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Minimally invasive surgically assisted rapid palatal expansion: are pterygomaxillary disjunction and nasal septum disinsertion necessary?

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B. M. da Rosa, A. Valls-Ontañón, O. L. Haas Jr, R. M. Bastos, R. B. de Oliveira, F. Hernández-Alfaro, L. M. de Menezes: Minimally invasive surgically assisted rapid palatal expansion: are pterygomaxillary disjunction and nasal septum disinsertion necessary?. Int. J. Oral Maxillofac. Surg. 2025; xx: 1–8.

Abstract. This retrospective multicentre study investigated the effects of pterygomaxillary disjunction (PD) and nasal septum disinsertion (NSD) by comparing two minimally invasive bone-anchored surgically assisted rapid palatal expansion techniques in adult patients. The analysis focused on their impact on the nasal septum and the extent of palatal expansion. Forty patients were allocated to two groups: G1 (without PD and NSD) and G2 (with PD and NSD). The transverse opening pattern in the anterior and posterior regions, as well as changes in the position of the nasal septum, were evaluated using cone beam computed tomography images. Both groups showed significant anterior and posterior transverse gains (G1: 4.8 mm and 2.9 mm; G2: 5.7 mm and 3.8 mm; all $P \le 0.001$). There was no significant difference between the groups in anterior or posterior opening ($P = 0.44$, $P = 0.20$). Both groups showed slight nasal septum displacement, but without statistical relevance (linear: $P = 0.099$, $P = 0.072$; angular: $P = 0.062$, $P = 0.16$). Both techniques were effective in treating maxillary deficiency in adult patients. The study suggests that PD and NSD may not be essential steps to achieve adequate palatal expansion with minimally invasive surgeries.

Keywords: Palatal expansion technique; Minimally invasive surgical procedures; Nasal cavity; Dentofacial deformities; Maxillary osteotomy.

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Just over a decade ago, surgically assisted rapid palatal expansion (SARPE) was considered the standard approach for adult patients with transverse maxillary deficiency. This technique involved performing osteotomies to weaken the bony resistance pillars under general anaesthesia, followed by maxillary expansion using a tooth-borne appliance[1].

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Several studies, however, have demonstrated that miniscrew-assisted rapid palatal expansion (MARPE), employing bone-borne devices, can achieve more parallel and significant skeletal expansion compared to tooth-borne appliances[2–4]. These findings have encouraged the development of surgical protocols combining MARPE with minimally invasive osteotomies, aimed at reducing surgical morbidity while maintaining skeletal effectiveness. Such approaches can be performed under local anaesthesia and/or sedation in an outpatient setting, thereby eliminating the need for hospitalization and potentially reducing costs[3,5–7].

In this context, the clinical benefit of including pterygomaxillary disjunction (PD) remains debated, since although it may improve force distribution and posterior expansion[8], it also carries potential intra- and postoperative risks[9]. On the other hand, concerns regarding nasal septum disinsertion (NSD) relate to the possibility of septal deviation with aesthetic and functional consequences, or entrapment of the septum causing resistance to expansion. Despite these controversies, no consensus exists in the literature regarding the necessity of performing PD and/or NSD during maxillary expansion[8,10,11].

Therefore, the aim of this study was to investigate the effects of PD and NSD by comparing two minimally invasive surgically assisted rapid palatal expansion techniques using tooth–bone-borne devices in adult patients. The techniques differ specifically in the inclusion or omission of these two controversial manoeuvres: PD and NSD. The primary outcomes evaluated were the transverse opening pattern in the anterior and posterior regions, and the effects on nasal septum positioning.

Materials and methods

Study design

This retrospective multicentre study was conducted in the Department of Orthodontics, Pontifical Catholic University of Rio Grande do Sul and the Department of Oral and Maxillofacial Surgery, Hospital São Lucas, in Porto Alegre, Brazil, and in the Institute of Maxillofacial Surgery, Teknon Medical Center, Barcelona, Spain.

The sample was obtained by analysing cases operated on until April 2024, in which adult patients underwent orthodontic-surgical treatment for a transverse maxillary deficiency using one of the two minimally invasive techniques described in the following section. To be included in the sample, the patients needed to have available pre- and post-surgical cone beam computed tomography (CBCT) and intraoral scans. Individuals with cleft lip and palate, syndromic disorders, or a history of previous orthopaedic procedures for maxillary expansion were excluded from the study.

The collected datasets consisted of initial photographs of the face and CBCT scans of the head performed using an i-CAT scanner (Imaging Sciences International, Hatfield, PA, USA; 120 kV, 8 mA, 0.3 mm voxel size). The images were acquired in the preoperative period (T0) and immediately after the completion of the expansion (T1; no longer than 30 days after the intervention) to verify the integrity of the structures involved in the surgical procedure. The patients were classified into two groups according to the technique applied: G1, without PD and NSD; G2, with PD and NSD. The patients were operated on by two different surgeons at two different institutions, and the grouping reflected the surgical protocol routinely adopted in each centre: all G1 patients were treated at Belle & Haas Center of Orthofacial Surgery, Hospital São Lucas and all G2 patients at Institute of Maxillofacial Surgery, Teknon Medical Center.

Surgical techniques

The main characteristics of each technique and their main differences are presented in Table 1, Fig. 1, and Supplementary material Video S1.

Supplementary material related to this article can be found online at doi:10.1016/j.ijom.2026.01.012.

Both techniques were performed in an outpatient setting under local anaesthesia by experienced surgeons using minimally invasive methods. The patients in G1 underwent the procedure either without sedation, as described previously[5,12], or with optional oral or intravenous sedation. In contrast, all patients in G2 received intravenous sedation.

The installation of the hybrid expander appliance (four bicortical miniscrews in the palate and support arms on the first upper molars) had been performed previously. A prefabricated device was used in G1 (MARPE Expander; Peclab, Belo Horizonte, Minas Gerais, Brazil) and a customized device was used in G2[13] (Power Expander Dr. Pérez Varela; Ortoplus, Málaga, Spain).

In G2, the intervention was initiated by PD using the transmucosal disjunction technique, with a piezoelectric device. This step was not included in G1 (Fig. 1A).

A reduced incision was made in the vestibular mucosa of the maxilla (from tooth 12 to tooth 22). In G1, subperiosteal detachment was performed in the nasomaxillary region, only accessing the entrance of the piriform aperture in its inferior and lateral portion, without entering the nasal fossa posteriorly. In G2, the nasal mucosa was detached along its entire anteroposterior length, and the NSD was performed with a detacher (Fig. 1B). For both groups, the detachment extended in a mucosal tunnel to the posterior region of the maxilla and the next step consisted of performing the osteotomies: (1) a subspinal osteotomy, (2) a midline osteotomy along the median palatal suture, and (3) a bilateral horizontal osteotomy from the

Table 1. Comparison of the main characteristics of the evaluated techniques.

	Group 1	Group 2
Technique name	MISMARPE (Minimally invasive surgical and miniscrew-assisted rapid palatal expansion)	SAMARPE (Surgically assisted miniscrew-assisted rapid palatal expansion)
Outpatient setting	Yes	Yes
Sedation	Optional	Yes
Expansion device	Prefabricated	Customized
Incision	Between the lateral incisors	Between the lateral incisors
Osteotomies	Subspinal, Le Fort I, and midline	Subspinal, Le Fort I, and midline
Pterygomaxillary disjunction	No	Yes – transmucosal disjunction with piezoelectric device
Nasal septum disinsertion	No	Yes

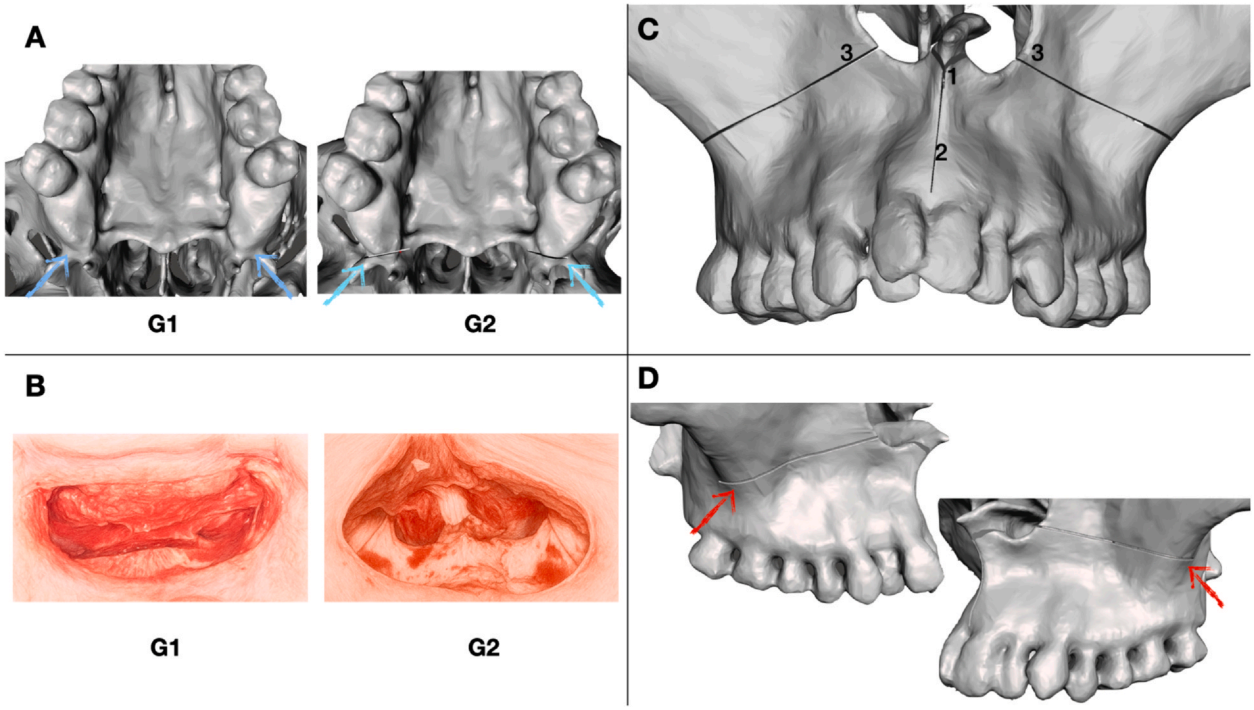

Fig. 1. Surgical technique: (A) view of the pterygopalatine junction in G1 (without osteotomy) and G2 (with osteotomy); (B) view of the nasal mucosa detachment in both groups, with nasal septum disinsertion performed in G2; (C) location of the three osteotomies performed in both groups; (D) posterior limit of the maxillary osteotomy in both groups.

zygomatic pillar region to the piriform aperture (Fig. 1C, D).

In G1, the expander was activated to check the release of resistance from the bony pillars and was then closed again. In G2, the manoeuvre was also performed for the complete release of the median palatal suture with a chisel during the osteotomy. In both G1 and G2, the surgical procedures were finalized with mucosal closure performed with absorbable sutures. All patients received postoperative care and medication instructions before being discharged home. Antibiotics, anti-inflammatory drugs, painkillers, and 0.12% chlorhexidine mouthwash were prescribed. After 7 days, the sutures were removed, and the patient was instructed to activate the expander a ¼ turn (0.2 mm) every 12 h until the appearance of an inter-incisal diastema, and then to reduce to a ¼ turn per day until the transverse expansion of the maxillary arch was achieved according to the requirement in each case.

CBCT scan analysis

The CBCT images at T0 were reconstructed with a slice thickness of 0.3 mm and analysed using Dolphin 3D Imaging software version 12.0 (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). To minimize measurement errors, the natural head orientation was used, which was adjusted in the software based on the patient photos[14]. The same reconstruction process was performed on the T1 scans, which were then superimposed with the cranial base as a reference[15], to ensure the same orientation of the images during measurements.

Variables and measurements

Demographic and clinical data were collected, including sex, age, and the presence/absence of septal deviation at T0. The same pre-calibrated operator (B.M.R.) performed all measurements on the T0 and T1 images. Dolphin Imaging software includes a built-in tool for measuring linear distances. Standardized cephalometric landmarks were selected, and the distance in millimetres between these reference points was automatically calculated using the '2D line' tool. Measurements were taken on the coronal view of the CBCT, with standardization performed using the axial section. For the transverse analysis of the anterior maxillary distance (AMD), the cursor was positioned over the apex of the canine root. For the posterior maxillary transverse distance (PMD), the axial reference used was the apex of the palatal root of the upper first molar. Additionally, the distance between the distopalatal cusps of the first molars (D16–26) was measured (Fig. 2A, B[8]; Supplementary material Table S1).

To evaluate the nasal septum in the coronal view, the point of greatest septal deviation relative to the midline in the axial view was identified. The linear distance (distance of septal deviation from the midline, SDM) and the deviation angle (septal deviation angle, SDA) were measured (Fig. 2C, D; Supplementary material Table S1), using a methodology described previously[16].

Statistical analysis

The statistical analysis was performed using IBM SPSS Statistics version 20.0 (IBM Corp, Armonk, NY, USA). In the calibration process, the intra- and inter-examiner reliability of the measurements was assessed using the intraclass correlation coefficient (ICC). The Kolmogorov–Smirnov test was applied to determine the distribution of the data, and the Student *t*-test for independent samples was applied to evaluate homogeneity at T0. Generalized estimating equations

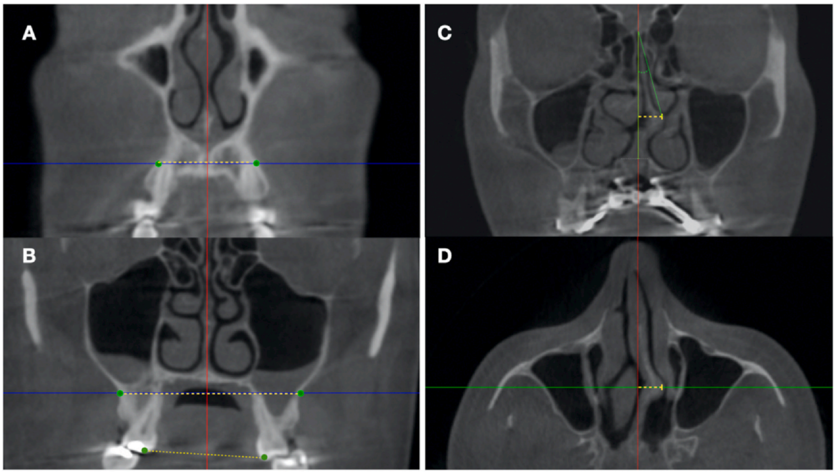

Fig. 2. Methodology for the measurements[3,16]. Evaluation of (A) the anterior region of the maxilla (frontal view); (B) the posterior region of the maxilla (frontal view); (C) the nasal septum (frontal view); (D) the nasal septum (axial view). The yellow dashed lines in A–C identify the linear measurements. In C, the green lines show the angle of deviation.

(GEE) were used to compare the variations between groups, while the paired *t*-test was applied to compare the preoperative and postoperative measurements within each group. The significance level used was 5%.

A post hoc assessment of statistical power was performed for each analysed variable based on the observed effect sizes, with an alpha level of 0.05. The estimated power to detect small differences between the two groups ranged from 12% to approximately 31%. This analysis was conducted to provide contextual information regarding the magnitude and clinical relevance of the observed differences. When considering a clinically relevant difference, such as 1.5 mm for SDA, the estimated power approached 80%.

Results

A total of 40 patients were evaluated. G1 (n = 27) consisted of 16 female patients and 11 male patients, with a mean ± standard deviation age of 36.0 ± 9.9 years; G2 (n = 13) consisted of six female patients and seven male patients, with a mean age of 42.2 ± 11.1 years. There was no significant difference in sex distribution or mean age between the groups (both $P > 0.05$).

The ICCs showed good to excellent intra- and inter-examiner reliability (Supplementary material Table S2). The T0 samples were homogeneous, with no statistically significant difference between the groups for any of the variables. In G1, the expansion screw showed a mean opening of 8.3 ± 1.8 mm, while in G2 it was 8.1 ± 3.6 mm, with no statistically significant difference between them.

The transverse gains between T0 and T1 were significant in both groups. G1 showed a mean anterior opening of 4.8 mm ($P < 0.001$) and posterior opening of 2.9 mm (both $P < 0.001$), while G2 showed 5.7 mm anterior ($P = 0.001$) and 3.8 mm posterior ($P < 0.001$). The differences between the groups in anterior and posterior opening were not statistically significant ($P = 0.44$, $P = 0.20$) (Table 2, Fig. 3).

At the dental level, a significant increase in the inter-molar distance was observed in both groups: the mean gain was 5.3 mm in G1 ($P < 0.001$) and 5.7 mm in G2 ($P = 0.001$), with no statistically significant difference between the groups ($P = 0.24$).

Regarding the nasal septum, 16 of the total sample of 40 patients had no

Table 2. Measurements for the assessment of maxillary transverse dimensions and septal deviation.

	G1 (without PD and NSD) (n = 27)			G2 (with PD and NSD) (n = 13)			ΔG1 vs ΔG2
		ΔT0–T1	*P*-value[a]		ΔT0–T1	*P*-value[a]	*P*-value[b]
AMD							
T0	27.0 ± 3.7	4.8 (3.8–5.7)	< 0.001*	27.2 ± 5.3	5.7 (3.4–8.1)	0.001*	0.44
T1	31.8 ± 4.6			32.9 ± 3.8			
PMD							
T0	56.3 ± 4.7	2.9 (2.2–3.5)	< 0.001*	54.3 ± 3.0	3.8 (2.5–5.1)	< 0.001*	0.20
T1	59.2 ± 4.7			58.1 ± 3.7			
D16–26							
T0	38.9 ± 4.6	5.3 (3.9–6.7)	< 0.001*	36.3 ± 4.8	5.7 (2.9–8.6)	0.001*	0.24
T1	44.2 ± 5.5			42.1 ± 4.8			
SDM							
T0	3.1 ± 3.2	0.3 (0.1–0.7)	0.099	3.6 ± 3.4	0.4 (0–0.9)	0.072	0.64
T1	3.4 ± 3.4			4.0 ± 3.6			
SDA							
T0	5.2 ± 5.5	0.5 (0–1.1)	0.062	7.1 ± 7.2	0.7 (0.3–1.6)	0.16	0.77
T1	5.7 ± 5.8			7.8 ± 7.5			

AMD, anterior maxillary distance; D16–26, distance between the upper first molars; NSD, nasal septum disinsertion; PD, pterygomaxillary disjunction; PMD, posterior maxillary distance; SDA, septal deviation angle; SDM, distance of septal deviation from the midline.

T0 (preoperative) and T1 (≤30 days after the intervention) measurements are presented as the mean ± standard deviation. The changes from T0 to T1 (ΔT0–T1) are presented as the mean and 95% confidence interval.

[a]Paired samples *t*-test.

[b]Generalized estimating equations.

*Significant difference, $P < 0.05$.

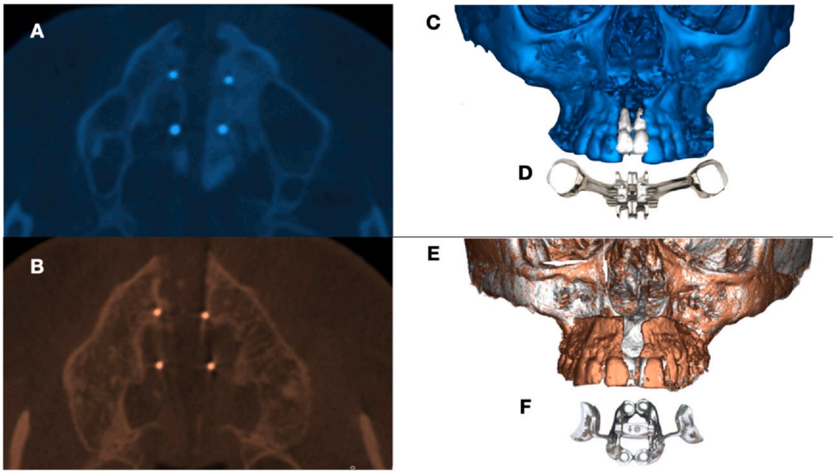

Fig. 3. Transverse maxillary opening in axial view for (A) G1 (without pterygomaxillary disjunction and nasal septum disinsertion) and (B) G2 (with pterygomaxillary disjunction and nasal septum disinsertion). 3D superimposition of pre- and postoperative images for (C) G1 and (E) G2. MARPE devices: (D) G1, Peclab; (F) G2, Power Expander Dr. Pérez Varela, Ortoplus.

preoperative deviation; only one of these patients, from G1, developed a postoperative deviation. The remaining 24 patients presented with a pre-existing septal misalignment prior to the procedure. Thirteen of these 24 patients showed a mild increase in septal deviation postoperatively. Hence, mild septal deviation after the procedure was identified in 14 patients overall (35%). Eleven patients with pre-existing deviation maintained the same degree of septal deviation relative to the midline at the T0 and T1 evaluations. In G1, the mean preoperative SDM was 3.1 ± 3.2 mm and SDA was 5.2 ± 5.5°. SDM increased by a mean 0.3 mm (P = 0.099) and SDA by 0.5° (P = 0.062); neither increase was statistically significant. In G2, the mean preoperative SDM was 3.6 ± 3.4 mm and SDA was 7.1 ± 7.2°. Postoperatively, the deviation increased by 0.4 mm (P = 0.072) and 0.7° (P = 0.16); these increases were not statistically significant. There was no significant difference in the change in SDM or SDA between the groups (Table 2).

Discussion

In this retrospective multicentre study, both minimally invasive techniques evaluated were effective in achieving maxillary expansion. No significant difference was observed between the groups regarding the expansion pattern, and mild septal displacement was detected, without statistical or clinical relevance.

Less invasive techniques have been proposed for the management of maxillary deficiency in adults, with the aim of reducing morbidity. It appears that evidence directly comparing minimally invasive surgical protocols combined with MARPE remains limited, and the present study adds further insight into this topic. The techniques analysed in this study have their main differences, at the surgical level, in two anatomical structures: the pterygomaxillary suture and the nasal septum. The technique employed in G1 involved a lower-morbidity surgical approach without PD and NSD. In contrast, both manoeuvres were performed in G2.

PD in orthognathic surgery is justified by the need for down-fracture of the maxilla and its complete mobilization; however, it is still a debated step for surgical maxillary expansion. Some authors suggest that this technique promotes a better force distribution, leading to greater posterior expansion[8]. Nevertheless, due to the proximity of the cranial base and the sphenopalatine fossa, where branches of the maxillary artery are located, significant risks related to the procedure have been reported[9,17]. Thus, although some authors have raised concerns about potential risks, its indication in outpatient settings remains a matter of debate.

Various manoeuvres and instruments can be used for PD[17]; however, the technique is highly operator-dependent and requires substantial knowledge, skill, and training to ensure its safety. In G2, transmucosal disjunction was performed with a piezoelectric blade, which has already been shown to be effective while maintaining the minimally invasive concept[18]. No complications or adverse events related to PD were reported, even when performed in the office setting. All patients received intravenous sedation, providing greater comfort and enabling better control of blood pressure.

Regarding treatment success, both techniques provided significant transverse gains (G1: 4.8 mm anteriorly and 2.9 mm posteriorly; G2: 5.7 mm anteriorly and 3.8 mm posteriorly). Although the mean anterior and posterior expansions were slightly larger in

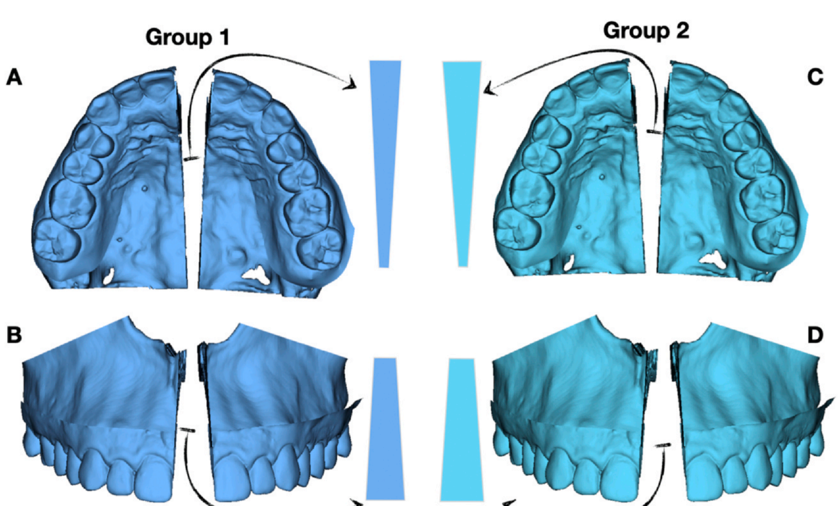

Fig. 4. Virtual simulation using Dolphin Imaging software, illustrating the mean results for G1 without pterygomaxillary disjunction and nasal septum disinsertion (A, B) and G2 with pterygomaxillary disjunction and nasal septum disinsertion (C, D), along with schematic representations of their respective expansion patterns.

G2, the differences compared to G1 were not statistically significant. These results align with those of other studies on conventional maxillary surgery that found no significant difference in expansion with or without PD. The literature remains inconclusive on the necessity for this manoeuvre for transverse correction, as well as on its differing effects on the anterior and posterior regions[19,20].

A recent non-surgical expansion study in young adults by Almaqrami et al.[21] demonstrated that both customized and prefabricated devices were effective in correcting maxillary deficiency. However, greater and more parallel expansion was observed in the group treated with customized devices, particularly in patients with narrower or higher palates[21]. In the current study, parallel opening was not identified in either group. Both techniques achieved an average of 1.9 mm greater expansion in the anterior region than in the posterior region (G1: 4.8 mm vs 2.9 mm; G2: 5.7 mm vs 3.8 mm). Similar increases in inter-molar distance were also observed in G1 and G2, with no significant difference between them (mean increase of 5.3 mm in G1 and 5.7 mm in G2). Both techniques presented a similar trapezoidal pattern in the coronal plane and a V-shaped opening pattern in the axial plane, with greater expansion anteriorly than posteriorly and inferiorly than superiorly (Fig. 4).

This V-shaped opening pattern appears in different MARPE device designs[21,22], and is even more pronounced in conventional SARPE[3]. When using bone-borne or tooth–bone-borne devices, there is increased concern regarding the effects on the nasal septum, as the more uniform opening pattern can exert a greater impact on the nasal cavity[3,11,23]. Schron et al.[24] did not find significant deviation of the septal structure after MARPE. Conversely, Seidita et al.[25] reported a mild septal displacement after SARPE in 93% of the evaluated patients, with only 6.8% experiencing a reduction of the air flow on the affected side. According to the authors, a deviation of between 0.4 mm and 1.2 mm is expected following the procedure.

In the present study, mild septal deviation after the procedure was identified in 14 patients overall (35%). The changes in deviation were not statistically significant in either of the evaluated groups (with or without PD). These findings are consistent with those reported by Jensen and Rodrigo-Domingo[11], who found no significant difference in septal position regardless of whether or not the septum was released during SARPE. The release of the nasal septum is a debated procedure due to the increased risk of intraoperative and postoperative bleeding and the potential retraction of the nasal mucosa[9]. In an outpatient surgical setting, manipulation of this area may lead to considerable patient discomfort. To ensure a comfortable experience, effective local anaesthesia and adequate sedation are necessary.

The fixed nasal septum is identified as a resistance zone during expansion[10], as is the incomplete osteotomy of the lateral nasal wall[8], which may occur if the nasal mucosa is not fully detached, as in the G1 technique. In the current study, the absence of the nasal septum release in G1 was not observed to be directly associated with a lower expansion outcome. This lack of association may be explained by the multifactorial nature of resistance sites during expansion, including incomplete osteotomies, individual anatomical variations, and differences in expander design. The potential influence of the nasal septum as a restrictive factor, however, warrants further investigation.

The role of PD in the anatomical structures of the nasal cavity remains incompletely understood[26]. To date, only one study has suggested that PD may facilitate more uniform nasal septum movement by enabling the separation of the posterior bony structures during SARPE[27]. However, that study did not specifically assess the isolated effect of PD on the septal position.

Although the present study focused on short-term outcomes, potential long-term differences—particularly regarding stability and relapse rates—should be considered. Prospective investigations with extended follow-up are needed to determine whether PD and NSD influence post-treatment stability.

This study has limitations that must be acknowledged. As this was a retrospective multicentre investigation, the surgeries were performed by different surgeons according to institution-specific protocols, which may have introduced variability. The retrospective design also carries the risk of selection bias, and the unequal group sizes reflect the availability of eligible cases during the inclusion period. In addition, no prospective sample size or power calculation was performed, and the post hoc power assessment should be interpreted with caution. Differences in expander design may have influenced the outcomes and should be considered when interpreting the results. The use of customized expanders may result in higher costs due to the personalized planning and manufacturing process. However, they appear to offer particular advantages for patients with severe maxillary atresia[21]. The final treatment decision should consider factors such as palatal anatomy, cost-effectiveness, and the preferences of both the orthodontist and the surgeon.

Despite these limitations, the comparison remains clinically relevant, as both protocols represent feasible options for the minimally invasive management of maxillary deficiency in adult patients. These techniques, which combine the advantages of skeletal anchorage with reduced surgical morbidity, may contribute to broader acceptance of these potential alternatives to conventional SARPE among orthodontists and surgeons.

In summary, both protocols demonstrated effectiveness for adult maxillary expansion. The findings suggest that pterygomaxillary disjunction and nasal septum disinsertion may not always be required to achieve adequate expansion. In both groups (G1 and G2), a slight nasal septum displacement was observed, without statistically or clinically significant repercussions. Further studies with larger samples are needed to clarify these aspects and to strengthen the evidence base for clinical decision-making.

Ethical approval

Approved by the ethics committees of Pontifical Catholic University of Rio Grande do Sul (PUCRS) (CAAE: 28064720.0.0000.5336) and Instituto Maxilofacial, Centro Médico Teknon, Barcelona (Internal Code: 2024/43-MAX-CMT).

Patient consent

Obtained.

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Competing interests

None.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ijom.2026.01.012.

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