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Systematic Review
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The value of cone beam computed tomography imaging in surgically assisted rapid palatal expansion: a systematic review of the literature

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Abstract. This study aimed to evaluate the reliability of cone-beam computed tomography (CBCT) imaging of the maxillary structures and the postoperative dentoskeletal, nasal airway, periodontal, and facial soft tissue changes after surgically assisted rapid palatal expansion (SARPE). A systematic review of the literature on CBCT analysis of SARPE was performed. The PubMed, Embase, and Cochrane Library databases were searched. Nine articles were included, involving a total of 228 patients. The general trend was tooth-borne distraction with pterygomaxillary dysjunction. A systematic increase in all transverse dimensions at the dentoalveolar and dental levels, as well as a certain degree of tipping and extrusion of the anchorage teeth and tipping of the skeletal segments, was detected. Soft tissue findings reflected the underlying dentoalveolar changes. A decrease in the buccal alveolar bone thickness and alveolar crest level occurred. Results confirm that CBCT is an accurate and reliable method to assess anatomical changes after SARPE. Although this systematic review provides valuable preliminary information about the effects of SARPE, results should be interpreted with caution due to the low level of evidence of the publications, great heterogeneity among study groups regarding outcome variables and surgical–orthodontic protocols, and lack of long-term data.

Key words: SARPE; surgically assisted rapid palatal expansion; rapid palatal expansion; RPE; cone beam computed tomography; CBCT; distraction osteogenesis; systematic review.

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Surgically assisted rapid palatal expansion (SARPE) is the procedure of choice to manage severe transverse maxillary deficiencies in adult patients.[1–28] It has been reported to improve stability compared to non-surgical rapid palatal expansion (RPE).[1–13,16–18,20,26] Indeed, SARPE releases bone structures that are resistant to expansion forces.[1,16,19] There is no consensus regarding the areas of major resistance to maxillary expansion and the number of osteotomies required to obtain a parallel opening of the midpalatal suture,[2,5–8,24,29,30] but some authors relate pterygomaxillary dysjunction to a parallel expansion.[3,31]

The majority of studies evaluating the transverse skeletal effects of maxillary expansion have been based on conventional cephalometric analysis using postero-anterior radiographs, occlusal views, or dental casts.[4,16–19,21] The inherent limitations of all planar two-dimensional (2D) projections, such as magnification, distortion, and difficulties in landmark identification and superimposition of the anatomical structures, result in images with low accuracy and reliability and explain why these methods have been open to some criticism. With the introduction of three-dimensional (3D) imaging modalities,[3–19,22,26,32–36] a more detailed and accurate evaluation of the dentoskeletal structures has become feasible compared with conventional 2D radiographs.[3,5,6,14,17,21,34] In particular, several studies have now analysed the efficacy of SARPE using cone beam computed tomography (CBCT).[17–19,26,36] Its high potential for evaluating the maxillary structures has been confirmed, mainly due to its advantages of good resolution and accuracy (only about 2% magnification), precision, non-invasiveness, lower effective radiation dose, and shorter acquisition times (60 s).[17,19,36]

Within this context, the purpose of the present study was to conduct a systematic review of the literature on CBCT imaging and analysis of maxillary changes after SARPE in order to investigate the reliability of CBCT for maxillary analysis and to study changes in the midpalatal suture, skeletal and dental changes, changes in the nasal cavity, periodontal effects, and soft tissue facial changes.

Materials and methods

This systematic review focused on non-growing, non-syndromic human patients with skeletal maxillary transverse deficiencies treated with SARPE and studied with CBCT. The variables studied (dentoskeletal, midpalatal, nasal, periodontal, and soft tissue changes) were compared before and after treatment. Case reports, case series with a sample of $n < 10$, oral communications, posters, and theses were excluded.

The PICOS principle (participants, intervention, comparisons, outcomes, and study design) was followed.

Search strategy

A systematic review of the literature on SARPE and analysis with CBCT was performed. An electronic search in the PubMed (National Library of Medicine, NCBI), Cochrane Library, and Embase databases was performed in January 2015 and subsequently updated in July 2016. Table 1 shows the key words used to build the search strategy. The electronic search was completed by a manual search of the reference lists of selected publications.

Table 1. Primary and secondary key words used for the systematic literature search.

Primary key words	Secondary key words
1. SARPE	1. Cone-beam
2. Surgically assisted rapid palatal expansion	2. Conebeam (MeSH)
3. SARME	3. CBCT
4. Surgically assisted rapid maxillary expansion	4. CB-CT
5. Palate surgery (MeSH)	5. Digital volume tomography
6. Maxilla surgery (MeSH)	6. CVT
7. Osteogenesis distraction (MeSH)	7. Compact computed tomography
8. Palatal expansion technique (MeSH)	8. Compact CT
	9. Compact volume tomography
	10. Volumetric computed tomography
	11. Volumetric CT
	12. Ortho cubic
	13. Flat panel
	14. 3 dimensional evaluation
	15. Three dimensional evaluation

MeSH, medical subject heading term.

Study selection and quality assessment

The search strategy was performed independently by two investigators (ICP, MPG). First, all titles obtained in the electronic search were screened. When the title did not contain sufficient information for exclusion, the paper was selected for abstract evaluation; the abstracts of all potentially relevant papers were reviewed based on the study inclusion criteria. The papers were obtained in full when they appeared to fulfil the inclusion criteria the also when the abstract did not contain sufficient information for exclusion. Full-text articles were analysed for final inclusion. If there was a discrepancy in results between the two investigators, a consensus decision was taken; when an article was rejected, the reason was noted. Cohen's kappa coefficient (κ) was used to measure inter-rater agreement for title and abstract selection. The electronic search was completed by a manual search of the reference lists of selected publications with the same selection strategy as described above. The methodological quality of the studies was assessed independently by the same two investigators. The materials and methods, results, and discussion sections were analysed based on the Cochrane Collaboration tool for assessing the risk of bias.

Results

Search results

The initial electronic search yielded 134 references in PubMed, 26 in Embase, and eight in Cochrane Library ($n = 168$). Eleven additional studies were identified by manual search ($n = 179$). After duplicate removal, 152 potentially relevant references were assessed. The full papers of 13 references were analysed in detail. Application of the inclusion criteria led to the exclusion of six more articles,[26,37–41] and two more references were added in an update performed in July 2016.[42,43] Finally, nine articles were found to be clinically or technically relevant to the subject of the study and were included in this systematic review.[17–19,36,42–46] A QUORUM flow diagram giving an overview of the selection process is presented in Fig. 1. The articles were categorized according to their emphasis, as shown in Table 2.

Types of studies

Out of the nine papers included in this systematic review, three were case series,[19,42,44] four were cohort studies,[17,18,36,45] and two were randomized