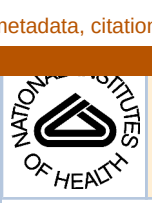

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A CLOSER LOOK AT STABILITY OF SURGICALLY-ASSISTED RAPID PALATAL EXPANSION

Sylvain Chamberland, DMD and
Chargé de cours en orthodontie, Faculté de medécine dentaire, Université Laval, Quebec, Qc

William R. Proffit, DDS, PhD
Dept. of Orthodontics, School of Dentistry, University of North Carolina, Chapel Hill, NC

Abstract

Objective—To assess the amount of dental and skeletal expansion and stability following surgically assisted rapid maxillary expansion,.

Methods—Data from 20 patients enrolled in the prospective study were collected prior to treatment, at maximum expansion, at the removal of the expander 6 months later, prior to the second surgical phase if there was one, and at the end of post-surgical orthodontics using P-A cephalograms and dental casts.

Results—With SARPE the mean maximum expansion at the first molar was 7.48 ± 1.39 mm and the mean relapse during post-surgical orthodontics was 2.22 ± 1.39 mm (30%). At the maximum, 3.49 ± 1.37 mm skeletal expansion was obtained, and this was stable, so the average net expansion was 67% skeletal.

Conclusion—Clinicians should anticipate loss of about one-third of the transverse dental expansion obtained with SARPE although the skeletal expansion is quite stable. The amount of post-surgical relapse with SARPE appears quite similar to the changes in dental arch dimensions after non-surgical rapid palatal expansion, and also quite similar to dental arch changes after segmental maxillary osteotomy for expansion.

Although a number of reports on stability after surgically-assisted rapid palatal expansion (SARPE) have been published, surprisingly little detailed information exists to document post-surgical changes with this procedure, differentiating dental and skeletal outcomes. This is the case for two reasons: most of the previous studies have used only dental casts or direct measurements of dental arch dimensions, without the use of P-A cephalograms (ceph) so that skeletal change could be differentiated from tooth movement,[1–5] and stability often was reported from the end of post-expansion orthodontic treatment, not from the point of maximum expansion.[1–4]

More recent papers using pre- and post-expansion P-A ceph and dental casts have reported more change than the earlier ones. In a series of 14 cases, Byloff and Mossaz observed a mean 8.7 mm expansion at the first molar, and on the average, 36% of this expansion (3.1 mm) had relapsed on debonding.[6] The skeletal expansion was 1.3 mm or 24 % of the dental expansion.

Corresponding author: Dr. Sylvain Chamberland, 10345 Boul. de l'Ormiere, Quebec, Qc, Canada G2B 3L2, email: drsylchamberland@biz.videotron.ca, phone : 418-847-1115.

Berger et al reported an average of 2.49 mm of skeletal expansion (52% of the dental expansion).[7] Nevertheless, two recent systematic reviews have concluded that no good evidence exists for the amount of relapse after SARPE.[8,9]

The goal of this research project was to provide detailed data for both dental and skeletal stability after SARPE, and to attempt to put the outcomes in the context of stability after non-surgical orthopedic maxillary expansion and expansion with segmental LeFort I osteotomy.

Methods

Twenty patients between 15 and 54 years of age, participating in a prospective observational study of SARPE outcomes that was approved by the Laval University ethical committee, had dental casts and P-A cephalograms prior to SARPE (T1), at the completion of expansion (T2), at removal of the expander approximately 6 months later (T3), prior to a 2nd surgical phase for those who were planned to have one (T4), and at the end of orthodontic treatment (T5). All had a transverse discrepancy of 5 mm or more, and were beyond the level of maturity at which palatal expansion without surgery would be possible (age range 15–54 years).

The surgical technique, which involved essentially all bone cuts required for a LeFort I osteotomy, included separation of the pterygoid junction and separation of the midpalatal suture between incisors roots with a thin osteotome.[10–13] At surgery, the expansion device (Superscrew™) was activated enough to achieve a 1 to 1.5 mm separation of the maxillary central incisors. All surgery was performed by the same surgeon.

A latency period of 7 days was observed and then patients were instructed to activate the screw by 0.25 mm twice a day. The patients were monitored twice a week until the planned expansion was achieved 12 to 20 days later. Brackets were bonded on the maxillary teeth 2 months after the expansion was stopped. Active orthodontic treatment usually was initiated prior to SARPE in the mandibular arch and 2 months after the expansion was stopped in the maxillary arch. The expansion device was kept in place for approximately 6 months. Following no other retention except the main arch wire was used until the end of orthodontic treatment.

The standardized PA cephs[14] were digitized using Quick Ceph 2000™, and maxillary width changes were evaluated as changes in the distance between Jugula (left and right) and changes in the width of the nasal cavity (Figure 1). Measurements on dental casts to evaluate changes in tooth positions were performed at each time point, using a digital caliper. Intercanine widths were measured at the cusp tip. The inter-premolar (1st, 2nd) widths were measured in the mesial fossa and the inter-molar (1s t, 2nd) widths were measured in the central fossa.

The width of the expansion screw was measured prior to cementation (T1). After removal of the expander (T3), the appliance was poured into lab stone and the screw width was measured again. The screw width was also measured on the PA ceph at T1 and T2. These measurements were used to calculate the true enlargement factor of the cephalogram, which was 4%.

The method error was tested on dental casts and PA cephs. Every measurement on the dental casts at T5 were repeated, and every PA ceph at T5 was retraced. Pearson correlations indicated a coefficient of fidelity of 99.94% for the measurements on the dental casts and 99.90% for the PA ceph. Statistical significance between baseline and post treatment data collection was assessed by Student T tests, Wilcoxon rank tests, paired T tests, one way ANOVA and repeated measures ANOVA.

Results

Changes during expansion (T1–T3), post-expansion changes (T3–T5) and net expansion (T1–T5) are shown in Figure 2. All the changes were significantly different from zero ($p < .001$) except those for the lower molar (not significant). Note that the amount of expansion at the molars was very similar to the expansion at the first premolar ($p = .95$). This shows the parallelism of the expansion of the posterior teeth.

The amount of skeletal expansion with SARPE and its stability is illustrated in Figure 3. Almost all the relapse was dental, not skeletal. The skeletal expansion measured at both Jugula and the nasal cavity was quite stable, and the percentage of expansion due to skeletal change increased from 47% to 68% as dental relapse occurred. At the time of expansion, all patients were expanded 2 mm beond the expected final position, and despite the dental replapse, none of the patients were in posterior crossbite at the end of treatment.

Of the 20 subjects, 8 had a second stage of maxillary surgery for A–P and/or vertical repositioning and 5 had a mandibular advancement only. There was no significant effect of phase 2 surgery on transverse relapse.

Discussion

Comparison to other studies of SARPE

The mean expansion at the first molar observed in the SARPE group is similar to previous studies using a comparable research design. The 30% relapse is less than the 36 % relapse Byloff and Mossaz reported.[6] Post-treatment retention is likely to be an important factor in any study of stability.[15] In this study, the expander was left in place for 6 months (5.98 ± 0.72 month) after the expansion was stopped, while Byloff and Moussaz[6] left the distractor for 3 months and then used a removable retainer for 3 months. The 30% relapse is higher than that reported by Berger et al[7] and Pogrel et al.[5] Both of these studies used 12 months follow-up, not the end of orthodontic treatment, as their end point. It is considerably higher than the reports from earlier papers that reported changes from end of treatment, not from the point of maximal expansion.[1–4]

The amount of dental versus skeletal expansion observed in our SARPE patients, and in the other studies[6,7,16] using PA cephs, is larger than clinicians often expect. Immediately after maximum expansion, about half the expansion (47%) was skeletal, as shown by widening of the maxilla and nasal cavity, and half (53%) was dental. The skeletal expansion with SARPE was quite stable—the relapse was almost totally due to lingual movement of the posterior teeth. It has been recommended previously that 2 mm expansion beyond the desired result should be done. Since a mean relapse of about 30% at the first molars can be expected, we concur that 2 mm excess expansion is indicated in SARPE patients with a typical expansion of 7–8 mm at the 1st molar. This is needed to compensate for buccal tipping of the entire posterior segment during expansion. Interestingly, there is no correlation between the amount of expansion and the amount of relapse at the 1st molar ($r = .01$).

The width of the midline diastema at the maximum expansion point (T2) is highly correlated with the first molar expansion ($r = .69$). This indicates that development of a diastema is a predictor that adequate molar expansion is occurring.

Even when skeletal expansion is obtained, the low correlation between skeletal changes and dental changes ($r = .36$) confirms that the maxillary segments often do not expand symmetrically. Instead, some rotation occurs, with the teeth expanding more widely than than bone above, as explained by Byloff and Mossaz[6] and demonstrated by Chung and Goldman.

[17] This rotation of the maxillary segments and/or alveolar bending explains why the skeletal change at the maximal expansion point is only 47% of the dental expansion (see Figure 3). Because of this, the horizontal portion of the screw should be more than 3 mm away from the palatal mucosa to avoid impingement.

It is interesting that this study did not confirm previous reports of a hinge-type expansion with SARPE, with more expansion anteriorly than posteriorly (see Figure 2). This suggests that changes in recent years in the surgical procedure for SARPE, which now includes surgical release of the pterygoid junction, may allow a similar anterior and posterior expansion. The increased rigidity of the Superscrew™ and its placement more in line with the first molars also may have contributed to the more parallel expansion.[18]

Stability compared to non-surgical RPE

In prepubertal children and adolescents, loss of about one-third of the maximum expansion across the first molars occurs after non-surgical rapid palatal expansion.[15,19–23] P-A cephs in patients with palatal implants who underwent maxillary expansion demonstrated that approximately 50% of the expansion achieved by RPE in children was skeletal and the remainder was dentoalveolar.[24,25]

Handelman et al compared expansion with non-surgical RPE in younger vs older patients, and estimated that skeletal expansion was only 18% in their adult group compared to 56% for the younger patients.[22] Bacetti et al[19] showed that only 0.9 mm of skeletal expansion is achieved in RPE patients treated during or after the peak in skeletal maturation, while 3 mm of skeletal expansion is obtained in a group treated before the peak of skeletal maturation. It is clear that with RPE, the nature of expansion shifts from skeletal to dentoalveolar in mature individuals, who are the candidates for SARPE. When changes are largely tooth movement through the alveolar housing, it has been shown to be detrimental periodontally.[1,26]

Our data show a mean 3.47 mm of skeletal expansion, which is 68% of the mean dental expansion (5.12 mm). Although the amount of relapse in dental arch widths with SARPE is about the same as with non-surgical RPE in younger patients, there is a difference: with SARPE the skeletal change is much more stable than with RPE.

Stability compared to segmental osteotomy

The best data for stability after transverse expansion with segmental LeFort I osteotomy remains the 42 patients reported by Phillips et al[27] in 1992. Comparison of the early papers on SARPE stability to this data set has been the basis for recommending SARPE as a first stage of treatment when repositioning of the maxilla in all three dimensions is planned.

Stability data for the 12 subjects in the Phillips's study who had expansion equivalent to that of our SARPE patients are shown in Table 1 and illustrated in Figure 4. The mean relapse across the first molars was greater for the LeFort I group but the difference was not statistically significant, while mean relapse across the canines was greater for the SARPE group and was significant. The greater change at the canines for the SARPE group almost surely reflects tooth movement generated by the finishing archwires. Rather than mean changes, Figure 4 shows the number of patients with SARPE and LeFort I expansion with changes of specific magnitudes across the first molars and first premolars, and the similarity of the distributions is apparent.

Clinical Implications

These data do not support the conclusion of the early papers on SARPE that this procedure produces more stable expansion than segmental osteotomies. Our data are quite compatible,

however, with data from other studies of SARPE that used both P-A ceph and measurements of dental cast, and found significant post-surgical changes.

It seems clear at this point that relapse in the amount of arch width increase produced by SARPE is comparable to relapse with the other expansion procedures. Our data show that with SARPE, the relapse is almost entirely dental, so that at the end of treatment there is a net skeletal expansion of 67% of the total change. With nonsurgical expansion in growing patients, the expectation is that 50% of the total change will be skeletal. No data from sequential P-A cephalograms exist for LeFort I expansion.

The clinical results with our SARPE patients, none of whom were in posterior crossbite at the end of treatment despite the dental relapse, support the routine use of 2 mm over-expansion during treatment. In the LeFort 1 patients reported by Philips et al[27], over-expansion was not done. Given the similarity of relapse in intermolar width between the SARPE and LeFort 1 patients, it appears that routine overexpansion also should be part of the protocol for expansion with osteotomy. With SARPE, space for alignment of crowded maxillary incisors can be provided by maxillary expansion rather than premolar extraction, so extraction decision should be postpone after the expander removed.

The similar stability of transverse expansion of the dental arches with SARPE and segmental LeFort I osteotomies does provide some insight into the choice between the procedures. In our view, when only transverse change is needed, SARPE would be the treatment of choice. When a second phase of maxillary surgery to reposition the maxilla vertically or antero-posteriorly is required, routinely doing a preliminary SARPE procedure to obtain better transverse stability does not appear to be warranted.[28] An exceptionally narrow maxilla that requires major expansion across the posterior teeth may be an exception.[29] Perhaps a consensus current view would be that the decision for 2-stage vs 1-stage LeFort I surgery should be based, not on the stability of transverse expansion, but on the risk and morbidity of 2 surgeries versus the risk and morbidity of one-stage multi-segmented LeFort I for large expansion along with vertical and/or A–P changes.

Conclusions

1. Skeletal expansion with SARPE is about half the total inter-molar expansion at the maximum expansion point. From that point, dental relapse occurs but the skeletal expansion is stable, so that at the end of treatment about two-thirds of the net expansion is skeletal.
2. The transverse stability of SARPE is not significantly greater than segmental LeFort I osteotomy, bringing into question the routine use of two-stage surgery as a way to improve transverse stability in patients requiring widening and A–P or vertical repositioning of the maxilla.

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References

1. Northway WM, Meade JB Jr. Surgically assisted rapid maxillary expansion: a comparison of technique, response, and stability. Angle Orthod 1997;67:309–320. [PubMed: 9267580]

2. Bays RA, Greco JM. Surgically assisted rapid palatal expansion: an outpatient technique with long-term stability. J Oral Maxillofac Surg 1992;50:110–113. [PubMed: 1732482]discussion 114–115
3. Stromberg C, Holm J. Surgically assisted, rapid maxillary expansion in adults. A retrospective long-term follow-up study. J Craniomaxillofac Surg 1995;23:222–227. [PubMed: 7560107]
4. Anttila A, Finne K, Keski-Nisula K, Somppi M, Panula K, Peltomaki T. Feasibility and long-term stability of surgically assisted rapid maxillary expansion with lateral osteotomy. Eur J Orthod 2004;26:391–395. [PubMed: 15366383]
5. Pogrel MA, Kaban LB, Vargervik K, Baumrind S. Surgically assisted rapid maxillary expansion in adults. Int J Adult Orthodon Orthognath Surg 1992;7:37–41. [PubMed: 1453038]
6. Byloff FK, Mossaz CF. Skeletal and dental changes following surgically assisted rapid palatal expansion. Eur J Orthod 2004;26:403–409. [PubMed: 15366385]
7. Berger JL, Pangrazio-Kulbersh V, Borgula T, Kaczynski R. Stability of orthopedic and surgically assisted rapid palatal expansion over time. Am J Orthod Dentofacial Orthop 1998;114:638–645. [PubMed: 9844202]
8. Koudstaal MJ, Poort LJ, van der Wal KG, Wolvius EB, Prahl-Andersen B, Schulten AJ. Surgically assisted rapid maxillary expansion (SARME): a review of the literature. Int J Oral Maxillofac Surg 2005;34:709–714. [PubMed: 15961279]
9. Lagravere MO, Major PW, Flores-Mir C. Dental and skeletal changes following surgically assisted rapid maxillary expansion. Int J Oral Maxillofac Surg 2006;35:481–487. [PubMed: 16567079]
10. Betts NJ, Vanarsdall RL, Barber HD, Higgins-Barber K, Fonseca RJ. Diagnosis and treatment of transverse maxillary deficiency. Int J Adult Orthodon Orthognath Surg 1995;10:75–96. [PubMed: 9082002]
11. Chung CH, Woo A, Zagarinsky J, Vanarsdall RL, Fonseca RJ. Maxillary sagittal and vertical displacement induced by surgically assisted rapid palatal expansion. Am J Orthod Dentofacial Orthop 2001;120:144–148. [PubMed: 11500655]
12. Conley RS, Legan HL. Correction of severe vertical maxillary excess with anterior open bite and transverse maxillary deficiency. Angle Orthod 2002;72:265–274. [PubMed: 12071611]
13. Epker, BNFL. Dentofacial deformities: Integrated orthodontics and surgical correction. volume 2. St-Louis, USA: Mosby; 1986. p. 818-875.
14. Ghafari J, Cater P, Shofer F. Effect of film-object distance on posteroanterior cephalometric measurements: Suggestions for standardized cephalometric methods. Am J Orthod Dentofacial Orthop 1995;108:30–37. [PubMed: 7598102]
15. Zimring JF, Isaacson RJ. Forces Produced by Rapid Maxillary Expansion. 3. Forces Present During Retention. Angle Orthod 1965;35:178–186. [PubMed: 14331018]
16. Kuo, PCWL. Surgical-Orthodontic treatment of maxillary constriction. Saunders, WB., editor. Oral and Maxillofacial Surgery Clinics of North America: 1990. p. 751-759.
17. Chung CH, Goldman AM. Dental tipping and rotation immediately after surgically assisted rapid palatal expansion. Eur J Orthod 2003;25:353–358. [PubMed: 12938840]
18. Klapper L, George R. A new telescopic maxillary expander. J Clin Orthod 1995;29:114–116. [PubMed: 8617842]
19. Baccetti T, Franchi L, Cameron CG, McNamara JA Jr. Treatment timing for rapid maxillary expansion. Angle Orthod 2001;71:343–350. [PubMed: 11605867]
20. Lagravere MO, Heo G, Major PW, Flores-Mir C. Meta-analysis of immediate changes with rapid maxillary expansion treatment. J Am Dent Assoc 2006;137:44–53. [PubMed: 16456998]
21. Lagravere MO, Major PW, Flores-Mir C. Long-term dental arch changes after rapid maxillary expansion treatment: a systematic review. Angle Orthod 2005;75:155–161. [PubMed: 15825776]
22. Handelman CS, Wang L, BeGole EA, Haas AJ. Nonsurgical rapid maxillary expansion in adults: report on 47 cases using the Haas expander. Angle Orthod 2000;70:129–144. [PubMed: 10833001]
23. Spillane LM, McNamara JA Jr. Maxillary adaptation to expansion in the mixed dentition. Semin Orthod 1995;1:176–187. [PubMed: 9002914]
24. Krebs A. Midpalatal Suture Expansion Studies by the Implant Method over a Seven-Year Period. Rep Congr Eur Orthod Soc 1964;40:131–142. [PubMed: 14318002]

25. Lagravere MO, Major PW, Flores-Mir C. Long-term skeletal changes with rapid maxillary expansion: a systematic review. Angle Orthod 2005;75:1046–1052. [PubMed: 16448254]

26. Vanarsdall, RL. Periodontal/orthodontic interelationships. In: Mosby, editor. Orthodontics, current principle and techniques. St-Louis: 1994. p. 715-721.

27. Phillips C, Medland WH, Fields HW Jr, Proffit WR, White RP Jr. Stability of surgical maxillary expansion. Int J Adult Orthodon Orthognath Surg 1992;7:139–146. [PubMed: 1291607]

28. Bailey LJ, White RP Jr, Proffit WR, Turvey TA. Segmental LeFort I osteotomy for management of transverse maxillary deficiency. J Oral Maxillofac Surg 1997;55:728–731. [PubMed: 9216506]

29. Silverstein K, Quinn PD. Surgically-assisted rapid palatal expansion for management of transverse maxillary deficiency. J Oral Maxillofac Surg 1997;55:725–727. [PubMed: 9216505]

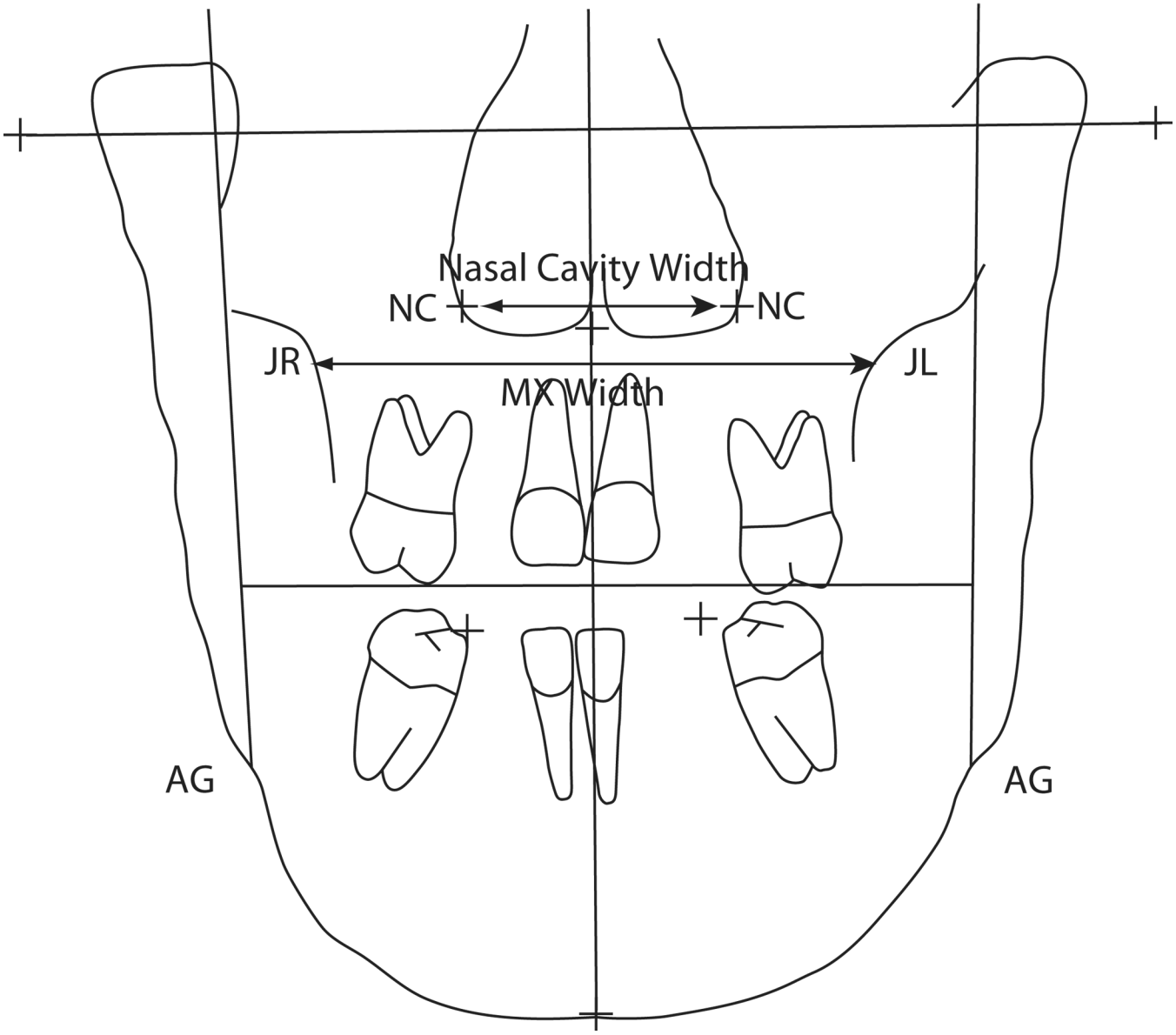


Figure 1.
Width measurements on P-A cephalometric radiographs used in this study. Maxillary (Mx) width was measured between Jugula left (JL) and right (JR), with Jugula defined as the point on the jugal process at the intersection of the outline of the maxillary tuberosity and the zygomatic process. Nasal cavity (NC) width was measured between the left and right points at the maximum concavity of the piriform rim.

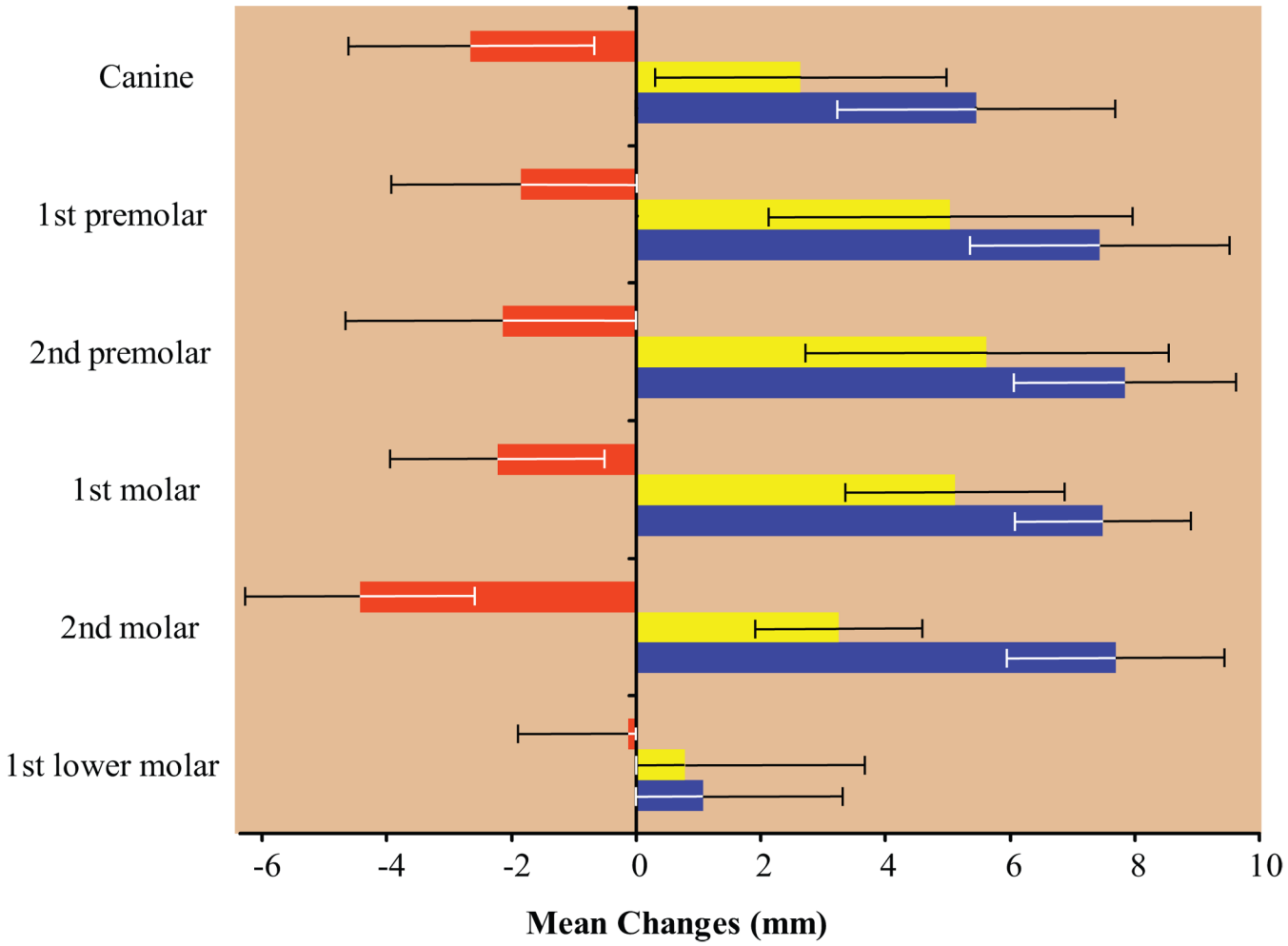


Figure 2.
Changes in arch width with SARPE. All maxillary changes were statistically significantly different from zero, the mandibular first molar change was not. Blue: changes during expansion (T1–T3). Red: post expansion changes (T3–T5). Yellow: net expansion (T1–T5).

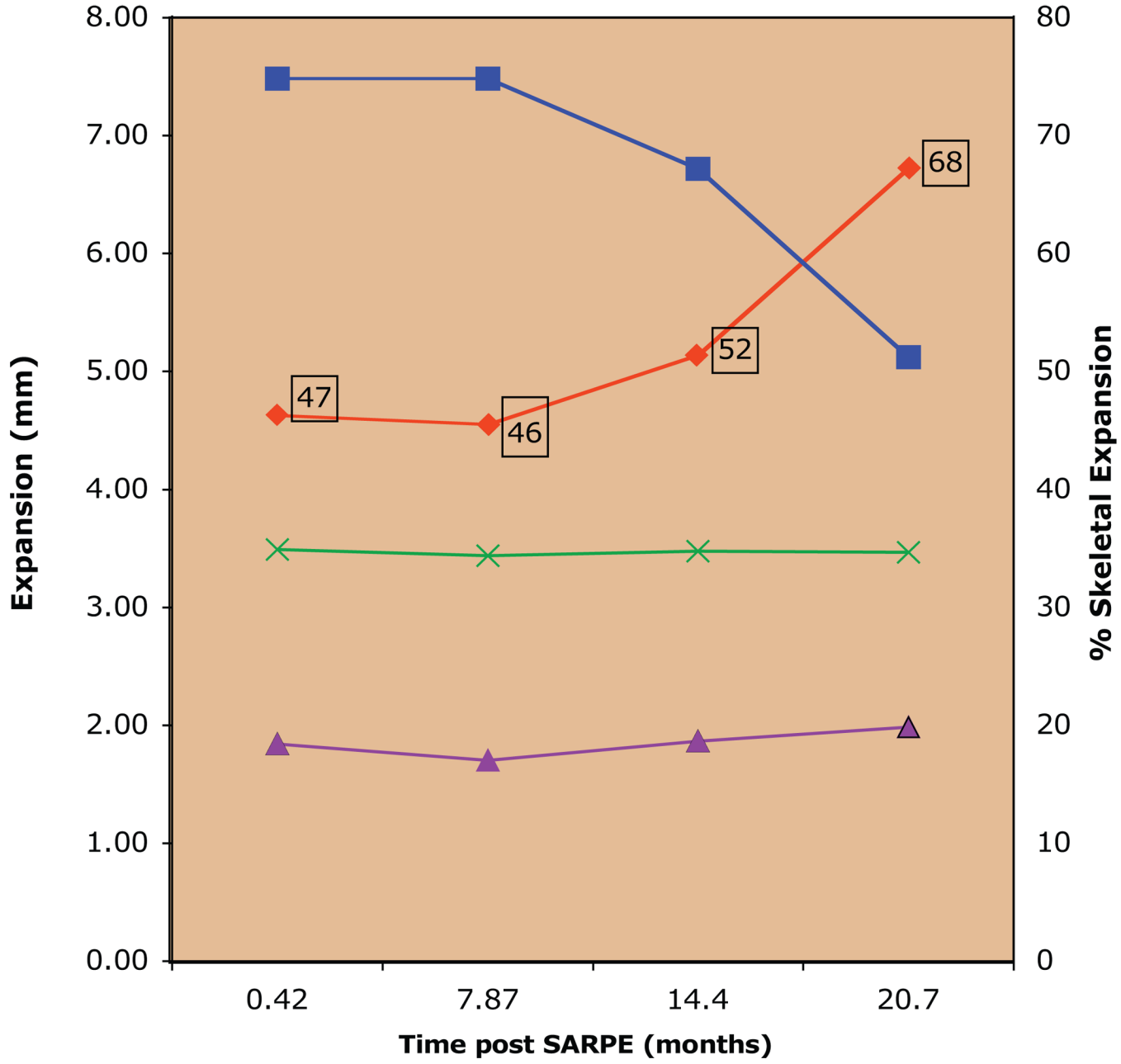
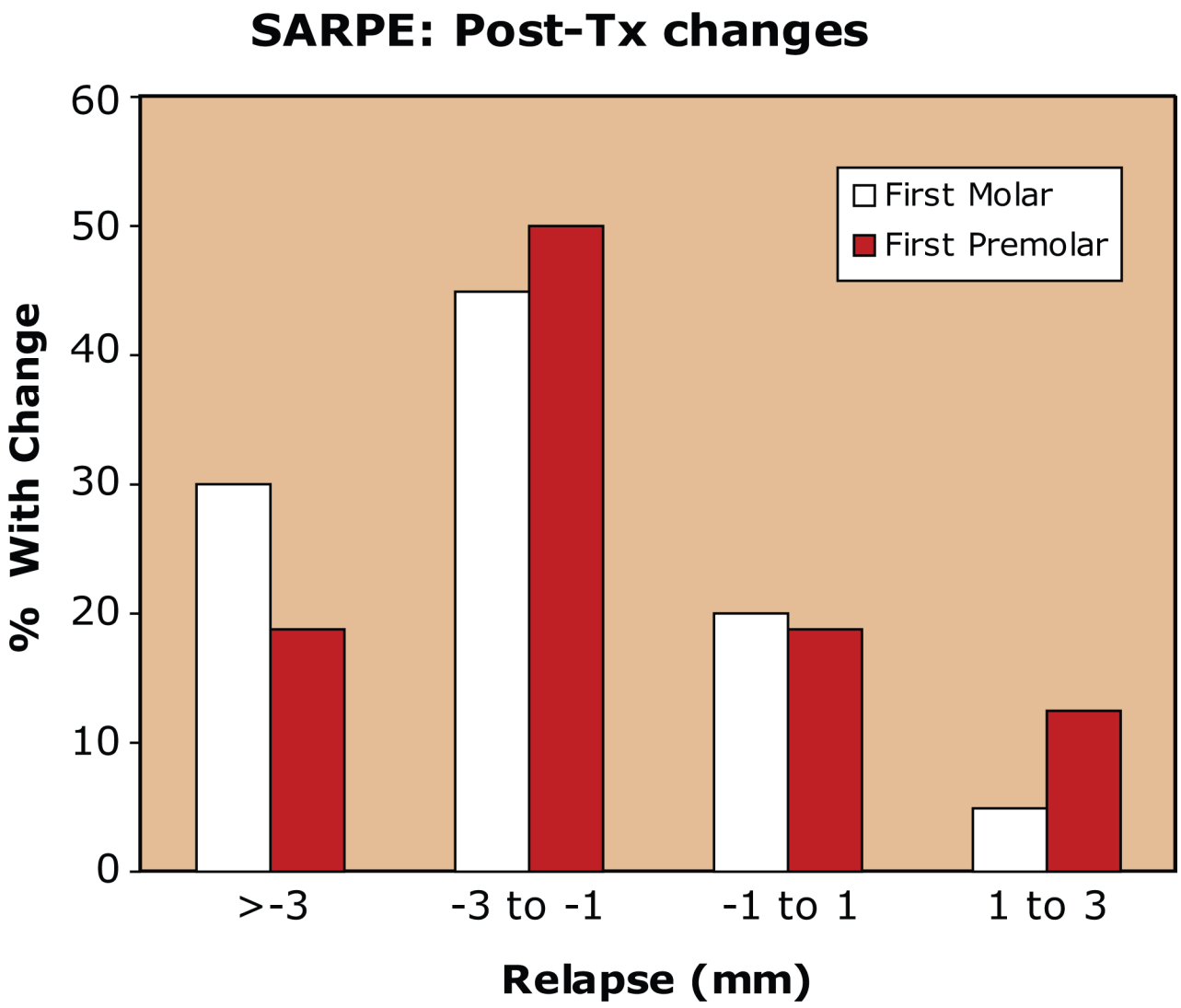


Figure 3.

Changes over time after SARPE in dental and skeletal dimensions, and in the percentage of expansion that is skeletal. Note that almost all the relapse was dental, not skeletal. Repeated measures ANOVA confirmed a significant relationship between amount of relapse and time elapsed after surgery. The blue blocks line show expansion at the first molar. The diamond red line shows the percentage of expansion that was skeletal at each time point. The X green line denotes maxillary skeletal expansion at Jugula and the magenta triangle shows the expansion across the nasal cavity.



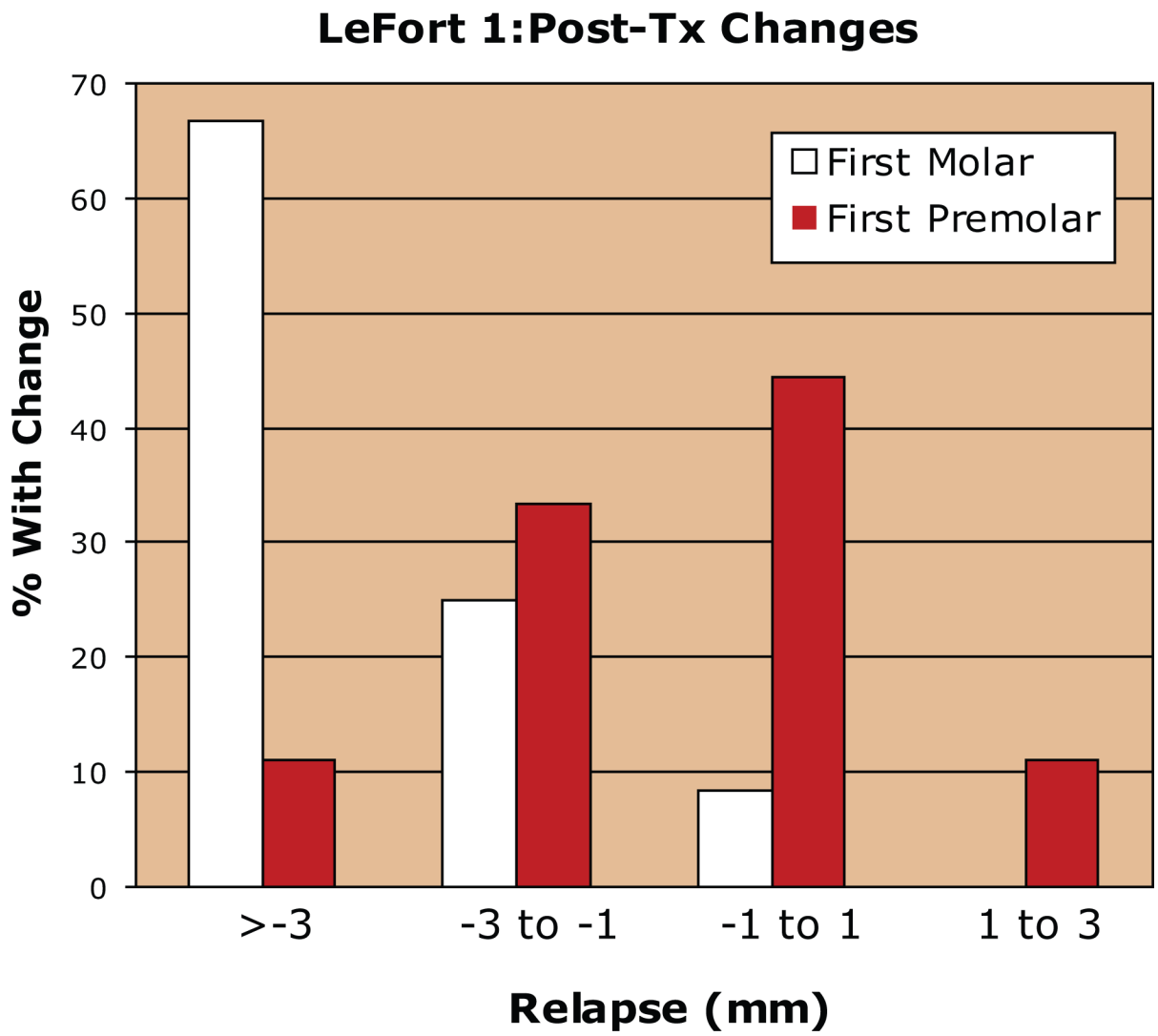


Figure 4.
The percentage of patients with major relapse (>3 mm), moderate relapse (1–3 mm), minimal change (−1 to 1 mm) and post-treatment expansion: A, after SARPE (1st molars: N = 20; 1st premolars: N =16); B, after LeFort I segmental osteotomy (1st molars: N= 12; 1st premolars: N = 9). The variation of N is explained by the fact that some patients had extraction of teeth so the number of measurements is reduce for those teeth.

Table 1

Relapse Between Maximum Expansion (T3) and End of Treatment (T5)

	SARPE				I				
Variable	**N**	**Mean**	**S-D**	**% Relapse**	**N**	**Mean**	**S-D**	**% Relapse**	**Significance**
Canine	19	−2,65	1,95	48	12	−0,74	1,84	32	p<.05
1st Premolar	16	−1,85	2,04	25	9	−1,32	1,67	33	NS
2nd Premolar	20	−2,14	2,48	27	11	−2,06	1,45	39	NS
1st Molar	20	−2,22	1,69	30	12	−3,06	1,31	42	NS
2nd Molar	18	−4,42	1,80	59	8	−3,69	1,08	40	NS

The variation of N is explained by the fact that some patients had extraction of teeth so the number of measurements is reduce for those teeth.