

Appendix 1. Literature searched conducted to identify eligible studies (last search date September 28th, 2018).

Search for clinical studies				Search for randomized studies			
Database	Search	Limits	Hits	Database	Search	Hits	
MEDLINE (via PubMed)	("maxillary expansion" OR ((expand* OR expans*) AND maxill*)) AND ("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction")	Humans	177	MEDLINE (via PubMed)	("maxillary expansion" OR ((expand* OR expans*) AND maxill*)) AND ("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction") AND (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized[tiab] OR placebo[tiab] OR clinical trials as topic[mesh:noexp] OR randomly[tiab] OR trial[ti] NOT (animals[mh] NOT humans [mh]))	26	
Embase	Same as MEDLINE	Human	30	Embase	("maxillary expansion" OR ((expand* OR expans*) AND maxill*)) AND ("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction") AND ('crossover procedure':de OR 'double-blind procedure':de OR 'randomized controlled trial':de OR 'single-blind procedure':de OR random*:de,ab,ti OR factorial*:de,ab,ti OR crossover*:de,ab,ti OR ((cross NEXT/1 over*):de,ab,ti) OR placebo*:de,ab,ti OR ((doubl* NEAR/1 blind*):de,ab,ti) OR ((singl* NEAR/1 blind*):de,ab,ti) OR assign*:de,ab,ti OR allocat*:de,ab,ti OR volunteer*:de,ab,ti) AND [embase]/lim	8	
CDSR	Same as MEDLINE		0	CDSR	("maxillary expansion" OR ((expand* OR expans*) AND maxill*)) AND ("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction")	0	
DARE	Same as MEDLINE		0	DARE	Same as CDSR	0	
CENTRAL	Same as MEDLINE		30	CENTRAL	Same as CDSR	31	
Scopus	(TITLE-ABS-KEY (("maxillary expansion" OR ((expand* OR expans*) AND maxill*))) AND TITLE-ABS-KEY (("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction")))	Dentistry Human/humans	131	Scopus	#1: (INDEXTERMS ("clinical trials" OR "clinical trials as a topic" OR "randomized controlled trial" OR "Randomized Controlled Trials as Topic" OR "controlled clinical trial" OR "Controlled Clinical Trials" OR "random allocation" OR "Double-Blind Method" OR "Single-Blind Method" OR "Cross-Over Studies" OR "Placebos" OR "multicenter study" OR "double blind procedure" OR "single blind procedure" OR "crossover procedure" OR "clinical trial" OR "controlled study" OR "randomization" OR "placebo")) OR (TITLE-ABS-KEY (("clinical trials" OR "clinical trials as a topic" OR "randomized controlled trial" OR "Randomized Controlled Trials as Topic" OR "controlled clinical trial" OR "Controlled Clinical Trials as Topic" OR "random allocation" OR "randomly allocated" OR "allocated randomly" OR "Double-Blind Method" OR "Single-Blind Method" OR "Cross-Over Studies" OR "Placebos" OR "cross-over trial" OR "single blind" OR "double blind" OR "factorial design" OR "factorial trial"))) OR (TITLE-ABS (clinical trial* OR trial* OR rct* OR random* OR blind*))		
					#2: ("maxillary expansion" OR ((expand* OR expans*) AND maxill*)) AND ("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction")		
					#1 AND #2	46	
Web of Knowledge	Same as MEDLINE	DENTISTRY ORAL SURGERY MEDICINE	205	Web of Knowledge	#1: TS= clinical trial* OR TS=research design OR TS=comparative stud* OR TS=evaluation stud* OR TS=controlled trial* OR TS=follow-up stud* OR TS=prospective stud* OR TS=random* OR TS=placebo* OR TS=(single blind*) OR TS=(double blind*)		
					#2: ("maxillary expansion" OR ((expand* OR expans*) AND maxill*)) AND ("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction")	79	
Virtual Health Library	Same as MEDLINE		19	Virtual Health Library	("maxillary expansion" OR ((expand* OR expans*) AND maxill*)) AND ("bone-anchorage" OR "bone-anchored" OR "bone-borne" OR "implant-anchorage" OR "implant-anchored" OR "implant-borne" OR "mini-implant" OR "minipin" OR "mini-pin" OR "miniscrew" OR "mini-screw" OR "mini-implant" OR "palatal implant" OR "skeletal anchorage" OR "skeletally-anchored" OR "transpalatal distraction") AND random*	0	
ClinicalTrials.gov	("maxillary expansion" OR ((expand* OR expans*) AND maxill*))		17	ClinicalTrials.gov	("maxillary expansion" OR ((expand* OR expans*) AND maxill*))	17	
SUM (with overlap)			432	SUM (with overlap)			207

CDSR, Cochrane Database of Systematic Reviews; CENTRAL, Cochrane Central Register of Controlled Trials; DARE, Database of Abstracts of Reviews of Effects.

Appendix 2. Additional information about this review, including deviations from protocol.

Deviations from protocol

- We decided post hoc to use the standardized mean difference to combine to similar measurements of the nasal cavity width (at the premolars and at the orbita). This is reported as a post hoc decision.
- The number needed to treat was planned to be calculated to clinically translate statistically significant relative risk, but no statistically significant relative risks were ultimately found.
- We had initially planned to use the Paule-Mandel variance estimator for the random-effect model instead of the DerSimonian-Laird one, according to appropriate guidance at the time of protocol writing. However, more recent guidance (from the same group of the first guidance) subsequently suggested a REML approach as a more appropriate and therefore this was ultimately chosen.
- Possible sources of heterogeneity were planned a priori in the protocol to be sought through mixed-effects subgroup analyses and random-effects meta-regression for meta-analyses of at least five studies. This could ultimately not be assessed, as less than 5 studies were included in any meta-analysis.
- Reporting biases were planned to be assessed for meta-analyses of at least 10 studies using contour-enhanced funnel plots and with the Egger's weighted regression test. This could ultimately not be assessed, as less than 10 studies were included in any meta-analysis.
- The robustness of the results was planned to be checked a priori with sensitivity analyses based on (i) inclusion/exclusion of trials with low risk of bias and (ii) improvement of the GRADE classification. However, all results were based on one, two, or seldom three trials and therefore any trial omissions were not deemed stable.

Appendix 3. List of studies identified from the literature and their inclusion/exclusion status, with reasons.

Nr	Paper	Status
Exclusion by title / abstract		
1	{NCT00519415}. Comparative Results of Maxillary Deficiency Treatment by Tongue Plate and Facemask in Growing Patients. Completed	Excluded by title
2	{NCT01770782}. Orthodontic Retention on the Maxillary Stability After SARME Using Laser Scanner. Completed	Excluded by title
3	{NCT02179593}. Effectiveness of SARPE With 3 and 2-Segment Technique: A Randomized Clinical Trial. Active, not recruiting	Excluded by title
4	{NCT02574117}. Cone Beam Computed Tomography for Evaluating Corticotomy-assisted Maxillary Expansion. Completed	Excluded by title
5	{NCT03267927}. Management of Obstructive Sleep Apnea (OSA) in Children and Maxillary and Mandibular Development. Recruiting	Excluded by title
6	Adolphs N, Ernst N, Menneking H, Hoffmeister B. Transpalatal distraction--state of the art for the individual management of transverse maxillary deficiency--a review of 50 consecutive cases. J Craniomaxillofac Surg. 2014;42(8):1669-74.	Excluded by title
7	Aglarci C, Esenlik E, Findik Y. Comparison of short-term effects between face mask and skeletal anchorage therapy with intermaxillary elastics in patients with maxillary retrognathia. Eur J Orthod 2016;38(3):313-23.	Excluded by title
8	Akay MC, Aras I, Gunbay T, Aras A. Does transpalatal distraction affect pharyngeal airway dimensions and related soft tissues? J Oral Maxillofac Surg. 2014;72(8):1559-64.	Excluded by title
9	Akay MC. IS THE MIDLINE BUCCAL INCISION IMPORTANT FOR THE OUTCOME OF SURGICALLY ASSISTED RAPID MAXILLARY EXPANSION? In reply. Journal of Oral and Maxillofacial Surgery. 2010;68(11):2924-.	Excluded by title
10	Akis H, Doruk C. Dentofacial Effects of Fixed Functional Appliances with or without Mini Screw Anchorage in the Treatment of Class II Division I Malocclusion: A Finite Element Analysis. Turkish Journal of Orthodontics. 2018;31(1):7-12.	Excluded by title
11	Alyessary AS, Yap AU, Othman SA, Rahman MT, Al-Namnam NM, Radzi Z. Is there an optimal initial amount of activation for midpalatal suture expansion? : A histomorphometric and immunohistochemical study in a rabbit model. J Orofac Orthop. 2018;79(3):169-79.	Excluded by title
12	Alyessary AS, Yap AUJ, Othman SA, Ibrahim N, Rahman MT, Radzi Z. Bone-borne accelerated sutural expansion: A microcomputed tomography study in rabbits. American Journal of Orthodontics and Dentofacial Orthopedics. 2018;154(2):260-9.	Excluded by title
13	Alyessary AS, Yap AUJ, Othman SA, Rahman MT, Radzi Z. Effect of Piezoelectric Sutural Osteotomies on Accelerated Bone-Borne Sutural Expansion. J Oral Maxillofac Surg. 2018;76(3):616-30.	Excluded by title
14	Alyessary AS, Yap AUJ, Othman SA, Rahman MT, Radzi Z. Effect of Piezoelectric Sutural Osteotomies on Accelerated Bone-Borne Sutural Expansion. Journal of Oral and Maxillofacial Surgery. 2017.	Excluded by title
15	Angelier F, Ruellas AC, Yatabe MS, Cevidanes LHS, Franchi L, Toyama-Hino C, et al. Zygomaticomaxillary suture maturation: Part II The influence of sutural maturation on the response to maxillary protraction. Orthodontics & Craniofacial Research. 2017;20(3):152-63.	Excluded by title
16	Asscherickx K, Govaerts E, Aerts J, Vande Vannet B. Maxillary changes with bone-borne surgically assisted rapid palatal expansion: A prospective study. Am J Orthod Dentofacial Orthop. 2016;149(3):374-83.	Excluded by title
17	Aziz SR, Tanchyk A. Surgically assisted palatal expansion with a bone-borne self-retaining palatal expander. J Oral Maxillofac Surg. 2008;66(9):1788-93.	Excluded by title
18	Baccetti T, Clerck HJ, Cevidanes LH, Franchi L. Morphometric analysis of treatment effects of bone-anchored maxillary protraction in growing Class III patients. Eur J Orthod 2011;33(2):121-5.	Excluded by title
19	Baek SH, Kim KW, Choi JY. New treatment modality for maxillary hypoplasia in cleft patients Protraction facemask with miniplate anchorage. Angle Orthod 2010;80(4):783-91.	Excluded by title
20	Baek SH, Park YH, Chung JH, Kim S, Choi JY. Orthodontic and orthopedic treatment for a growing patient with Tessier number 0 cleft. Korean Journal of Orthodontics. 2018;48(2):113-24.	Excluded by title
21	Baek SH, Seo YJ. Application of orthodontic mini-implants and ligation for absolute skeletal anchorage to the intraoral labiolingual appliance: midface distraction osteogenesis cases treated with the RED System. J Craniofac Surg. 2011;22(2):609-13.	Excluded by title
22	Baik UB, Chun YS, Jung MH, Sugawara J. Protraction of mandibular second and third molars into missing first molar spaces for a patient with an anterior open bite and anterior spacing. Am J Orthod Dentofacial Orthop 2012;141(6):783-95.	Excluded by title
23	Batra P, Agrawal V, Kiran HJ, Madanagowda SB. Treatment of a patient with a bilateral cleft lip and palate with implants and surgery of the maxillary anterior region. World J Orthod. 2010;11(4):380-6.	Excluded by title
24	Battistetti GD, Sinaglia AC, Fleig CdN, Bombonatti R. Nova proposta de expansor maxilar com ancoragem óssea: relato de caso clínico. Rev Clin Ortop Dent Press. 2011;10(1):28-34.	Excluded by title
25	Bicalho RdF, Bicalho JS, Laboissiere Jr M. Utilização de microparafuso ortodôntico autoperfurante para reabilitação temporária de incisivo lateral superior. ImplantNews. 2010;7(3):389-96.	Excluded by title
26	Bila M, Defranco J, Nadimi N, Renier L, Stevens S, Vanassche B, et al. CBCT analysis of skeletal, dental and nasal changes after transpalatal distraction. International Journal of Oral and Maxillofacial Surgery. 2015;44:e39.	Excluded by title
27	Block MS, Akin R, Chang A, Gottsegen GB, Gardiner D. Skeletal and dental movements after anterior maxillary advancement using implant-supported distraction osteogenesis in dogs. Journal of Oral and Maxillofacial Surgery. 1997;55(12):1433-9.	Excluded by title
28	Bozkaya E, Yuksel AS, Bozkaya S. Zygomatic miniplates for skeletal anchorage in orthopedic correction of Class 111 malocclusion: A controlled clinical trial. Korean J Orthod 2017;47(2):118-29.	Excluded by title
29	Buzatta LN, Toyofuku ACMM, Pinto AdS, Gandini Junior LG, Shimizu RH. Expansão rápida da maxila osseossuportada: um relato de caso e passo a passo laboratorial. Ortho Sci, Orthod sci pract. 2017;10(39):223-33.	Excluded by title
30	Byloff FK, Mossaz CF. Skeletal and dental changes following surgically assisted rapid palatal expansion. Eur J Orthod 2004;26(4):403-9.	Excluded by title
31	Cai M, Shen GF. [Development of bone-anchored surgically assisted rapid maxillary expansion]. Shanghai Kou Qiang Yi Xue. 2009;18(4):441-5.	Excluded by title
32	Camps-Pereperez I, Guijarro-Martinez R, Peiro-Guijarro MA, Hernandez-Alfaro F. The value of cone beam computed tomography imaging in surgically assisted rapid palatal expansion: a systematic review of the literature. International Journal of Oral and Maxillofacial Surgery. 2017;46(7):827-38.	Excluded by title
33	Carlino F, Cortese A. Original technique for mandibular transversal surgical expansion via a tooth-borne lingual device. International Journal of Oral and Maxillofacial Surgery. 2015;44:e49.	Excluded by title
34	Carlino F, Pantaleo G, Ciuffolo F, Claudio PP, Cortese A. New Technique for Mandibular Symphyseal Distraction by a Double-Level Anchorage and Fixation System: Advantages and Results. J Craniofac Surg. 2016;27(6):1469-75.	Excluded by title
35	Carneiro JT, Jr., Paschoal EH, Carreira AS, Real RP. Carotid cavernous fistula after surgically assisted rapid maxillary expansion with a bone anchored appliance. Int J Oral Maxillofac Surg. 2013;42(3):326-8.	Excluded by title
36	Carpentier S, van Gastel J, Schoenaers J, Carels C, Vander Poorten V, Coucke W, et al. Evaluation of Transverse Maxillary Expansion After a Segmental Posterior Subapical Maxillary Osteotomy in Cleft Lip and Palate Patients With Severe Collapse of the Lateral Maxillary Segments. Cleft Palate-Craniofacial Journal. 2014;51(6):651-7.	Excluded by title
37	Carvalho Trojan L, Andres Gonzalez-Torres L, Claudia Moreira Melo A, Barbosa de Las Casas E. Stresses and Strains Analysis Using Different Palatal Expander Appliances in Upper Jaw and Midpalatal Suture. Artif Organs. 2017;41(6):E41-e51.	Excluded by title
38	Cevidanes L, Baccetti T, Franchi L, McNamara JA, Jr., De Clerck H. Comparison of two protocols for maxillary protraction: bone anchors versus face mask with rapid maxillary expansion. Angle Orthod. 2010;80(5):799-806.	Excluded by title
39	Cha BK, Choi DS, Ngan P, Jost-Brinkmann PG, Kim SM, Jang IS. Maxillary protraction with miniplates providing skeletal anchorage in a growing Class III patient. Am J Orthod Dentofacial Orthop. 2011;139(1):99-112.	Excluded by title
40	Choi SH, Kang DY, Hwang CJ. Adult patient with hemifacial microsomia treated with combined orthodontics and distraction osteogenesis. Am J Orthod Dentofacial Orthop. 2014;145(1):72-84.	Excluded by title
41	Cortese A, de Cristofaro M, Savastano G. A new transpalatal distraction device: Report of three cases with surgical and occlusal evaluations. Proceedings of the 7th European Craniofacial Congress 2003. p. 57-67.	Excluded by title
42	Cortese A, Savastano G, Savastano M, Spagnuolo G, Papa F. New Technique: Le Fort I Osteotomy for Maxillary Advancement and Palatal Distraction in 1 Stage. Journal of Oral and Maxillofacial Surgery. 2009;67(1):223-8.	Excluded by title
43	Cousley RR. A clinical strategy for maxillary molar intrusion using orthodontic mini-implants and a customized palatal arch. J Orthod.	Excluded by title

	2010;37(3):202-8.	
44	Cousley RR. Molar intrusion in the management of anterior openbite and 'high angle' Class II malocclusions. J Orthod. 2014;41 Suppl 1:S39-46.	Excluded by title
45	Cousley RRJ. Molar intrusion in the management of anterior openbite and 'high angle' Class II malocclusions. Journal of Orthodontics. 2014;41:S39-S46.	Excluded by title
46	Cunha ACD, Lee H, Nojima LI, Nojima M, Lee KJ. Miniscrew-assisted rapid palatal expansion for managing arch perimeter in an adult patient. Dental Press J Orthod. 2017;22(3):97-108.	Excluded by title
47	De Clerck EEB, Swennen GRJ. Success rate of miniplate anchorage for bone anchored maxillary protraction. Angle Orthod 2011;81(6):1010-3.	Excluded by title
48	De Clerck H, Nguyen T, de Paula LK, Cevidanes L. Three-dimensional assessment of mandibular and glenoid fossa changes after bone-anchored Class III intermaxillary traction. Am J Orthod Dentofacial Orthop 2012;142(1):25-31.	Excluded by title
49	de Gijt JP, Gul A, Sutedja H, Wolvius EB, van der Wal KG, Koudstaal MJ. Long-term (6.5 years) follow-up of mandibular midline distraction. J Craniomaxillofac Surg. 2016;44(10):1576-82.	Excluded by title
50	de Gijt JP, Gul A, Tjoa STH, Wolvius EB, van der Wal KGH, Koudstaal MJ. Follow up of surgically assisted rapid maxillary expansion after 6.5 years: skeletal and dental effects. British Journal of Oral & Maxillofacial Surgery. 2017;55(1):56-60.	Excluded by title
51	de Menezes LM, de Oliveira RB, Weissheimer A, Avelar RL. Midfacial Protraction With Skeletal Anchorage After Pterygomaxillary Separation. J Craniofac Surg. 2016;27(6):1561-4.	Excluded by title
52	Deeb W, Hansen L, Hotan T, Hietschold V, Harzer W, Tausche E. Changes in nasal volume after surgically assisted bone-borne rapid maxillary expansion. Am J Orthod Dentofacial Orthop. 2010;137(6):782-9.	Excluded by title
53	Defranco E, Weckx K, Nadjmi N, Van HG, Verduyck H, Van Der Dussen N, et al. Cone Beam CT assessment of nasal septal deviation changes following surgical rapid maxillary expansion. Xx Congress of the European Association of Cranio-Maxillo-Facial-Surgery. 2010:101-12.	Excluded by title
54	Di Leonardo B, Ludwig B, Lisson JA, Contardo L, Mura R, Hourfar J. Insertion torque values and success rates for paramedian insertion of orthodontic mini-implants. Journal of Orofacial Orthopedics-Fortschritte Der Kieferorthopadie. 2018;79(2):109-15.	Excluded by title
55	Eid OM, Ramadan AAF, Nadim MA, Hamed TAB. Maxillary protraction using orthodontic miniplates in correction of Class III malocclusion during growth. Journal of the World Federation of Orthodontists. 2016;5(3):100-6.	Excluded by title
56	Elnagar MH, Elshourbagy E, Ghobashy S, Khedr M, Evans CA. Comparative evaluation of 2 skeletally anchored maxillary protraction protocols. Am J Orthod Dentofacial Orthop. 2016;150(5):751-62.	Excluded by title
57	Elnagar MH, Elshourbagy E, Ghobashy S, Khedr M, Evans CA. Dentoalveolar and arch dimension changes in patients treated with miniplate-anchored maxillary protraction. Am J Orthod Dentofacial Orthop. 2017;151(6):1092-106.	Excluded by title
58	Elnagar MH, Elshourbagy E, Ghobashy S, Khedr M, Kusnoto B, Evans CA. Three-dimensional assessment of soft tissue changes associated with bone-anchored maxillary protraction protocols. Am J Orthod Dentofacial Orthop. 2017;152(3):336-47.	Excluded by title
59	El-Sayed KM, Khalil H. Transpalatal distraction osteogenesis prior to alveolar bone grafting in cleft lip and palate patients. Int J Oral Maxillofac Surg. 2010;39(8):761-6.	Excluded by title
60	El-Sayed KM, Khalil H. Transpalatal distraction osteogenesis prior to alveolar bone grafting in cleft lip and palate patients. International Journal of Oral and Maxillofacial Surgery. 2010;39(8):761-6.	Excluded by title
61	Evans CA, Scarfe WC, Ahmad M, Cevidanes LHS, Ludlow JB, Palomo JM, et al. Clinical recommendations regarding use of cone beam computed tomography in orthodontics. Position statement by the American Academy of Oral and Maxillofacial Radiology. Oral Surgery Oral Medicine Oral Pathology Oral Radiology. 2013;116(2):238-57.	Excluded by title
62	Feng XX, Li JH, Li Y, Zhao ZH, Zhao S, Wang J. Effectiveness of TAD-anchored maxillary protraction in late mixed dentition A systematic review. Angle Orthod 2012;82(6):1107-14.	Excluded by title
63	Finn MD. Surgical Assistance for Rapid Orthodontic Treatment and Temporary Skeletal Anchorage. Oral and Maxillofacial Surgery Clinics of North America. 2014;26(4):539-+.	Excluded by title
64	Finn MD. Surgical assistance for rapid orthodontic treatment and temporary skeletal anchorage. Oral Maxillofac Surg Clin North Am. 2014;26(4):539-50.	Excluded by title
65	Fukui T, Fukui K, Yoshida K, Tsuruta M, Galang-Boquiren MTS. Invisible treatment of a severe Class II deep over bite with narrow mandibular dental arch with multilingual bracket appliances. Journal of the World Federation of Orthodontists. 2017;6(2):69-79.	Excluded by title
66	Gamey SN, Goss AN. Surgically-assisted rapid maxillary expansion of narrowed maxillae: a case-cohort study. Australian Orthodontic Journal. 2013;29(1):21-7.	Excluded by title
67	Gamble J, Lagravere MO, Major PW, Heo G. New statistical method to analyze three-dimensional landmark configurations obtained with cone-beam CT: basic features and clinical application for rapid maxillary expansion. Korean J Radiol. 2012;13(2):126-35.	Excluded by title
68	Gamble J, Lagravere MO, Major PW, Heo G. New statistical method to analyze three-dimensional landmark configurations obtained with cone-beam CT: Basic features and clinical application for rapid maxillary expansion. Korean Journal of Radiology. 2012;13(2):126-35.	Excluded by title
69	Garib D, Yatabe M, de Souza Faco RA, Gregorio L, Cevidanes L, de Clerck H. Bone-anchored maxillary protraction in a patient with complete cleft lip and palate: A case report. Am J Orthod Dentofacial Orthop. 2018;153(2):290-7.	Excluded by title
70	Garreau E, Bouscaillou J, Rattier S, Ferri J, Raoul G. Bone-borne distractor versus tooth-borne distractor for orthodontic distraction after surgical maxillary expansion: The patient's point of view. Int Orthod. 2016;14(2):214-32.	Excluded by title
71	Garreau E, Wojcik T, Rakotomalala H, Raoul G, Ferri J. Symphyseal distraction in the context of orthodontic treatment: A series of 35 cases. International Orthodontics. 2015;13(1):81-95.	Excluded by title
72	Gautam P, Zhao LP, Patel P. Determining the osteotomy pattern in surgically assisted rapid maxillary expansion in a unilateral palatal cleft A finite element model approach. Angle Orthod 2011;81(3):410-9.	Excluded by title
73	Ge YS, Liu J, Chen L, Han JL, Guo X. Dentofacial effects of two facemask therapies for maxillary protraction Miniscrew implants versus rapid maxillary expanders. Angle Orthodontist. 2012;82(6):1083-91.	Excluded by title
74	Ge YS, Liu J, Chen L, Han JL, Guo X. Dentofacial effects of two facemask therapies for maxillary protraction. Angle Orthod. 2012;82(6):1083-91.	Excluded by title
75	Gerlach KL, Zahl C. Surgically assisted rapid palatal expansion using a new distraction device: Report of a case with an epimucosal fixation. Journal of Oral and Maxillofacial Surgery. 2005;63(5):711-3.	Excluded by title
76	Goonewardene M, Allan B. Biomechanics and Treatment of Dentofacial Deformity. Biomechanical Foundation of Clinical Orthodontics 2015. p. 389-432.	Excluded by title
77	Gunbay T, Akay MC, Aras A, Gommel M. Effects of transmandibular symphyseal distraction on teeth, bone, and temporomandibular joint. J Oral Maxillofac Surg. 2009;67(10):2254-65.	Excluded by title
78	Gunbay T, Akay MC, Aras A, Gommel M. Effects of Transmandibular Symphyseal Distraction on Teeth, Bone, and Temporomandibular Joint. Journal of Oral and Maxillofacial Surgery. 2009;67(10):2254-65.	Excluded by title
79	Hamed-Sangsari A, Chinipardaz Z, Carrasco L. Following Surgically Assisted Rapid Palatal Expansion, Do Tooth-Borne or Bone-Borne Appliances Provide More Skeletal Expansion and Dental Expansion? J Oral Maxillofac Surg. 2017;75(10):2211-22.	Excluded by title
80	Hernández-Alfaro F, Guijarro-Martínez R, Peiró-Guijarro MA. Surgery first in orthognathic surgery: What have we learned? A comprehensive workflow based on 45 consecutive cases. Journal of Oral and Maxillofacial Surgery. 2014;72(2):376-90.	Excluded by title
81	Hernandez-Alfaro F, Mareque Bueno J, Diaz A, Pages CM. Minimally invasive surgically assisted rapid palatal expansion with limited approach under sedation: a report of 283 consecutive cases. J Oral Maxillofac Surg. 2010;68(9):2154-8.	Excluded by title
82	Hess D, Buser D, Dietschi D, Grossen G, Schonenberger A, Belzer UC. Esthetic single-tooth replacement with implants: a team approach. Quintessence Int. 1998;29(2):77-86.	Excluded by title
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406	Kim KB, Helmkamp ME. Miniscrew implant-supported rapid maxillary expansion. <i>J Clin Orthod.</i> 2012;46(10):608-12; quiz 31.	Excluded; no dental-anchored expansion
407	Lee SY, Choi YJ. Skeletal and dentoalveolar changes after miniscrew-assisted rapid palatal expansion in young adults: A cone-beam computed tomography study. <i>Korean J Orthod</i> 2017;47(4):213-4.	Excluded; no dental-anchored expansion
408	Lim HM, Park YC, Lee KJ, Kim KH, Choi YJ. Stability of dental, alveolar, and skeletal changes after miniscrew-assisted rapid palatal expansion. <i>Korean J Orthod</i> 2017;47(5):313-22.	Excluded; no dental-anchored expansion
409	Maino BG, Paoletto E, Lombardo L, Siciiani G. From Planning to Delivery of a Bone-Borne Rapid Maxillary Expander in One Visit. <i>J Clin Orthod.</i> 2017;51(4):198-207.	Excluded; no dental-anchored expansion
410	Ngan P, Nguyen UK, Nguyen T, Tremont T, Martin C. Skeletal, Dentoalveolar, and Periodontal Changes of Skeletally Matured Patients with Maxillary Deficiency Treated with Microimplant-assisted Rapid Palatal Expansion Appliances: A Pilot Study. <i>Apos Trends in Orthodontics.</i> 2018;8(2):71-85.	Excluded; no dental-anchored expansion
411	Ramieri GA, Nasi A, Dell'Acqua A, Verzé L. Facial soft tissue changes after transverse palatal distraction in adult patients. <i>International Journal of Oral and Maxillofacial Surgery.</i> 2008;37(9):810-8.	Excluded; no dental-anchored expansion
412	Seo YJ, Chung KR, Kim SH, Nelson G. Camouflage treatment of skeletal class III malocclusion with asymmetry using a bone-borne rapid maxillary expander. <i>Angle Orthod.</i> 2015;85(2):322-34.	Excluded; no dental-anchored expansion
413	Seo YJ, Lin L, Kim SH, Chung KR, Nelson G. Strategic camouflage treatment of skeletal Class III malocclusion (mandibular prognathism) using bone-borne rapid maxillary expansion and mandibular anterior subapical osteotomy. <i>Am J Orthod Dentofacial Orthop.</i> 2016;149(1):114-26.	Excluded; no dental-anchored expansion
414	Tausche E, Hansen L, Hietschold V, Lagravere MO, Harzer W. Three-dimensional evaluation of surgically assisted implant bone-borne rapid maxillary expansion: a pilot study. <i>Am J Orthod Dentofacial Orthop.</i> 2007;131(4 Suppl):S92-9.	Excluded; no dental-anchored expansion
415	Vassar JW, Karydis A, Trojan T, Fisher J. Dentskeletal effects of a temporary skeletal anchorage device-supported rapid maxillary expansion appliance (TSADRME): A pilot study. <i>Angle Orthod.</i> 2016;86(2):241-9.	Excluded; no dental-anchored expansion
416	Vassar JW, Karydis A, Trojan T, Fisher J. Dentskeletal effects of a temporary skeletal anchorage device-supported rapid maxillary expansion appliance (TSADRME): A pilot study. <i>Angle Orthodontist.</i> 2016;86(2):241-9.	Excluded; no dental-anchored expansion
417	Willmann JH, Nienkemper M, Becker K, Hssen B, Wilmes B, Drescher D. The Hybrid Hyrax Distalizer - Skeletal Anchorage Device for Transversal and Sagittal Corrections in the Maxilla. <i>Informationen Aus Orthodontie Und Kieferorthopaedie.</i> 2016;48(4):228-36.	Excluded; no dental-anchored expansion
418	Wilmes B, Nienkemper M, Drescher D. Application and effectiveness of a mini-implant- and tooth-borne rapid palatal expansion device: the hybrid hyrax. <i>World J Orthod.</i> 2010;11(4):323-30.	Excluded; no dental-anchored expansion
419	Winsauer H, Vlachoianis J, Winsauer C, Ludwig B, Walter A. A bone-borne appliance for rapid maxillary expansion. <i>J Clin Orthod.</i> 2013;47(6):375-81; quiz 88.	Excluded; no dental-anchored expansion
420	Lin L, Ahn HW, Kim SJ, Moon SC, Kim SH, Nelson G. Tooth-borne vs bone-borne rapid maxillary expanders in late adolescence. <i>Angle Orthod.</i> 2015;85(2):253-62.	Excluded; retrospective study
421	Lin L, Ahn HW, Kim SJ, Moon SC, Kim SH, Nelson G. Tooth-borne vs bone-borne rapid maxillary expanders in late adolescence. <i>Angle Orthodontist.</i> 2015;85(2):253-62.	Excluded; retrospective study
422	Yilmaz A, Arman-Ozircipici A, Erken S, Polat-Ozsoy O. Comparison of short-term effects of mini-implant-supported maxillary expansion appliance with two conventional expansion protocols. <i>Eur J Orthod.</i> 2015;37(5):556-64.	Excluded; retrospective study
423	Yilmaz A, Arman-Ozircipici A, Erken S, Polat-Ozsoy O. Comparison of short-term effects of mini-implant-supported maxillary expansion appliance with two conventional expansion protocols. <i>European Journal of Orthodontics.</i> 2015;37(5):556-64.	Excluded; retrospective study
424	Mosleh MI, Kaddah MA, Abd ElSayed FA, ElSayed HS. Comparison of transverse changes during maxillary expansion with 4-point bone-borne and tooth-borne maxillary expanders. <i>Am J Orthod Dentofacial Orthop.</i> 2015;148(4):599-607.	Excluded; non-randomized
Inclusion		
425	Bazargani F, Magnuson A, Ludwig B. Effects on nasal airflow and resistance using two different RME appliances: a randomized controlled trial. <i>Eur J Orthod.</i> 2018;40(3):281-4.	Included; randomized
426	Canan S, Senisik NE. Comparison of the treatment effects of different rapid maxillary expansion devices on the maxilla and the mandible. Part 1: Evaluation of dentoalveolar changes. <i>Am J Orthod Dentofacial Orthop.</i> 2017;151(6):1125-38.	Included; randomized
427	Celenk-Koca T, Erdinc AE, Hazar S, Harris L, English JD, Akyalcin S. Evaluation of miniscrew-supported rapid maxillary expansion in adolescents: (A prospective randomized clinical trial). <i>Angle Orthod</i> 2018 [Epub ahead of print]	Included; randomized
428	Feldmann I, Bazargani F. Pain and discomfort during the first week of rapid maxillary expansion (RME) using two different RME appliances: A randomized controlled trial. <i>Angle Orthod</i> 2017;87(3):391-6.	Included; randomized
429	Gunyuz Toklu M, Germec-Cakan D, Tozlu M. Periodontal, dentoalveolar, and skeletal effects of tooth-borne and tooth-bone-borne expansion appliances. <i>Am J Orthod Dentofacial Orthop.</i> 2015;148(1):97-109.	Included; randomized
430	Kabalan O, Gordon J, Heo G, Lagravere MO. Nasal airway changes in bone-borne and tooth-borne rapid maxillary expansion treatments. <i>Int Orthod.</i> 2015;13(1):1-15.	Included; randomized
431	Lagravere MO, Carey J, Heo G, Toogood RW, Major PW. Transverse, vertical, and anteroposterior changes from bone-anchored maxillary expansion vs traditional rapid maxillary expansion: a randomized clinical trial. <i>Am J Orthod Dentofacial Orthop.</i> 2010;137(3):304.e1-12; discussion -5.	Included; randomized
432	Lagravere MO, Gamble J, Major PW, Heo G. Transverse dental changes after tooth-borne and bone-borne maxillary expansion. <i>Int Orthod.</i> 2013;11(1):21-34.	Included; randomized
433	Stepanko LS, Lagravère MO. Sphenoid bone changes in rapid maxillary expansion assessed with cone-beam computed tomography. <i>Korean J Orthod</i> 2016;46(5):269-79.	Included; randomized
434	Forst DD. External Root Resorption Associated with Maxillary Expansion Therapies as Evaluated via Cone Beam Computed Tomography: A Retrospective Randomized Clinical Trial. MSc Thesis, 2015, University of Alberta.	Included; randomized
435	Lagrevere MOV. Analysis of Skeletal and Dental Changes with a Tooth-Borne and a Bone-Borne Maxillary Expansion Appliance assessed through Digital Volumetric Imaging. PhD Thesis, 2009, University of Alberta.	Included; randomized

Appendix 4. Details of the expansion appliances used in the included trials.

Study	Bone anchorage (bone-borne or hybrid)	Tooth anchorage (tooth-borne)
Bazargani 2018	Hybrid RME <ul style="list-style-type: none"> ▪ 2 x 1.7 x 8 mm mini-screw implants (Orthoeasy®; Forestadent, Pforzheim, Germany) at the anterior palate ▪ 1st molar bands soldered to the expander 	Tooth-borne RME <ul style="list-style-type: none"> ▪ 1st molar bands soldered to the expander; extension arms at the 1st / 2nd primary molars
Canan 2017	Bone-borne RME <ul style="list-style-type: none"> ▪ 4 x 1.8 x 9 mm pre-drilling mini-screw implants (Yesanchor; Seoul, Korea) at the palatal sides Hybrid RME <ul style="list-style-type: none"> ▪ 2 x 1.8 x 9 mm pre-drilling mini-screw implants (Yesanchor; Seoul, Korea) at the posterior palate ▪ 1st molar bands soldered to the expander 	Tooth-borne RME <ul style="list-style-type: none"> ▪ 1st premolar & 1st molar bands connected and soldered to the expander
Celenk-Koca 2018	Bone-borne RME <ul style="list-style-type: none"> ▪ 4 x 1.8 x 9 mm pre-drilling mini-screw implants (Orlus; Ortholution Co, Seoul, Korea) at the palatal sides 	Tooth-borne RME <ul style="list-style-type: none"> ▪ Cast expander on the 1st premolar, 2nd premolar, & 1st molar with extension arm for the 2nd molar
Feldmann 2017	Hybrid RME <ul style="list-style-type: none"> ▪ 2 x 1.7 x 8 mm mini-screw implants (Orthoeasy®; Forestadent, Pforzheim, Germany) at the anterior palate ▪ 1st molar bands soldered to the expander 	Tooth-borne RME <ul style="list-style-type: none"> ▪ 1st molar bands soldered to the expander; extension arms at the 1st / 2nd primary molars
Gunyuz Toklu 2015	Hybrid RME <ul style="list-style-type: none"> ▪ 2 x 1.8 x 9 mm mini-screw implants (Total Anchor; Trimed, Ankara, Turkey) at the anterior palate ▪ 1st molar bands soldered to the expander 	Tooth-borne RME <ul style="list-style-type: none"> ▪ 1st premolar & 1st molar bands connected and soldered to the expander
Lagravere 2009 ^{collated†}	Hybrid RME <ul style="list-style-type: none"> ▪ 2 x onplants and 2 x 1.5 x 12 mm mini-screw implants (Straumann GBR-System; Andover, Mass) at the anterior palate 	Tooth-borne RME <ul style="list-style-type: none"> ▪ 1st premolar & 1st molar bands connected and soldered to the expander

RME, rapid maxillary expansion

Appendix 5. Risk of bias assessment of included randomized trials.

Study	Sequence generation	Allocation concealment	Blinding of participants/ personnel	Blinding of outcome assessors	Incomplete outcome data	Selective outcome reporting	Other sources of bias
Bazargani 2018	Low risk - "Participants were randomly allocated in blocks of different sizes, using the concealed allocation principle in a 1:1 ratio, to two groups, a TB group and a TBB group. The randomization procedure was as follows: a computer-generated randomization list..."	Low risk – central allocation: "...and stored with a research secretary at the Postgraduate Dental Education Centre. Each time a patient gave his/her consent, the secretary was contacted by e-mail to provide the information about which type of expander the patient should receive."	Low risk – patients and treatment providers were not blinded, but treatment providers could have been. However, the outcome is objective and has been assessed blindly.	Low risk – "The intermolar measurements were blinded; the examiner was unaware of which treatment the patients had received or which models were taken at pre- and post-expansion. The care providers at the ENT unit who conducted all the rhinomanometry examinations were blinded to which group the patients were allocated to".	Unclear – double attrition rate for the more invasive group (33%) compared to the conventional group (16%); although imputation methods were used to assess the effect of attrition on the results, higher attrition might indicate lower tolerability of the intervention.	Unclear – no obvious selective reporting; however, only dental arch width is assessed and no dental inclination or skeletal width is assessed; finally, it is difficult to judge however whether selective reporting is a problem, as no protocol exists.	Low risk – no other sources of bias; intervention is dependent on patient compliance (which is not reported), but as treatment end was based on objective effects (expansion), this was considered irrelevant.
Canan 2017	Unclear - "Three study groups were designated with stratified randomization (strata, sex)..."	Unclear – No mention throughout the paper.	Unclear - Blinding of participants and personnel impossible; outcome is objective but it is unclear if assessed blindly.	High risk – No mention of blinding throughout the paper; blinding however is possible.	Low risk – 6 drop-outs (11%) after randomization (5 after treatment administration); although reasons for drop-outs might be related to treatment tolerability/acceptance, drop-out rate is relatively low.	Unclear – no obvious selective reporting; however, it is difficult to judge however whether selective reporting is a problem, as no protocol exists.	Low risk – no other sources of bias; intervention is dependent on patient compliance (which is not reported), but as treatment end was based on objective effects (expansion) and expansion duration is reported, this was considered irrelevant.
Celenk-Koca 2018	Low risk – "Patients were randomly assigned to one of the two treatment groups via a block randomization procedure with a block size of four, using a computer-generated list of random numbers".	Low risk – "The allocation sequence was concealed from the orthodontist, researchers, and the patients. When a patient was deemed as eligible for enrollment, the patient was assigned to a treatment group using opaque and sealed envelopes containing the allocation number."	Low risk - Blinding of participants and personnel impossible; outcome is objective and has been assessed and analyzed blindly.	Low risk – "Since it was impossible to blind the patient and orthodontist to the treatment groups, the researcher who traced the cone-beam computed tomography (CBCT) images and the statistician who evaluated the data were blinded".	Low risk – no drop outs.	Low risk – no obvious selective reporting; although it is difficult to judge however whether selective reporting is a problem, as no protocol exists, all possible dental/skeletal outcomes that could be measured by CBCT are reported.	Low risk – no other sources of bias; intervention is dependent on patient compliance (which is not reported), but as treatment end was based on objective effects (expansion), this was considered irrelevant.
Feldmann 2017	Low risk - "...a computer-generated randomization list was created using SPSS software (version 17.0; SPSS, Chicago, Ill) and stored with a research secretary at the Postgraduate Dental Education Centre"	Low risk – central allocation: "Each time a patient gave his/her consent, the secretary was contacted by e-mail and the information about which type of expander the patient should receive was acquired".	Low risk - Blinding of participants and personnel impossible; outcome is subjective but was assessed blindly.	Low risk – "The questionnaires were analyzed by one of the coauthors, who was blinded to the study and performed no orthodontic treatment on the patients."	Low risk – low drop-out rate (7%) which is transparently reported and balanced and the post-drop-out similarity is assessed.	Low risk – no obvious selective reporting; although it is difficult to judge however whether selective reporting is a problem, as no protocol exists, all possible patient-reported outcomes that could be measured within a trial with so short span (1 week) are reported.	Unclear –intervention (and probably outcome) is dependent on patient compliance (which is not reported) and no information given about patient compliance with given instructions.
Gunyuz Toklu 2015	High risk – randomization is unclear, but resembles more an alteration scheme: "According to the order of referral with a randomization ratio of 1:1, they were randomly allocated to 2 groups by an orthodontist (D.G.-C.) who did not know in advance which treatment the next patient would get."	Low risk – central allocation; see sequence generation text.	Unclear - Blinding of participants and personnel impossible; outcome is objective but it is unclear if assessed blindly.	High risk – No mention of blinding of outcome assessment, even though this is possible. Only measurement of the statistician, which is not equally important: "All measurements were made by the same researcher (M.G.T.). Blinding was used at the analysis level."	Low risk – Low drop-out rate (4%): "One patient who lost the palatal miniscrews 2 days after insertion of the expander because of consuming hard foods was excluded from the study."	Unclear – no obvious selective reporting; however, it is difficult to judge however whether selective reporting is a problem, as no protocol exists.	Low risk – no other sources of bias; intervention is dependent on patient compliance (which is not reported), but as treatment end was based on objective effects (expansion) and expansion duration is reported, this was considered irrelevant.
Lagravere 2009 ^{collated} †	Low risk - "...the subjects were randomized into the groups by using a random numbers generated list."	Unclear – No mention throughout the paper.	Unclear – Blinding of participants and personnel impossible; outcome is objective but it is unclear if assessed blindly.	High risk – No mention of blinding throughout the paper; blinding however is possible.	Low risk - No drop-outs or patient losses are reported.	Unclear – no obvious selective reporting; however, it is difficult to judge however whether selective reporting is a problem, as no protocol exists.	Low risk – no other sources of bias; intervention is dependent on patient compliance (which is not reported), but as treatment end was based on objective effects (expansion), this was considered irrelevant.

Appendix 6a. List of included trials comparing bone-borne with tooth-borne rapid maxillary expansion.

Outcome category	Trial	Outcome	Timing	MD	95% CI	P	Clinically relevant ⁵
Skeletal _{maxilla}	Lagravere 2009	External maxilla width at 1 st molar	Pst-Exp	-0.53	-1.48, 0.42	0.27	-
Skeletal _{maxilla}	Lagravere 2009	External maxilla width at 1 st premolar	Pst-Exp	-0.26	-1.41, 0.89	0.66	-
Skeletal _{maxilla}	Lagravere 2009	External maxilla width at pterygoid	Pst-Exp	-0.39	-1.71, 0.93	0.56	-
Dental _{position}	Canan 2017	Inter-canine width (cusp)	Pst-Exp	-0.70	-0.97, -0.43	<0.001	Yes
Dental _{position}	Lagravere 2009	Inter-central-incisor width (apex)	Pst-Exp	-0.56	-1.65, 0.53	0.32	-
Dental _{position}	Lagravere 2009	Inter-central-incisor width (pulp chamber)	Pst-Exp	-0.87	-1.77, 0.03	0.06	-
Dental _{position}	Lagravere 2009	Intermolar width (apex)	Pst-Exp	0.08	-0.82, 0.98	0.86	-
Dental _{position}	Canan 2017	Intermolar width (cusp)	Pst-Exp	-0.09	-0.34, 0.16	0.48	-
Dental _{position}	Lagravere 2009	Intermolar width (pulp chamber)	Pst-Exp	-0.15	-1.30, 1.00	0.80	-
Dental _{position}	Lagravere 2009	Inter-1 st -premolar width (apex)	Pst-Exp	-0.52	-1.53, 0.49	0.31	-
Dental _{position}	Canan 2017	Inter-1 st -premolar width (cusp)	Pst-Exp	0.23	-0.15, 0.61	0.23	-
Dental _{position}	Lagravere 2009	Inter-1 st -premolar width (pulp chamber)	Pst-Exp	-1.80	-2.92, -0.68	0.002	No
Dental _{inclination}	Canan 2017	Inclination 1 st molar (left)	Pst-Exp	-5.39	-8.04, -2.74	<0.001	Yes
Dental _{inclination}	Lagravere 2009	Inclination 1 st molar (left)	Pst-Exp	-0.35	-3.40, 2.70	0.82	-
Dental _{inclination}	Canan 2017	Inclination 1 st molar (right)	Pst-Exp	-2.12	-5.46, 1.22	0.21	-
Dental _{inclination}	Lagravere 2009	Inclination 1 st molar (right)	Pst-Exp	-0.76	-4.27, 2.75	0.67	-
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (left)	Pst-Exp	-4.03	-6.79, -1.27	0.004	No
Dental _{inclination}	Lagravere 2009	Inclination 1 st premolar (left)	Pst-Exp	-1.25	-3.33, 0.83	0.24	-
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (right)	Pst-Exp	-4.28	-6.92, -1.64	0.001	Yes
Dental _{inclination}	Lagravere 2009	Inclination 1 st premolar (right)	Pst-Exp	-3.79	-6.60, -0.98	0.008	No
Nasal cavity	Lagravere 2009	Nasal cavity width at orbita	Pst-Exp	0.24	-0.13, 0.61	0.20	-
Cranial _{vertical}	Lagravere 2009	Height orbita-incisor (left)	Pst-Exp	-0.50	-1.79, 0.79	0.45	-
Cranial _{vertical}	Lagravere 2009	Height orbita-incisor (right)	Pst-Exp	-1.40	-2.48, -0.32	0.01	No
Cranial _{vertical}	Lagravere 2009	Height orbita-1 st molar (left)	Pst-Exp	0.02	-1.53, 1.57	0.98	-
Cranial _{vertical}	Lagravere 2009	Height orbita-1 st molar (right)	Pst-Exp	-0.38	-1.36, 0.60	0.45	-
Cranial _{vertical}	Lagravere 2009	Height orbita-menton (left)	Pst-Exp	-0.67	-2.58, 1.24	0.49	-
Cranial _{vertical}	Lagravere 2009	Height orbita-menton (right)	Pst-Exp	-0.80	-1.68, 1.08	0.40	-
Mandible	Lagravere 2009	Lower intermolar width (pulpal chamber)	Pst-Exp	-0.56	-1.28, 0.16	0.13	-
Mandible	Lagravere 2009	Mandible width at foramen	Pst-Exp	0.30	-0.07, 0.67	0.11	-
Skeletal _{maxilla}	Celenk-Koca 2018	Buccal bone thickness at 1 st molar	Reten	0.14	0.04, 0.24	0.005	No
Skeletal _{maxilla}	Celenk-Koca 2018	Buccal bone thickness at 1 st premolar	Reten	0.25	0.13, 0.37	<0.001	Yes
Skeletal _{maxilla}	Celenk-Koca 2018	Incisal foramen width	Reten	1.80	1.27, 2.33	<0.001	Yes
Skeletal _{maxilla}	Lagravere 2009	External maxilla width at 1 st molar	Reten	-0.70	-1.83, 0.43	0.22	-
Skeletal _{maxilla}	Lagravere 2009	External maxilla width at 1 st premolar	Reten	-1.01	-2.23, 0.21	0.22	-
Skeletal _{maxilla}	Lagravere 2009	External maxilla width at pterygoid	Reten	-0.33	-1.71, 1.05	0.11	-
Skeletal _{maxilla}	Celenk-Koca 2018	Parallel suture opening	Reten	*2.50	*0.55, 11.41	0.24	-
Skeletal _{maxilla}	Celenk-Koca 2018	Suture width at 1 st molar	Reten	2.00	1.40, 2.60	<0.001	Yes
Skeletal _{maxilla}	Celenk-Koca 2018	Suture width at 1 st premolar	Reten	2.30	1.69, 2.91	<0.001	Yes
Dental _{position}	Lagravere 2009	Inter-central-incisor width (apex)	Reten	-0.33	-1.26, 0.60	0.49	-
Dental _{position}	Lagravere 2009	Inter-central-incisor width (pulpal chamber)	Reten	-0.11	-0.67, 0.45	0.70	-
Dental _{position}	Canan 2017	Inter-canine width (cusp)	Reten	-0.51	-0.95, -0.07	0.02	Yes
Dental _{position}	Lagravere 2009	Intermolar width (apex)	Reten	-0.71	-1.87, 0.45	0.23	-
Dental _{position}	Canan 2017	Intermolar width (cusp)	Reten	0.15	-0.36, 0.66	0.57	-
Dental _{position}	Celenk-Koca 2018	Intermolar width (palatal crown middle)	Reten	0.30	-0.64, 1.24	0.53	-
Dental _{position}	Lagravere 2009	Intermolar width (pulpal chamber)	Reten	-0.08	-1.16, 1.00	0.89	-
Dental _{position}	Lagravere 2009	Inter-1 st -premolar width (apex)	Reten	-1.81	-3.07, -0.55	0.005	No
Dental _{position}	Canan 2017	Inter-1 st -premolar width (cusp)	Reten	-0.39	-1.07, 0.29	0.26	-
Dental _{position}	Celenk-Koca 2018	Inter-1 st -premolar width (palatal)	Reten	0.60	-1.18, 2.38	0.51	-

		crown middle)					
Dental _{position}	Lagravere 2009	Inter-1 st -premolar width (pulpal chamber)	Reten	-1.76	-2.66, -0.86	<0.001	Yes
Dental _{inclination}	Celenk-Koca 2018	Inclination 1 st molar (right-left average)	Reten	-5.20	-6.95, -3.45	<0.001	Yes
Dental _{inclination}	Canan 2017	Inclination 1 st molar (left)	Reten	-5.83	-9.98, -1.68	0.006	Yes
Dental _{inclination}	Lagravere 2009	Inclination 1 st molar (left)	Reten	1.92	-1.74, 5.58	0.30	-
Dental _{inclination}	Canan 2017	Inclination 1 st molar (right)	Reten	-2.38	-6.30, 1.54	0.23	-
Dental _{inclination}	Lagravere 2009	Inclination 1 st molar (right)	Reten	1.44	-1.28, 4.16	0.30	-
Dental _{inclination}	Celenk-Koca 2018	Inclination 1 st premolar (right-left average)	Reten	-5.10	-6.78, -3.42	<0.001	Yes
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (left)	Reten	-6.21	-10.13, -2.30	0.002	No
Dental _{inclination}	Lagravere 2009	Inclination 1 st premolar (left)	Reten	1.09	-1.25, 3.43	0.36	-
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (right)	Reten	-1.39	-5.17, 2.39	0.47	-
Dental _{inclination}	Lagravere 2009	Inclination 1 st premolar (right)	Reten	-0.43	-3.24, 2.38	0.76	-
Nasal cavity	Lagravere 2009	Nasal cavity width (cross-section 1; left)	Reten	-0.02	-0.06, 0.02	0.36	-
Nasal cavity	Lagravere 2009	Nasal cavity width (cross-section 1; right)	Reten	0.02	-0.04, 0.08	0.48	-
Nasal cavity	Lagravere 2009	Nasal cavity width (cross-section 2; left)	Reten	1.04	-0.87, 2.95	0.29	-
Nasal cavity	Lagravere 2009	Nasal cavity width (cross-section 2; right)	Reten	0.02	-0.03, 0.07	0.39	-
Nasal cavity	Lagravere 2009	Nasal cavity volume 1 (left)	Reten	0.42	-0.25, 1.09	0.22	-
Nasal cavity	Lagravere 2009	Nasal cavity volume 1 (right)	Reten	0.39	-0.31, 1.09	0.27	-
Nasal cavity	Lagravere 2009	Nasal cavity volume 2 (left)	Reten	0.15	-0.54, 0.84	0.67	-
Nasal cavity	Lagravere 2009	Nasal cavity volume 2 (right)	Reten	0.68	-0.91, 2.27	0.40	-
Nasal cavity	Celenk-Koca 2018	Nasal cavity width at 1 st molar	Reten	1.70	0.81, 2.59	<0.001	Yes
Nasal cavity	Lagravere 2009	Nasal cavity width at orbita	Reten	0.17	-0.24, 0.58	0.42	-
Nasal cavity	Celenk-Koca 2018	Nasal cavity width at 1 st premolar	Reten	1.00	-0.09, 2.09	0.07	-
Cranial _{vertical}	Lagravere 2009	Height orbita-incisor (left)	Reten	-0.18	-0.96, 0.60	0.65	-
Cranial _{vertical}	Lagravere 2009	Height orbita-incisor (right)	Reten	-0.51	-1.17, 0.15	0.13	-
Cranial _{vertical}	Lagravere 2009	Height orbita-1 st molar (left)	Reten	0.40	-0.32, 1.12	0.27	-
Cranial _{vertical}	Lagravere 2009	Height orbita-1 st molar (right)	Reten	0.25	-0.51, 1.01	0.52	-
Cranial _{vertical}	Lagravere 2009	Height orbita-menton (left)	Reten	0.03	-0.91, 0.97	0.95	-
Cranial _{vertical}	Lagravere 2009	Height orbita-menton (right)	Reten	0.05	-1.01, 1.11	0.93	-
Mandible	Lagravere 2009	Lower intermolar width (pulpal chamber)	Reten	-0.20	-0.72, 0.32	0.45	-
Mandible	Lagravere 2009	Mandible width at foramen	Reten	0.20	-0.19, 0.59	0.31	-
Root resorption	Celenk-Koca 2018	Root resorption linear (1 st molar mesiobuccal root)	Reten	0.06	-0.04, 0.16	0.23	-
Root resorption	Celenk-Koca 2018	Root resorption linear (1 st molar mesiodistal root)	Reten	-0.07	-0.19, 0.05	0.27	-
Root resorption	Celenk-Koca 2018	Root resorption linear (1 st molar palatal root)	Reten	0.07	-0.03, 0.17	0.16	-
Root resorption	Celenk-Koca 2018	Root resorption linear (1 st premolar buccal root)	Reten	0.13	0.01, 0.25	0.04	No
Root resorption	Celenk-Koca 2018	Root resorption linear (1 st premolar palatal root)	Reten	0.09	-0.05, 0.23	0.20	-
Root resorption	Lagravere 2009	Root resorption volume (1 st molar)	Reten	-17.82	-46.01, 10.37	0.22	-
Root resorption	Lagravere 2009	Root resorption % volume (1 st molar)	Reten	-1.51	-3.91, 0.89	0.22	-

CI, confidence interval; MD, mean difference; Pst-Exp, post expansion; Reten, post retention period (at least 3 months).

* pertains to risks and not mean difference.

Judged arbitrarily as mean difference being equal or greater to one standard deviation of the control group.

Appendix 6b. List of included trials comparing hybrid (tooth-bone-borne) with tooth-borne rapid maxillary expansion.

Outcome category	Trial	Outcome	Timing	MD	95% CI	P	Clinically relevant [§]
Pain	Feldmann 2017	Analgesic use on day 4	Mid-Exp	*0.78	*0.34, 1.76	0.55	-
Pain	Feldmann 2017	Analgesic use on day 4	Mid-Exp	*0.40	*0.09, 1.87	0.25	-
Dental _{position}	Canan 2017	Inter canine width (cusp)	Pst-Exp	-0.68	-0.94, -0.42	<0.001	Yes
Dental _{position}	Canan 2017	Inter molar width (cusp)	Pst-Exp	-0.06	-0.36, 0.24	0.69	-
Dental _{position}	Canan 2017	Inter-1 st -premolar width (cusp)	Pst-Exp	0.14	-0.28, 0.56	0.52	-
Dental _{inclination}	Canan 2017	Inclination 1 st molar (left)	Pst-Exp	-1.45	-4.03, 1.13	0.27	-
Dental _{inclination}	Canan 2017	Inclination 1 st molar (right)	Pst-Exp	3.20	-0.62, 7.02	0.10	-
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (left)	Pst-Exp	-3.31	-6.85, 0.23	0.07	-
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (right)	Pst-Exp	-1.16	-4.32, 2.00	0.47	-
Nasal cavity	Bazargani 2018	Nasal airflow	Pst-Exp	57.70	1.44, 113.96	0.04	No
Nasal cavity	Bazargani 2018	Nasal resistance	Pst-Exp	-0.23	-0.43, -0.04	0.02	No
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at canine (left)	Reten	-0.25	-0.63, 0.13	0.20	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at canine (right)	Reten	0.00	-0.28, 0.28	1.00	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st molar (averaged)	Reten	-0.15	-0.66, 0.36	0.56	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st molar (distobuccal root; left)	Reten	-0.21	-0.65, 0.23	0.35	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st molar (distobuccal root; right)	Reten	-0.13	-0.77, 0.51	0.69	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st molar (mesiobuccal root; left)	Reten	-0.11	-0.64, 0.42	0.69	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st molar (mesiobuccal root; right)	Reten	-0.15	-0.58, 0.28	0.49	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st premolar (averaged)	Reten	0.63	0.10, 1.16	0.02	Yes
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st premolar (left)	Reten	0.79	0.30, 1.28	0.001	Yes
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 1 st premolar (right)	Reten	0.46	-0.13, 1.05	0.13	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 2 nd premolar (left)	Reten	0.15	-0.32, 0.62	0.53	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at 2 nd premolar (right)	Reten	-0.11	-0.42, 0.20	0.49	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at canine (left)	Reten	-0.31	-0.96, 0.34	0.35	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Buccal bone thickness at canine (right)	Reten	-0.03	-0.72, 0.66	0.93	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Palatal bone thickness at 1 st molar (left)	Reten	0.04	-0.61, 0.69	0.90	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Palatal bone thickness at 1 st molar (right)	Reten	-0.43	-0.95, 0.09	0.10	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Palatal bone thickness at 1 st premolar (left)	Reten	-1.62	-2.21, -1.03	<0.001	Yes
Skeletal _{maxilla}	Gunyuz Toklu 2015	Palatal bone thickness at 1 st premolar (right)	Reten	-0.61	-1.55, 0.33	0.20	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Palatal bone thickness at 2 nd premolar (left)	Reten	-0.17	-0.67, 0.33	0.51	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Palatal bone thickness at 2 nd premolar (right)	Reten	-0.66	-1.25, -0.07	0.03	No
Skeletal _{maxilla}	Gunyuz Toklu 2015	External maxilla width at 1 st molar	Reten	0.64	-1.41, 2.69	0.54	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	Palatal maxilla width at 1 st molar	Reten	-0.47	-2.29, 1.35	0.61	-
Skeletal _{maxilla}	Gunyuz Toklu 2015	External maxilla width at pterygoid	Reten	0.14	-1.09, 1.37	0.82	-
Dental _{position}	Gunyuz Toklu 2015	Inter canine width (apex)	Reten	1.69	-0.71, 4.09	0.17	-
Dental _{position}	Canan 2017	Inter canine width (cusp)	Reten	-0.01	-0.37, 0.35	0.96	-
Dental _{position}	Gunyuz Toklu 2015	Inter canine width (cusp)	Reten	-0.95	-2.39, 0.49	0.19	-
Dental _{position}	Gunyuz Toklu 2015	Inter molar width (apex)	Reten	-1.69	-4.39, 1.01	0.22	-
Dental _{position}	Canan 2017	Inter molar width (cusp)	Reten	0.14	-0.46, 0.74	0.65	-
Dental _{position}	Gunyuz Toklu 2015	Inter molar width (mesiobuccal cusp)	Reten	0.57	-1.38, 2.52	0.57	-

Dental _{position}	Gunyuz Toklu 2015	Intermolar width (averaged cusp)	Reten	0.54	-1.38, 2.46	0.58	-
Dental _{position}	Gunyuz Toklu 2015	Intermolar width (distobuccal cusp)	Reten	0.52	-1.37, 2.41	0.59	-
Dental _{position}	Gunyuz Toklu 2015	Inter-1 st -premolar width (apex)	Reten	-3.06	-5.73, -0.39	0.03	No
Dental _{position}	Canan 2017	Inter-1 st -premolar width (cusp)	Reten	0.00	-0.69, 0.69	1.00	-
Dental _{position}	Gunyuz Toklu 2015	Inter-1 st -premolar width (buccal cusp)	Reten	-4.33	-7.04, -1.62	0.002	Yes
Dental _{position}	Gunyuz Toklu 2015	Inter-1 st -premolar width (palatal cusp)	Reten	-5.29	-7.81, -2.77	<0.001	Yes
Dental _{position}	Gunyuz Toklu 2015	Inter-2 nd -premolar width (apex)	Reten	-0.38	-3.00, 2.24	0.78	-
Dental _{position}	Gunyuz Toklu 2015	Inter-2 nd -premolar width (buccal cusp)	Reten	-3.33	-6.15, -0.51	0.02	Yes
Dental _{position}	Gunyuz Toklu 2015	Inter-2 nd -premolar width (palatal cusp)	Reten	-3.48	-6.38, -0.58	0.02	No
Bone _{inclination}	Gunyuz Toklu 2015	Alveolar inclination at 1 st molar (left)	Reten	-1.02	-5.16, 3.12	0.63	-
Bone _{inclination}	Gunyuz Toklu 2015	Alveolar inclination at 1 st molar (right)	Reten	-0.35	-4.57, 3.87	0.87	-
Bone _{inclination}	Gunyuz Toklu 2015	Alveolar inclination at 1 st premolar (left)	Reten	-1.48	-5.00, 2.04	0.41	-
Bone _{inclination}	Gunyuz Toklu 2015	Alveolar inclination at 1 st premolar (right)	Reten	-1.04	-6.74, 4.66	0.72	-
Dental _{inclination}	Gunyuz Toklu 2015	Absolute inclination 1 st molar (left)	Reten	0.95	-2.80, 4.70	0.62	-
Dental _{inclination}	Gunyuz Toklu 2015	Absolute inclination 1 st molar (right)	Reten	-3.99	-8.75, 0.77	0.10	-
Dental _{inclination}	Gunyuz Toklu 2015	Absolute inclination 1 st premolar (left)	Reten	-1.30	-3.55, 0.95	0.26	-
Dental _{inclination}	Gunyuz Toklu 2015	Absolute inclination 1 st premolar (right)	Reten	-0.14	-5.60, 5.32	0.96	-
Dental _{inclination}	Gunyuz Toklu 2015	Inclination canine (left)	Reten	-3.58	-8.51, 1.35	0.15	-
Dental _{inclination}	Gunyuz Toklu 2015	Inclination canine (right)	Reten	0.48	-3.72, 4.68	0.82	-
Dental _{inclination}	Canan 2017	Inclination 1 st molar (left)	Reten	-2.41	-5.63, 0.81	0.14	-
Dental _{inclination}	Gunyuz Toklu 2015	Inclination 1 st molar (left)	Reten	-0.07	-3.42, 3.28	0.97	-
Dental _{inclination}	Canan 2017	Inclination 1 st molar (right)	Reten	1.64	2.63, 5.91	0.45	-
Dental _{inclination}	Gunyuz Toklu 2015	Inclination 1 st molar (right)	Reten	-4.34	-9.71, 1.03	0.11	-
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (left)	Reten	-6.09	-10.17, -2.01	0.003	No
Dental _{inclination}	Gunyuz Toklu 2015	Inclination 1 st premolar (left)	Reten	-2.78	-4.96, -0.61	0.01	No
Dental _{inclination}	Canan 2017	Inclination 1 st premolar (right)	Reten	-0.06	-4.16, 4.04	0.98	-
Dental _{inclination}	Gunyuz Toklu 2015	Inclination 1 st premolar (right)	Reten	-1.17	-4.11, 1.77	0.44	-
Dental _{inclination}	Gunyuz Toklu 2015	Inclination 2 nd premolar (left)	Reten	-1.48	-6.39, 3.43	0.55	-
Dental _{inclination}	Gunyuz Toklu 2015	Inclination 2 nd premolar (right)	Reten	1.41	-2.04, 4.86	0.42	-
Nasal cavity	Gunyuz Toklu 2015	Nasal cavity width	Reten	0.08	-1.35, 1.51	0.91	-

CI, confidence interval; MD, mean difference; Pst-Exp, post expansion; Reten, post retention period (at least 3 months).

* pertains to risks and not mean difference.

Judged arbitrarily as mean difference being equal or greater to one standard deviation of the control group.