several advantages: a reduction in intraoperative bleeding and surgical trauma, leading to improved visibility and reduced operating time, resulting in less morbidity for the patient.[12] Corticision, a flapless corticotomy method using scalpel and mallet, introduced by Kim et al.[13] , had the disadvantage of causing dizziness post-surgery due to malleting. Dibart et al.[14] introduced piezocision as a minimally invasive corticotomy procedure.

Piezosurgery knives are available in specific thicknesses, which limits their use in patients with roots in very close proximity. The feasibility of procuring a piezotome in a routine orthodontic setup is impractical.[15] Buyuk et al.[7] used an implant disk saw, which is compatible with a physiodispenser and readily available in dental clinics, for performing corticotomy. This technique has demonstrated satisfactory results in hastening the alignment of crowded teeth.[15]

There is a dearth of literature comparing the above-mentioned techniques in accelerating OTM. Hence, this preliminary prospective clinical study compared the rate of canine retraction assisted by piezocision and decision. The null hypothesis was that there would be no difference between the rate of tooth movement achieved by piezocision and decision.

METHODS

Sample size estimation was performed using G* Power 3 software with power (1-β error prob) of 80% and an α error of 0.05, resulting in a determined sample size of 12 patients (Group A= 6 patients, Group B= 6 patients). The level of statistical significance level was set at p≤0.05.[16] This parallel arm study was approved by the Institute's Scientific Review Board and Ethical Committee of SRM Dental College (approval no: SRMDC/IRB/2019/MDS/No.108A, date: 04.01.2022) and was registered under the Clinical Trial Registry. The study was designed as a preliminary parallel-arm investigation following a split mouth study design, where one quadrant of the maxillary arch served as the corticotomy side and the opposite side serving as the control (Figure 1).

Patients for the study were selected based on specific criteria, including being adults within the age range of 20-35 years, having a full permanent dentition with or without third molars, requiring therapeutic extraction of both maxillary first premolars, having periodontal probing depths less than or equal to 3mm, maintaining adequate oral hygiene, possessing adequate width of attached gingiva, and exhibiting no associated bone loss. Exclusion criteria included systemic diseases that affect bone formation or density, such as osteoporosis, hyperparathyroidism, or vitamin D deficiency, as well as other systemic diseases like blood dyscrasias and a history of smoking. Twelve patients meeting the criteria were enrolled in the study. Informed consent was procured from all participants after having explained the entire treatment protocol to them.

All patients underwent therapeutic orthodontic extraction of all four first premolars followed by fixed mechanotherapy. After initial alignment and leveling, a working archwire (0.019X0.025" stainless steel) was engaged in the upper arch. Orthopantomograms, intraoral photographs and impressions

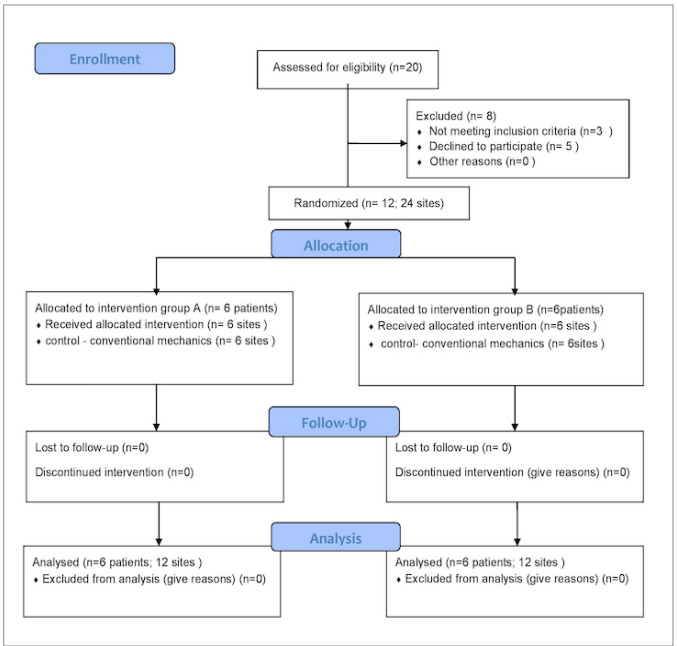

Figure 1. Consort flow diagram

of the upper and lower arches were recorded as presurgical records (M0).

The twelve participants were randomly assigned to one of the groups. Split mouth design with both surgical techniques in the same patient was avoided to prevent the crossover effect of either technique across the quadrants. The test sites received corticotomy assisted by piezocision (group A) or decision (group B). On the contralateral side, canine retraction was carried out using conventional friction mechanics in both groups.

Surgical Intervention

Sterilization and personal protection protocols were followed before and during surgical procedure. Under local anesthesia (2% Lignocaine with 1:80,000 Adrenaline), a minimally invasive vertical microperiosteal incision was executed on the mid-buccal aspect using a surgical scalpel blade no.15C. The incision was approximately 7 mm long, beginning 3 mm from the gingival crest and extending to the alveolar mucosa.

For the Piezocision technique: The guiding soft tissue incision was followed by a cortical penetrating vertical cut made using Piezoelectric BS1-insert at 27-36 khz (9 mm cutting depth, Piezotome, Satelec, Acteon, France) at the center of the site distal to canine. The cut was 7 mm long and 3 mm deep, penetrating the alveolar bone[14] (Figure 2).

In the case of the Dissection technique: Following the guiding soft tissue incision, a cortical penetrating vertical cut executed using a disk saw (3.5 mm radius, Esset KIT-Osstem, Seoul, Korea) operating at 350 rpm, compatible with a physiodispenser (NSK, USA) on the site distal to the canine in the maxillary arch. The cut was 7 mm long and 3.5 mm deep in the bone, positioned distal to the canine within the maxillary arch[7] (Figure 3).

Figure 2. Piezocision case: a) before corticotomy; b) during corticotomy; c) immediate loading of forces with closed NiTi coil spring

The contralateral extraction space located distal to the canine within the maxillary arch served as the control, ensuring the implementation of split mouth design. Immediately after the corticotomy, the sites were irrigated with copious saline solution and gentle pressure was applied using sterile gauze packs to minimize bleeding. After achieving hemostasis, canine retraction was initiated. No sutures or periodontal dressings were placed at the surgical site (Figures 2 and 3). Postsurgery instructions were given, and patients were advised to take paracetamol for the management of postoperative pain if needed.

For each participant after the corticotomy procedure, retraction was initiated for both sites in the maxilla using closed NiTi (Nickel Titanium) coil springs that applied a calibrated force of 120 gms/side for visualising the maxillary canines (Figures 1 and 2).

Activation of the NiTi closed coil spring was performed every 2 weeks during the 3 months follow-up period. Stage impressions were recorded for measuring the rate of canine retraction every month for a follow-up period of three months [M0 (pre-activation), M1, M2, M3].

All stage models were scanned using a 3 Shape Trios intraoral scanner (SHAPE, Copenhagen, Denmark) and saved as standard Triangle Language (.STL) files. The distance from the tip of the maxillary canine to the tip of the mesiobuccal cusp of the maxillary first molar was measured on both the corticotomised and control sites using Maestro 3D software (Figure 4). Cusp tips were chosen as reference points because they offered better visibility and ease of measurement with the three-dimensional analyzing software.[17,18]

A self-designed questionnaire was used to assess patient pain and satisfaction levels on a visual analogue scale during, after, 24, and 48 h after the surgical procedure (Tables 1 and 2).

Figure 3. Discision case: a) before corticotomy, b) during corticotomy, c) immediate loading of forces with closed NiTi coil spring

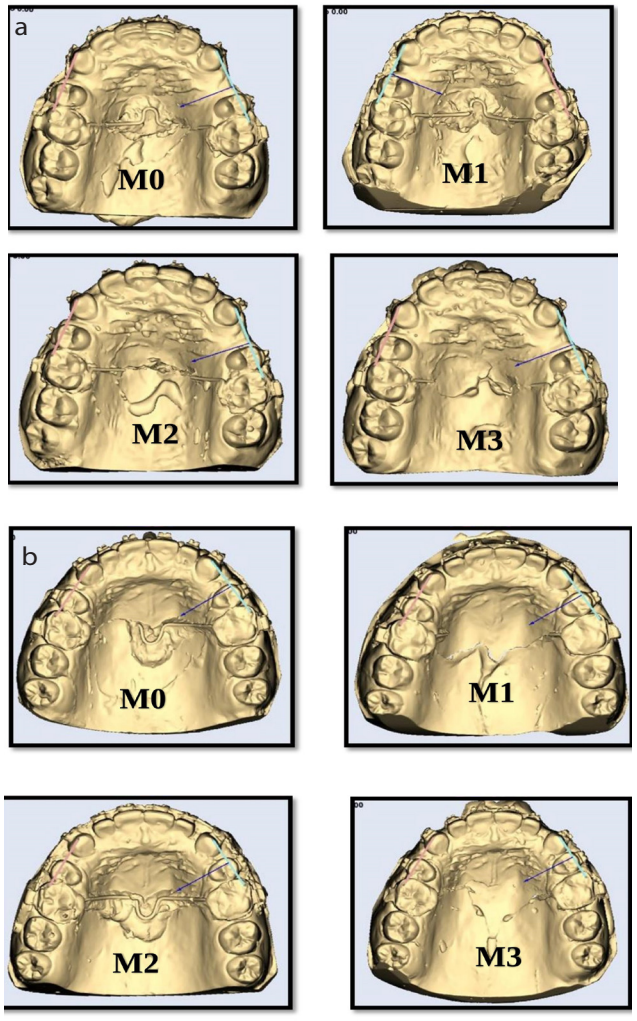

Figure 4. Scanned images of stage models: a) piezocision and b) discision cases

Table 1. Self designed questionnaire interpretation for participants in Group A (piezocision assisted corticotomy)

Pain			
		Piezocision	Control
1	Site	-	-
2	Duration	-	-
3	Intensity	-	-
4	Symptom	-	-
Interference			
		Piezocision	Control
1	Site	-	3
2	Duration	-	Up to 24 hr
3	When	-	Mostly while eating or activity
4	Intensity	-	23%
Satisfaction			
		Piezocision	Control
1	Site of comfort	Equally comfortable	
2	Intensity of comfort	-	
3	Site of discomfort	-	
4	Intensity of discomfort	-	
5	Intensity of satisfaction overall	100%	
6	Overall satisfaction of sites	Equal	

Statistical Analysis

The collected data were analyzed with IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp, Armonk, NY, USA). Test for normality was performed using the Sharpiro-Wilk test. Further Independent Samples Student's t-test was performed to compare piezocision with control, discission with control, and piezocision with discision (Tables 3 and 4).

RESULTS

The rate of distal movement of canines in Group A was greater at the piezocision site compared to the control sites at all stages, demonstrating statistically significant differences for M0-M1 (p=0.025), M1-M2 (p=0.012), M2-M3 (p=0.003) and M0-M3 (p=0.007) (Table 3). The rate of distal movement of canines in group B was higher at discission sites than at the control sites during M0-M1 (p=0.048) and M0-M3 (p=0.012) (Table 3). The rate of canine distalization at both piezocision and discission sites showed no significant difference throughout the 3-month follow-up periods (Table 4). Hence, the two experimentalcorticotomy techniques are equally comparable in terms of accelerating OTM.

Evaluation of the self-designed questionnaire indicated almost complete satisfaction with both the corticotomy combined orthodontic mechanics and the conventional mechanics used. 50% of the participants in Group B noted experiencing pain on the first day with an average intensity of 36.66% on the discission side. On the contrary, participants in Group A experienced no pain. Disturbance during mastication for the first 24 h was observed on the discission side by 67% of the participants. In group A, around 50% of participants found the control site disturbing during eating for the first postoperative 24 h, while all participants experienced neither disturbance nor interference from the piezocision procedure performed (Tables 1 and 2).

DISCUSSION

Factors like hormones, age, occlusal factors, orthodontic forces, health status and bone type affect bone density and remodeling, thereby affecting orthodontic tooth movement

Table 2. Self designed questionnaire interpretation for participants in Group B (discision assisted coticotomy)

Pain			
		Discision	Control
1	Site	50%	-
2	Duration	Up to 24 hr	-
3	Intensity	36.66%	-
4	Symptom	Nil	-
Interference			
		Discision	Control
1	Site	4	1
2	Duration	24-48 hr	Up to 24h
3	When	Mostly during eating, only one during activity	Eating and activity
4	Intensity	30%	35%
Satisfaction			
		Discision	Control
1	Site of comfort	Equal	
2	Intensity of comfort	100%	
3	Site of discomfort	None	Only one patient
4	Intensity of discomfort	-	70% (one patient)
5	Intensity of satisfaction overall	100%	
6	Overall satisfaction of sites	Equal	

Table 3. Intra group comparison for the rate of canine retraction

	Group A (Piezocision)			Group B (Discision group)		
	Piezocision site (mm)	**Control site (mm)**	**p value**	**Discision site (mm)**	**Control site (mm)**	**p value**
M0-M1	1.40+0.20	1.15+0.12	0.025*	1.25+0.28	0.68+0.55	0.048*
M1-M2	1.43+0.44	0.80+0.23	0.012*	1.72+1.10	0.87+0.63	0.13
M2-M3	1.53+0.49	0.70+0.14	0.003*	0.96+0.36	0.23+1.08	0.14
M0-M3	3.97+1.54	1.78+0.42	0.007*	3.95+1.14	1.78+1.31	0.012*

*P value <0.05 - significant
M0- before corticotomy
M1- one month after corticotomy
M2- two months after corticotomy
M3- three months after orticotomy

Table 4. Comparison between rate of canine retraction assisted by piezocision and discision

	Piezocision site (mm)	**Discision site (mm)**	**p value**
M0-M1	1.40+0.20	1.25+0.28	0.32
M1-M2	1.43+0.44	1.72+1.10	0.55
M2-M3	1.53+0.49	0.96+0.36	0.052
M0-M3	3.97+1.54	3.95+1.14	0.97

*p value <0.05 - significant
M0- before corticotomy
M1- one month after corticotomy
M2- two months after corticotomy
M3- three months after orticotomy

(OTM).[19]Age plays a critical role in tooth movement due to its significant relation with bone density, the recruitment of inflammatory markers, and the activation of osteoclasts.[20] Hence, all participants enrolled in this study were between 20 and 35 years. Patients with similar severities of malocclusion requiring extraction of the permanent maxillary first bicuspid were included in this clinical study. To eliminate the potential of uneven occlusal forces arising from a dominant habitual occlusion on one side, the allocation of corticotomy and control sites to the left or right side for each patient was done through randomization.[19] Extractions affect the rate of tooth movement by increasing the activity of inflammatory markers and hence overlap and obscure the effect of corticotomy.[21] In order to minimize this, extractions in this study were performed before bonding brackets to permit recovery of bone architecture and prevent potential inflammation and its obstructing effects. Canine retraction was started only after completion of the alignment and leveling stages. The application of excessive force could lead to many complications such as root resorption.[17] Since literature reports that effective tooth movement is possible with light forces, a force of 120 gms/side was calibrated using a dontrix gauge during activation of closed coil NiTi springs.[22] The maxilla and mandible respond differently to the same force;

loads on maxilla get dissipated to the rest of the cranium, while mandible experiences torsional and bending strain. Different bone mass and geometry account for the difference in response to orthodontic loading in the two bones.[11,19,20] Hence for the present study, corticotomy (test) and control sites were confined to the maxillary arch.

Cortical bone is devoid of blood supply but still considered vital for accelerating OTM. "Mechanical movement theory" has been replaced by Frost's "RAP" which states that there is an increased recruitment of cells involved in bone metabolism at the site of intentional injury. The regional response to surgical insult directly correlates with the magnitude and nature of stimulus.[5] Thickness of cortical bone in the maxillary premolar region is 1.8 mm and corticotomy cut should be more than 1 mm in depth to provide the required stimulus to initiate RAP.[19,23] Uribe et al.[23] concluded that piezotome-corticision-assisted orthodontics could not effectively alleviate mandibular anterior crowding. Their maximum permitted cortical penetration depth was 1mm, which was insufficient to enhance the regional inflammatory process.[23] In this study, the penetration depth was set as 3 mm and length of the cut was 7 mm into the alveolar bone for both piezocision and discision.[5,7,11,15,24] The RAP initiated on the buccal side could readily involve the non-corticotomized palatal side.[5,25] Hence, to minimize the invasive nature of the procedure, discomfort, and operative time for the clinician, corticotomy cuts were made only at the buccal cortex of alveolar bone.[25]

RAP is a transient, ubiquitous post-injury phenomenon that accelerates OTM with its peaks in the first two months.[12,14] Therefore, it is suggested to activate the retraction every two weeks to exploit the exacerbated response. Although RAP lasts for a minimum of four months, its efficacy diminishes with resultant deceleration in the velocity of OTM over time.[17,18,26] In the present study, the rate of canine retraction at the experimental sites was similar to that reported by Aksakalli et al.[18]. Çağlı Karcı and Baka[27] reported only half the amount of canine retraction every month compared to this study. It is not the design of corticotomy that determines the rate of tooth movement but the regional, transient and exaggerated cellular response that is responsible for the acceleration.[5,19] In the present study, piezocision and discission sites demonstrated a statistically comparable rate of canine distalisation. Hence, there was no difference in the rate of canine retraction between the two corticotomy techniques.

The power of the study was 80%; although the sample size was small, it was clear from the results that the rate of canine retraction at both piezocision and discission sites was significantly higher than that at contralateral control sites ($p<0.05$) Table 3. The two experimental sites showed approximately two times faster rates of tooth movement when compared to the control sites. This result is in accordance with previous studies.[6,19] However, it has been reported that microperiosteal flap elevation was associated with faster tooth movement compared to the present study.[5,9,26] When the surgical intervention is adequate to stimulate a rapid alveolar reaction, there is early osteoclastic activation and enhanced turnover of alveolar bone, which is the reason for the acceleration of tooth movement. Corticotomy-assisted OTM demonstrates continuous and steady movement without evidence of a "lag phase", which often corresponds to periodontal ligament hyalinization in conventional OTM. Mucoperiosteal flap elevation by itself is found to be a stimulus for RAP and it could have a synergistic effect to corticotomy.[8,11,28] Although using an implant disk saw for corticotomy can aid in accelerating OTM as demonstrated in this study, the disk saw design, the localized condition of the selected site, and its adjoining structures should be carefully examined and practically correlated. The angulation of the disk to the shaft was at the right angle, which posed technical difficulty in use in the posterior region due to anatomical and access limitations. The vestibular depth decreases posteriorly, and accidental injury to the frenal muscular attachment in the premolar region could be expected even with the most experienced clinical hand. There are increased chances of laceration of buccal frenal attachments with even a slight slippage of the disk saw.

The initial pain or pressure is a common concern expressed by orthodontic patients, for a minimum of 24 hours at every activation.[29] Complete recovery after corticotomy with flap elevation takes nearly seven to ten days with minor postsurgical complications including swelling. Al-Naoum et al.[9] reported that all participants complained of pain while eating for the first two days after surgery, which gradually decreased over time. However, in the current study, 66% of participants experienced pain intermittently for 24 hours with an average intensity of 36.66% on the discission side and disturbance was noticed for two days during mastication. Participants in the piezocision group experienced neither pain nor disturbance. Some participants, however, reported that they found the control sides disturbing for 24 hours compared to the piezocision side. This study suggests that though both procedures are invasive, they are minimally invasive. There was almost a similar level of satisfaction with both corticotomy combined with orthodontic mechanics and conventional mechanics among patients.

The trial was conducted to assess the rate of OTM assisted by corticotomy using piezocision and discission, comparing both with the control side, making it a purely clinical study. This research, however, lacks the analysis of cellular and molecular-level changes occuring due to the regional acceleratory phenomenon (RAP) induced by these procedures. This could serve as a potential scope for future research. This study could not compare augmentation combined with the two procedures because there was no previous research that compared the rate of OTM following piezocision or decision. Exploring this aspect could be a future scope for comparison as augmentation with materials like platelet-rich fibrin and bone-grafts has demonstrated synergistic effects.[16,27]

CONCLUSION

The rates of tooth movement assisted by piezocision and discission were comparable with no statistical difference between the two. Both the corticotomy techniques were found to enhance OTM at twice the pace of conventional mechanics. Although patients reported complete satisfaction with the corticotomy procedures or conventional mechanics, mild pain

and disturbance during the initial 24 hours were reported n the discission group. With piezocision trauma to adjoining structures was minimal, while with discission trauma to adjacent soft tissue structures such as buccal frenal attachments were noted.

Ethics

Ethics Committee Approval: The study was approved by the Institute's Scientific Review Board and Ethical Committee of SRM Dental College (approval no: SRMDC/IRB/2019/MDS/No.108A, date: 04.01.2022).

Informed Consent: Informed consent was procured from all participants after having explained the entire treatment protocol to them.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - S.S., P.R.J., K.R., A.T., R.K.; Design - S.S., P.R.J., K.R., A.T., R.K.; Data Collection and/or Processing - S.S., P.R.J., K.R., A.T., R.K.; Analysis and/or Interpretation - S.S., P.R.J., K.R., A.T., R.K.; Literature Review - S.S., P.R.J., K.R., A.T., R.K.; Writing - S.S., P.R.J., K.R., A.T., R.K.

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