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Implants for orthodontic anchorage

An overview

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Abstract

Implantanchorage continues to receive much attention as an important orthodontic anchorage. Since the development of orthodontic implants, the scope of applications has continued to increase. Although multiple reviews detailing implants have been published, no comprehensive evaluations have been performed. Thus, the purpose of this study was to comprehensively evaluate the effects of implants based on data published in review articles.

An electronic search of the *Cochrane Library*, *Medline*, *Embase, Ebsco* and *Sicencedirect* for reviews with "orthodontic" and "systematic review or meta analysis" in the title, abstract, keywords, or full text was performed. A subsequent manual search was then performed to identify reviews concerning orthodontic implants. A manual search of the orthodontic journals *American Journal of Orthodontics and Dentofacial Orthopedics* (AJODO), *European Journal of Orthodontics* (EJO), and *Angle Othodontist* was also performed. Such systematic reviews that evaluated the efficacy and safety of orthodontic implants were used to indicate success rates and molar movements.

A total of 23 reviews were included in the analysis. The quality of each review was assessed using a measurement tool for *Assessment of Multiple Systematic Reviews* (AMSTAR), and the review chosen to summarize outcomes had a quality score of >6. Most reviews were less than moderate quality. Success rates of implants ranged in a broad scope, and movement of the maxillary first molar was superior with implants compared with traditional anchorage.

Abbreviations: AMSTAR = assessment of multiple systematic reviews, TPA = transverse palatal bar.

Keywords: implant, molar movement, orthodontics, overview, success rate

1. Introduction

Orthodontic anchorage is used to resist the force applied to teeth. Thus, successful orthodontic treatments rely on the adequate control of anchorage. Anchorage can be divided into strong, moderate, and weak anchorage. Traditionally, strong and moderate anchorage requires a headgear, a Nance bow, or a transverse palatal bar (TPA); however, recently implant anchorage have been increasingly used because of their small size, simple operation, high efficacy, and low cost.[1]

Successful orthodontic treatments rely on the control of orthodontic anchorage; however, in many cases, traditional orthodontic anchorage cannot achieve satisfactory results. For example, headgear is dependent on patient appliance, the Nance bow is large and oppresses the mucosa, and TPA lacks sufficient strength.[2]

Recently, implant anchorages have been used for auxiliary anchorage reinforcement. The implant anchorage is typically made of stainless steel, commercially available titanium, or titanium alloy. The diameter of them is from 1 to 2 mm whereas the length is generally 8 to 20 mm. Implant anchorages and dental implants are different in that implant anchorages are not bone-binding, but instead, bind mechanically. Multiple types of implant anchorages are available, mostly including palatal plates, onplants, miniplates, and miniscrews.[3]

1. Palatal plates: The implant position is primarily on the maxillary hard palate, which is located in the median palatine suture or on either side of the median palatine suture behind the foramina incisivum. Most palatal implants are made of titanium alloy and are screw-like with a cylindrical surface. Following implantation in the oral cavity, impressions are obtained to produce the TPA, which connects the 2 sides of the maxillary teeth to the implant to strengthen the anchor.
2. Onplants: The onplant has the same role as the palatal plate and is implanted in the median palatine suture. Onplants are button shaped and implanted between the periosteum and jaw. Such implants require secondary surgeries, whereas palatal plates require a single surgery.

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XZ and YS contributed equally to the study.

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3. Miniplates: Miniplates are implanted on the apical buccal area of the upper and lower jaw, and are implanted following periosteum flap surgery. Titanium plates are fixed in dense buccal bone by miniscrews. Most of the implant is located under the periosteum. Miniplates and miniscrews are made of titanium alloy. Miniplates are applied immediately following implantation, and have better retention than other implants. Miniplates can also withstand large orthopedic forces, including front traction of the maxilla, or retraction of the overall dentition.
4. Miniscrews: Miniscrews are made of pure titanium or titanium alloy, with a diameter of 1 to 2 mm and a length of 10 mm. The shape of the implant below the bone surface is screw-like, and is not generally used for surface treatment. The advantage of the miniscrew is its simple operation. Miniscrews are self-drilling or auxiliary. Owing to their small size, microscrew implants can be applied to nearly all locations in the jaw or alveolar bone. The most common implant positions are between the buccal-apical side of the upper and lower teeth. The use of miniscrew implants (MIs) controls the movement of teeth in the mesial, distal, and vertical directions, without the need for additional anchorage.

Currently, orthodontists use various temporary anchorage devices (TADs) for anchorage. A considerable body of research has tested the efficacy and success rates of implant anchorages and the aim of this review was to provide information to orthodontists and balance the benefits and harms associated with orthodontic implants anchorage. In this overview, we address the following.

1. Success rates vary widely among reviews, with no clear conclusions.
2. The success application of implant anchorages is based on comparisons with traditional anchors, and the movement of teeth. Thus, the overall effectiveness of implant anchorage remains unknown.
3. Since the advent of orthodontic implant anchorages, multiple reviews have been published; however, only 1 is included in the Cochrane Library database. The remaining reviews are published in magazines and have unknown qualities.

2. Material and methods

2.1. Inclusion criteria for review articles

2.1.1. Types of studies. In accordance with the standard criteria for reviews of orthodontic implant anchorages, we included studies using trials to estimate molar movement and success rates.

2.1.2. Types of participants. All orthodontic implant-based reviews were included and comprised data for teenagers and adults from both sexes and different nationalities and ethnicities.

2.1.3. Types of interventions. Interventions included palatal plates, onplants, miniplates, and miniscrews. Such interventions were delivered as monotherapies or combinations. Success rates and molar movements were evaluated for different orthodontic implants.

2.1.4. Types of outcomes. The primary outcome was success rates of orthodontic implants (i.e., implants remained in the position in which they were implanted). Secondary outcomes included the mean loss of molar anchorage and molar destabilization.

2.2. Search methods to identify reviews

The *Cochrane Library*, *Medline*, *Embase*, *Ebsco*, and *Sicence-direct* were searched for reviews with “orthodontic$” and “systematic review or meta-analysis” in the title, abstract, keywords, or full text. A subsequent manual search was then performed to identify reviews concerning orthodontic implants. A manual search of the 3 orthodontic journals AJODO, EJO, and *Angle Orthodontist* was also performed. The search was performed in September 2016, and the inclusion and exclusion criteria were as follows:

Inclusion criteria:

1. Systematic reviews or meta-analysis
2. Randomized controlled clinical trials (RCTs)
3. Prospective controlled clinical trials (CCTs)
4. Retrospective controlled cohort studies
5. Other human studies
6. No restrictions were applied concerning the publication year or status.

Exclusion criteria:

1. Studies that failed to perform systematic reviews or meta-analyses.
2. Studies contains animal studies or corpse research

2.3. Data collection and analysis

2.3.1. Selection of reviews. Two authors (XZ and YS) independently assessed all reviews identified by the search strategy.

2.3.2. Data extraction and management. The data extraction form summarizes the key information obtained from each review, including the participant details, the interventions, comparisons, and outcomes. One author (XZ) extracted the data, whereas the second (YS) verified the extracted information. Disagreements were referred to a third author (YZ) for discussion and resolution.

2.3.3. Assessments of methodological quality of reviews. We used the AMSTAR measurement tool[4] to assess the quality of the reviews. The modified assessment comprised the following 11 factors:

1. Was an “a priori” design provided?
2. Were study-selection and data-extraction methods duplicated?
3. Was a comprehensive literature search performed?
4. Were published and unpublished studies eligible, irrespective of language of publication?
5. Was a list of studies (included and excluded) provided?
6. Were the characteristics of the included studies provided?
7. Was the scientific quality of the included studies assessed and documented?
8. Was the scientific quality of the included studies used appropriately when formulating conclusions?
9. Were appropriate methods used to combine results?
10. Was the likelihood of publication bias assessed?
11. Was a conflict of interest disclosed?

Each criterion was rated as “Yes” (done), “No” (not done), “Can’t answer” (unclear), or “Not applicable.” A “Yes” rating indicated adequate quality and was given a score of 1. Criteria rated as “Not applicable” were not counted against the review, but were removed from the denominator with appropriate adjustment to the ranking. A "No," "Can't answer," and "Not applicable" were given a score of 0. The sum of the scores provided the overall quality score.

All reviews were ranked as being of high quality (scoring 8–11), of medium quality (scoring 4–7), or of low quality (scoring 0–3). Reviews were not excluded based on AMSTAR rankings.

2.4. Data synthesis

To analyze the success rates of implant anchorages and the levels of molar movement compared to traditional anchorage, we analyzed the outcomes of reviews. Owing to the large number of reviews pertaining to orthodontic implants and the complex definition of outcomes, we did not analyze the outcomes by network meta-analysis, but instead extracted high quality data of orthodontic implants for clinicians' use.

To assess the efficacy of orthodontic implants, we performed this overview at the review level, and did not reanalyze the studies. Although we intended to update the overview immediately using the Cochrane policy, this was not added to the reviews included.[5] Additionally, our decision to update the overview depended on whether the reviews could essentially change the findings from the previous overview.

3. Results

3.1. Description of included reviews

In this study, we screened 2253 articles of all the orthodontic systematic reviews and meta-analyses electronically. And we manually searched 38 reviews concerning orthodontic implants in those 2253 articles beyond the consideration of language, style or if the experiment in the review is about animals but strictly follow our criteria. Then we screened the 38 reviews last time and chose 23 reviews in the 38 articles according to our criteria. A flow chart detailing the articles included is shown in Figure 1. The characteristics of all the 23 reviews are listed in Table 1.[2,3,6,–26]

Of the 23 articles selected, the most recent were published in 2016. Among the reviews, some were restricted and included RCT, CCT, and retrospective studies. All others included live humans. The written language was English. The outcomes of the reviews were broad, and included success rates for orthodontic implants and the degrees of molar movements. The remaining outcomes detailed the probability of implants to contact the root, or have front traction in the maxilla. Owing to the small number of articles analyzed, we focused on the success rates and the level of molar movement between implant anchorages and traditional anchorages.

3.2. Methodological quality of the reviews

AMSTAR ratings for the reviews are summarized in Table 2.[2,3,6,–26] All 23 reviews were classified as high, medium, or low quality based on 11 domains. Following our previous classification criteria, a grade of 0 to 3 was considered low quality, 4 to 7 was considered medium quality, and 8 to 11 was considered high quality. A total of 3 articles were deemed to be of low quality,[3,6,7] whereas 15 were of medium quality,[2,8–21] and 5 were of high quality.[22–26]

3.3. Effects of interventions

Orthodontic implants are palatal plates, onplants, miniplates, and miniscrews. All reviews concerning orthodontic implants illustrated the efficacy and application of the 4 implants. To summarize the outcomes of such studies, high-quality reviews were selected. For those studies, the AMSTAR score was 11. We used 50% as the reference and summarized reviews with scores >6. There were 22 outcomes, with most detailing the success rate for implantations and the level of molar movement. Other

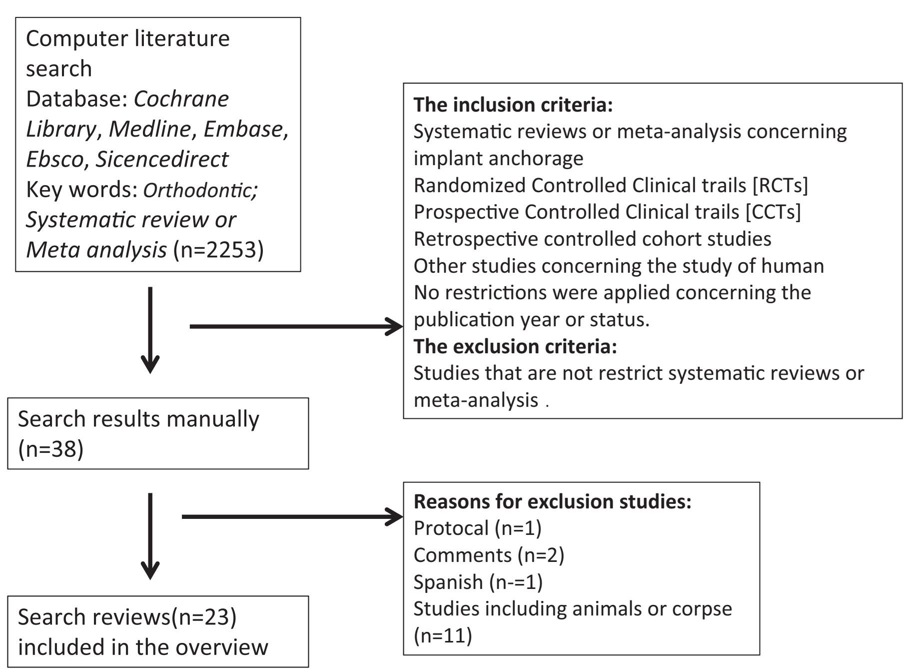

Figure 1. Flowchart illustrating the selection of relevant articles.

Table 1
PICO of the 23 reviews.

Review	Date assessed as up to date	Population	Interventions	Comparison	Outcomes for which data were reported
Yi et al[8]	2016.5	Patients needs TAD treatment	Self-drilling miniscrew	Self-tapping miniscrew	No difference between the 2 types of screws in the success rates.
Hong et al[24]	2016.5	Clinical human studies	MIs placed in the buccal area only	Before and after	OR of the success of MIs with a subgroup meta-analysis
Alsafadi et al[9]	2016.3	Patients who have open bite malocclusion	Molar intrusion with temporary anchorage	No	Mandibular counterclockwise rotation was found to be between 2.3 and 3.9 degree in 6 studies (assassed by mandibular plane angle, between MeGo or GoGn and SN or FH plane), whereas it was <2 degreein the remaining studies.
Winsauer et al[10]	2014.10	Studies on human subjects	Studies measuring VBH or bone thick- ness in the palate	No	Optimal sites for OMI insertion
Dalessandri et al[11]	2014.6	Patients need orthodontic temporary anchorage devices	TAD used as orthodontic anchorage	No	The success rates was reported >80%
Rodriguez et al[12]	2014.4	Subjects using implants	Implants placed in maxilla and mandible and Implants placed in hard palate	No	Survival rate of the implants
Grec et al[13]	2013.5	Subjects with Class II malocclusion	Intraoral distalizers with conventional anchorage	Intraoral distalizers with skeletal anchorage	Efficiency in the correction of Class II malocclusion
Alsamak et al[14]	2013.2	Patients need orthodontic implant anchorage	OMIs and another detailed search for CT or CBCT	No	Optimal sites for OMI insertion
Marquezan et al[15]	2012.7	Patients using skeletal anchorage	Skeletal anchorage	No	There is a positive association between implant primary stability and bone mineral density of the receptor site
Tsui et al[3]	2012.6	Patients need bone anchorage	Patients using one kind of bone anchorage	Little study compare another kind of bone anchorage	The success rates for the four groups of bone anchorage systems and bone anchorage systems can achieve effective orthodontic movement with low morbidities.
Alves et al[25]	2012.5	Human clinical studies	Surgical screws with a diameter less than 2.5 mm	No	The roots did not exhibit clinical changes after coming into contact with the IMS, but this situation depends on the root damage level
Papageorgiou et al[23]	2012.5	Patients needs orthodontic anchorage reinforcement	Patients using miniscrew implants for orthodontic anchorage reinforcement	Patients using other means of orthodontic anchorage reinforcement	Failure rate of the minisrew implants
Feng et al[16]	2012.2	Children with maxillary deficiency	TAD anchored MP	Tooth anchored MP	TAD-anchored maxillary protraction has a greater maxillary advancement effect and might reduce skeletal and dental side effects compared with tooth anchored maxillary protraction
Li et al[2]	2011.2	Patients needs orthodontic anchorage	Implant anchorage	Headgear anchorage Or headgear +TPA	All with insignificant differences in terms of anchorage loss, anterior teeth retraction, maxillary incisor inclination, positional change of basal bone, and treatment duration
Papadopoulos et al[22]	2011.2	Patients needs orthodontic treatment	Subjects using MIs	Subjects using Conventional anchorage	Anchorage loss during the treatment
Fudalej and Antoszewska[17]	2011.1	Patients needs molar distalization	Temporary anchorage devices to distalize molars	No	Molar distalizers reinforced with the temporary skeletal anchorage devices seem to effectively

(*continued*)

Table 1
(continued).

Review	Date assessed as up to date	Population	Interventions	Comparison	Outcomes for which data were reported
					move molars distally without unwanted mesial incisor tipping
Crismani et al[6]	2010.1	Human clinical trials	Orthodontic mini-im-plants or miniscrews	Before and after	Success rate
Schatzle et al[26]	2009.5	Patients need absolute anchorage	Different types of TADs	Before and after	Survival rate of subgroups
Reyders et al[18]	2009.5	Patients need absolute anchorage	Orthodontic implants	Before and after	Success rate
Chen et al[19]	2009.3	Patients need orthodontic mini-implants	Mini-implants used as orthodontic anchorage	No	Mini-implants are effective as anchorage, and their success depends on proper initial mechanical stability and loading quality and quantity
Jambi[20]	2007.5	Patients undergoing orthodontic treatment	Mid-palatal implants, onplants, miniscrews, spider screws, titanium plates, and zygomatic wires	Conventional anchorage	Mesial movement of the upper first permanent molar teeth
Ohashi et al[21]	2006.7	Patients need strong orthodontic anchorage	Implant used as orthodontic anchorage	Screws used as orthodontic anchorage	Loading protocols for implants involve a minimum waiting period of 2 mo before applying orthodontic forces Loading protocols for screws involve immediate loading or a waiting period of 2 wk to apply forces.
Labanauskaite et al[7]	2005.7	Patients need orthodontic anchorage.	Orthodontic implants	No	No exact conclusion

CT = computed tomography, IMS = intermaxillary screws, MIs = miniscrew implants, OMI = orthodontic mini implant, OR = odds ratio, TAD = temporary anchorage device, TPA = transverse palatal bar, VBH = vertical palatal bone height.

outcomes included the level of incisor movement, traction of the maxilla, and the rotation of the mandibular plane. Such outcomes were typically present in 1 to 2 reviews; however, most of those reviews were of low quality. Therefore, we focused on the outcomes that clinicians require, which is the success rate and level of molar movement.

3.4. Success rate

The success of an implant is determined by its shedding after implantation. A total of 7 reviews were selected with an AMSTAR score >6. The success rates for those studies are shown in Table 3. All 7 articles were published after 2009.[8,18,19,22–24,26] Only Schatzle et al[26] discussed the success rate of all 4 implant types. The success rate of onplant was 82.8% (64.2%, 94.1%), whereas that of the palatal implant was 89.5% (81.9%, 93.9%), the midplate 92.7% (90.1%, 94.6%), and the miniscrew 83.6% (70.9%, 86.6%). Most other studies evaluated the success rate of miniscrews. For example, Papageogiou et al[23] revealed a miniscrew success rate of 87.7% (83.3%, 91.1%), whereas Papadopoulos et al[22] revealed a similar miniscrew success rate of 84.4% (81.9%, 86.7%). Reynders et al and Chen et al identified a success rate that differed substantially,[18,19] whereas Chen et al and Hong et al did not perform meta-analyses.[19,24]

A review by Hong et al, 2016, also performed subgroup analyses; the success rates between different groups were analyzed based on implant position, sex, age, and the length/diameter of miniscrews.[24] They concluded that success rates differed minimally with gender and age; however, the success rate was higher when miniscrews were implanted in the maxilla compared with the mandible. Higher success rates were also observed with longer and larger miniscrews.

3.5. Molar movement

A total of 5 reviews had AMSTAR scores >6 and discussed molar movements in Table 4.[2,13,17,20,22] Papadopoulos compared MIs to traditional anchorages and found that the mean anchor loss of MI was 0.05 (95% confidence interval [CI] = −0.3 to 0.4 mm), while the mean difference in the anchorage-loss ratio was −0.5 (95% CI = −0.6 to 0.3). Papadopoulos et al[22] also performed subgroup analyses between implants in different positions, numbers, ages, or whether they were performed directly or indirectly. However, meta-analyses were not performed.

Jambi revealed in the Cochrane Library that the anchorage loss of MI was 1.5 mm, whereas that of traditional anchorages was 3 mm. Additionally, the MI reduced anchorage consumption.[20] Li et al[2] compared midpalatal implants to headgear and concluded that the sm-OLP (the distance of the mesial contact point of the maxillary first permanent molar) was −1.34 mm (−2.02, −0.67), whereas Grec et al compared MIs to traditional anchorage and measured the distilizing distance between the upper first molars and premolars.[13] The distance of the distal molar was 5.10 mm (−6.09, −4.11) when implant anchorages were used, whereas the distance of the distal molar using traditional anchorage was 3.34 mm (−3.85, −2.83). The distance of the distal premolar to the implant was −4.01 mm (−4.80, −3.32) and from the distal premolar to the traditional anchor was 2.30 mm (1.73, 2.86). Fudalej and Antoszewska[17] revealed the inclination of the anchorage molar as 0.8 to 12.2 degree when using implant anchorage.

Table 2

AMSTAR score of the 23 reviews included.

	11 Factors of the AMSTAR											
Review	1	2	3	4	5	6	7	8	9	10	11	Total
Yi et al[8]	1	0	1	0	0	1	1	1	1	0	0	6
Hong et al[24]	1	1	1	0	0	1	1	1	1	1	1	9
Alsafadi et al[9]	0	0	1	1	0	1	1	1	0	0	1	6
Winsaur et al[10]	1	1	0	0	0	1	0	1	0	0	0	4
Dalessandri et al[11]	1	0	0	0	0	1	1	1	1	0	0	5
Rodriguez et al[12]	1	0	1	0	0	1	0	1	0	0	1	5
Grec et al[13]	0	1	1	0	0	1	1	1	1	0	0	6
Alsamak et al[14]	1	1	1	0	0	1	0	1	0	0	0	5
Marquezan et al[15]	0	1	0	0	0	1	1	1	0	0	0	4
Tsui et al[3]	1	0	0	0	0	1	0	0	0	0	1	3
Alves et al[25]	1	1	1	0	0	1	1	1	0	0	1	7
Papageorgiou et al[23]	1	1	1	1	0	1	1	1	1	1	0	9
Feng et al[16]	1	1	1	0	0	1	1	1	1	0	0	7
Li et al[2]	1	1	0	0	0	1	1	1	1	0	0	6
Papadopoulos et al[22]	1	1	1	1	0	1	1	1	1	1	0	9
Fudalej and Antoszewska[17]	1	1	1	0	0	1	1	1	1	0	0	7
Crismani et al[6]	1	0	0	0	0	1	0	1	0	0	0	3
Schatzle et al[26]	1	1	0	0	1	1	1	1	1	0	1	8
Reyders et al[18]	1	1	1	0	1	1	0	1	0	0	0	6
Chen et al[19]	1	1	1	0	0	1	1	1	0	0	0	6
Jambi et al[20]	1	1	1	1	1	1	1	1	1	0	1	10
Ohashi et al[21]	0	1	1	0	0	1	1	1	0	0	0	5
Labanauskite et al[7]	0	0	0	0	0	0	0	1	0	0	0	1

AMSTAR = assessment of multiple systematic reviews.

4. Discussion

This study summarized reviews detailing orthodontic implants. Thus, this overview provides a comprehensive analysis of multiple systematic reviews and meta-analyses of orthodontic implants. When performing an overview, the literature must meet the inclusion criteria and cannot be simply excluded or included based on their quality. As overviews summarize all reviews, even low-quality reviews should be included. An inherent limitation to overviews is that not all reviews will be updated as is desired.

There are multiple sources of bias in the overview process. Studies were screened by the Cochrane assessment and were assumed to represent the most comprehensive and consistent evidence. The underlying weakness is that three authors (ZX, SY, ZY) contributed to the comments outlined in this summary, or provided editorial contributions. To reduce this weakness, we used independent objective criteria, including the modified AMSTAR scale to assess the quality and limitations of the included assessments.

Based on the standards of the Cochrane Library, most reviews that met the inclusion criteria were of moderate quality, whereas 1 article was of high quality. In general, the overall quality of implant reviews was low. Additionally, not all studies of medium quality (or higher) collected meta-data. The reason the quality of reviews pertaining to orthodontic implants was low was because

Table 3

Outcomes of success rate of the 7 reviews whose AMSTAR score higher than 6.

Success rate	Amstar	Comparison	Numbers of implants (study)	Absolute effect	Relative effect
Papadopoulos et al[22]	9	Miniscrew implants	297 (8)	87.7% (83.3%,91.1%)	
Chen et al[19]	6	Mini-implants	1302 (16)	0%–100%	
Yi et al[8]	6	Self-drilling vs. self-tapping	1308 (6)		0.90 (0.52, 1.52)
Papageogiou et al[23]	9	Mini-screw implants	4987 (52)	84.4% (81.9%, 86.7%)	
Reynders et al[18]	6	Mini-implants	2293 (19)	6.4%–100%	
Hong et al[24]	9	Miniscrew implants	3473 (17)		
		1. mandible/maxilla			2.32 (1.83, 2.96)
		2. male/female			1.18 (0.92, 1.51)
		3. age ≥ 20/age < 20			1.59 (1.14, 2.22)
		4. MI lenth < 8 mm/≥ 8 mm			0.46 (0.26, 0.80)
		5. MI diameter ≤ 1.4 mm/> 1.4 mm			0.62 (0.40, 0.97)
Schatzle et al[26]	8	Onplant	29 (1)	82.8% (64.2%, 94.1%)	
		Miniscrew	2374 (17)	83.6% (70.9%, 86.6%)	
		Palatal implants	190 (6)	89.5% (81.9%, 93.9%)	
		Midplate	586 (7)	92.7% (90.1%, 94.6%)	

AMSTAR = assessment of multiple systematic reviews.

Table 4

Outcomes of molar movement of the 6 reviews whose AMSTAR is >6.

Reviews	Amstar	Comparison	Mean anchorage loss of MI	Mean difference of anchorage loss ratio	Sm-OLP	Average molar distalization	Premolar movement	Molar distal tipping
Papadopoulos et al[22]	9	MI vs. traditional anchorage	0.05 mm (95% CI = −0.3 to 0.4)	−0.5 (95% CI = −0.6 to 0.3)				
		MI in mandible vs. maxilla	−0.6 vs. 0.2 mm					
		MI in 5/6 vs. palatal	−0.2 vs. 1.3 mm					
		MI of 2 vs. 1	−0.2 vs. 1.3 mm					
		MI connected directly vs. indirectly	−0.2 vs. 0.8 mm					
		Young vs. adult maxilla		−0.6 vs. −0.4				
		Mandible vs. maxilla		−0.7 vs. −0.4				
Li et al[2]	6	Midpalatal implant vs. headgear group			−1.34 mm (−2.02, −0.67)			
Crec et al[13]	6	Skeletal anchorage vs conventional anchorage				5.10 mm (−6.09, −4.11) vs. 3.34 mm (−3.85, −2.83)	−4.01 mm (−4.80, −3.23) vs. 2.30 mm (1.73, 2.86)	
Fudalej and Antoszewska[17]	7					3.5–6.4 mm		0.8 to 12.2 degree
Jambi[20]	10	Surgical methods vs. conventional methods	1.5 vs. 3 mm					

AMSTAR = assessment of multiple systematic reviews, CI = confidence interval, MI = miniscrew implant.

the study design of the orthodontic implants was RCT and most were from perspective and retrospective clinical trials. Thus, trials were unlikely to be blind. Additionally, the duration of orthodontic treatment was long and variable.

Here, we discuss implant success rates and molar movements. We chose a literature score of >6 points and summarized 2 outcomes. High-quality studies were identified that some of them perform meta-analyses. The success rates in high-quality studies were mostly >80%. What's more, although Reynder et al and Chen et al[18,19] give the results of a large range. Some of them did show extreme circumstance such as very poor bone density and very small sample size that cause the success rate to reach 0. Of course, the immature surgery of implantation is also one of the reasons that cause the total failure. So we can conclude that clinicians can refer the conclusion of the success rate of orthodontic implantation to reach 80%. Additionally, molar movements were superior when implant anchorages were used, compared with those associated with the use of traditional anchorages. Thus, when the planting sites and bones are suitable, orthodontists should use implant anchorages. However, when the patient has poor hygiene and the bone of the implantation site is not sufficiently dense, we recommend a different approach for reinforcing the anchorage.

The high-quality studies analyzed in this research suggest that molar movement is reduced by implants and is superior to traditional anchoring techniques. Thus, if implantation conditions permit, it is recommended that implant anchorages be used.

5. Conclusion

Multiple systematic reviews and meta-analyses have been published on orthodontic implants; however, their qualities vary and only a single review is published in the Cochrane Library database. In this overview, we assessed the quality of such systematic reviews and found that most were of moderate quality. The number of high quality studies was small. Thus, clinicians should use caution when reviewing such studies. Additionally, the success rates reported between studies were highly variable. Notably, molar movement was reduced when orthodontic implants were used, compared with when traditional anchorages were used.

Author contributions

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