Content available at: https://www.ipinnovative.com/open-access-journals

Journal of Contemporary Orthodontics

Journal homepage: https://www.jco-ios.org/

Review Article

Failure rate of infra-zygomatic crest (IZC) bone screws in orthodontics: A Systematic review

Hemwati Nandan[1]*, Srinivas Gosla Reddy[1], Ashi Chug[2], Ashutosh Dixit[2], Pragjyoti Jha[1]

[1]*GSR Institute of Craniofacial Surgery, Karnataka, Hyderabad, India*
[2]*All India Institute of Medical Sciences Rishikesh, Uttarakhand, India*

ARTICLE INFO

Article history:
Received 29-10-2022
Accepted 28-02-2024
Available online 15-05-2024

Keywords:
Failure rate
IZC miniscrew
infrazygomatic crest
TAD
Anchorage devices
Systematic review

ABSTRACT

Objective: The aim of this review is to provide a precise estimation of infra-zygomatic crest (IZC) bone screw failure rate during orthodontic treatment.
Materials and Methods: Data were obtained using the Cochrane Central Register of Controlled Trails (central), PUBMED, EMBASE, google scholar, OVID, Wiley library till 1 January 2022. The titles and abstract of the electronic search were screened and evaluated by two observers according to the inclusion and exclusion criteria. This review was enrolled in PROSPERO (registration ID number CRD42020206610).
Search Method: There were 1725 records identified through electronic and 1 additional record identified through manual search. After 377 duplicate removal, 1349 studies were screened on the base of title and abstract the final sample included 9 studies that meet the primary inclusion criteria were selected. Each study was assessed using the evaluation method described in the Cochrane handbook for systematic reviews.
Result: All studier collectively included of the 1238 IZC miniscrews. Included studies ranged from 20 to 772 IZC miniscrews and the average number was approximate 137 IZC miniscrews per study. The diameter of inserted IZC miniscrews ranged from 1.2 to 2.3 mm and length ranged from 6 to 17 mm. The recorded failure rate ranged from 0% to 47.2%, and the average failure rate for IZC miniscrew was 9.45% (with 95% CI [58.91; 93.82]).
Conclusion: IZC miniscrew has low failure rate which suggest that IZC miniscrew are clinically reliable. Miniscrew are a stable anchorage for orthodontic tooth movement and zygomatic buttress of maxilla is suitable region for skeletal anchorage device placement.

1. Background

A crucial side of treatment in orthodontic is anchorage reinforcement. Orthodontic professionals are using different types of intraoral and extraoral anchorage systems from decades to achieve a better treatment outcome. Patient co-operation and compliance are the major problems associated with headgear appliances.[1,2] There is always a chance of self-injury while using a headgear appliance.[3] On the other side, transpalatal arches or lingual arches are non-compliance intra-oral appliances that overcome the co-operation problem associated with extra-oral devices, but they have limited effectiveness in anchorage reinforcement.[4–6]

Temporary anchorage devices (TADs) like miniscrews[7] or osseointegrated implants provide skeletal anchorage.[8,9]

* *Corresponding author*.
E-mail address: hemwatinandanbahuguna@gmail.com (H. Nandan).

https://doi.org/10.18231/j.jco.2024.019

Kanomi introduced Miniscrew anchorage in 1997[10] and these miniscrew become an important tool in the orthodontic profession for anchorage reinforcement, especially after the development of refined miniscrews.[7,10] Orthodontic miniscrews provide anchorage during orthodontic treatment like dental retraction, protraction, intrusion and extrusion of teeth.[11]

Skeletal anchorage devices have become more popular as a helping tool in modern orthodontic treatment which increases the efficiency, spectrum of the treatment and reduction of treatment time. There are different types of skeletal anchorage system like mini implants, mini screw, mini plate and infra-zygomatic crest (IZC) bone screw, which has different indication and efficiency. Among these IZC bone screw has become more popular nowadays in the past few years due to its versatility, efficiency and better three-dimension anchorage control, which provide better treatment outcome. Numerous scientific papers and case reports have been published, documenting the clinical feasibility of IZC bone screw. The literature exploring the failure rate of particularly IZC bone screws has not been evaluated systematically. The purpose of this systematic review was to determine average clinical failure rate of IZC bone screw used during orthodontic treatment.

2. Materials and Methods

This review had not received any kind of support or financial help from any organization or individual person. This systematic review was carried out according to guidelines described in PRISMA statement[12] and Cochrane Handbook of Systematic Reviews.[13] This review was enrolled in PROSPERO (registration ID number CRD420202066100).

The research question was structured and design in PICO form. (P) Participants/population: Patients receiving any orthodontic/orthopedic treatment with the incorporation of infra-zygomatic crest (IZC) bone screw type of skeletal anchorage system was included.

(I) Intervention: Any orthodontic or dentofacial orthopedic appliance which includes infra-zygomatic crest (IZC) bone screw type of Skeletal Anchorage System for anchorage reinforcement.

(C) Comparator/control: There was no comparator group planned/needed for the calculation of the average failure rate.

(O) Outcome: Outcome was the failure resulting in the premature loss of the Infra-zygomatic crest (IZC) bone screws for the predefined study period.

(S) Study design: Randomized controlled trials and cohort studies investigating the failure rate of infra-zygomatic crest (IZC) bone screw used for orthodontic anchorage reinforcement during orthodontic treatment were used in this study. We excluded studies on animals, in vitro study, or the other kinds of studies that are not in vivo clinical studies. In order to assess precisely the average failure rate, minimum 20 IZC bone screw per study was set as eligibility criteria.

A comprehensive search was designed with well-organized words and text for allocating eligible studies. Search terms were updated after the primary search to add all the related studies in this systematic review. Electronic searching was performed on the Cochrane Library, Embase, Google scholar, OVID, PubMed, Scopus, Willey library database till 1 January 2022.

Other bibliographic databases were searched for current and unpublished data including till 1 January 2022. Different leading orthodontic journals were hand searched for relevant studies (Supplementary file-1). References of selected studies and related systematic were explored for any other related study. However, these exclusion criteria were applied following the primary search so as to avoid bias in the search protocol. To avoid the complex procedure of translating different language studies in English, the step was initiated to include those studies which were available in English. Studies other then English were excluded after the first search to avoid search bias.

2.1. Study selection and data extraction

Rayyan QCRI software package was used for removing duplicate studies. Two reviewers (HN and SGR) went thr

ough the titles and abstracts and sorted eligible studies on the bases of inclusion criteria for full text read from primary search data (electronic and manual search data). Those suitable studies and abstracts do not contain sufficient data to allow decision-making. Data for such studies were retrieved and assessed by one reviewer (HN); all the data were again assessed and checked by a second reviewer (SGR). Data was collected in a predefined form, which was finalized and checked by two more reviewers (AC, AD) before searches completion. The variation between the two reviews were discussed and resolved after the opinion of the other two authors (AC and AD). Data were extracted by one author (HN), while a second author (SGR) read the full texts of the included studies again independently from the first one, checks the data extracted. Discrepancies were resolved in the same way as above. Any relevant information which was unclear in any study was evaluated from available data or obtained by contacting the authors.

3. Results

Study characteristics: There were 1725 records identified through electronic and one additional record identified through manual search. After deletion of 377 identical studies, title and abstract of 1349 studies were evaluated, among them 1276 studies were excluded. Total 73 qualifying studies were screened on the bases full-text. Among them 64 studies were excluded because they were the systematic review of other miniscrews, meta-analysis of

other miniscrew system, umbrella review, case report with sample size less than 20 IZC bone screw per study, review, failure rate is not specified, editor's summary and Q&A, other mini screw system, full text is not available and other zygomatic anchorage system (Figure 1). Total nine studies were included for final data calculation. Authors were contacted to collect missing data, in case of no response from the corresponding author study was conducted with available data. The full list of communications with corresponding authors is presented in Supplementary file-2. The main characteristics of 9 included studies (3 RCT, 2 PCS, 2 RCS 1 retrospective pilot study, and1 retrospective observation study) which collectively included of the 1238 IZC miniscrews are presented in (Table 1). Among these, 7 (77.8%) of studies were conducted in the university setting, one study took place in private and one in an unknown setting.

There was a significant difference in the number of IZC bone screws, manufactures, and length of the IZC miniscrew used in every study. Total number of used IZC miniscrew in included studies ranged from 20 to 772 IZC miniscrews and the average number was approximate 137 IZC miniscrews per study. The diameter of inserted IZC miniscrews ranged from 1.2 to 2.3 mm and length ranged from 6 to 17 mm. The recorded failure rate ranged from 0% to 47.2%, and the average failure rate for IZC miniscrew was 9.45% (with 95% CI [58.91; 93.82]).

Material, diameter, length, loading time are the factors with effect IZC bone screws failure. These risk factors were analyzed as subgroups (Figure 2 , Figure 2). Two studies reported failure rate of IZC miniscrew based on SS material as 6.5% (with 95% CI [3.4-9.9]) and two studies reported failure rate of Ti-IZC miniscrew as 10.7% (with 95% CI [7.2-14.2]). Four studies reported a failure rate of IZC miniscrews in female about 5.9% (with 95% CI [2.1-8.8]). Two studies reported the failure rate of IZC miniscrews in male about 5.8% (with 95% CI [2.4-9.1]). Four studies reported a failure rate of IZC miniscrews length ≥ 12 mm about 6.7% (with 95% CI [3.2-10.1]). Two studies reported a failure rate of IZC miniscrews length < 12 mm about 3.8% (with 95% CI [1.3-7.1]). Four studies reported the failure of IZC miniscrew according to diameter = 2mm about 6.7% (with 95% CI [3.6-9.4]). Three studies reported the failure of IZC miniscrew according to diameter < 2mm about 25.7% (with 95% CI [19.8-30.5]). Two studies reported failure rate for immediate loading of IZC miniscrew is 6.2% (with 95% CI [3.1-7.2]). Four studies reported failure rate for delayed loading of IZC miniscrew is 8.1% (with 95% CI [4.9-12.1]).

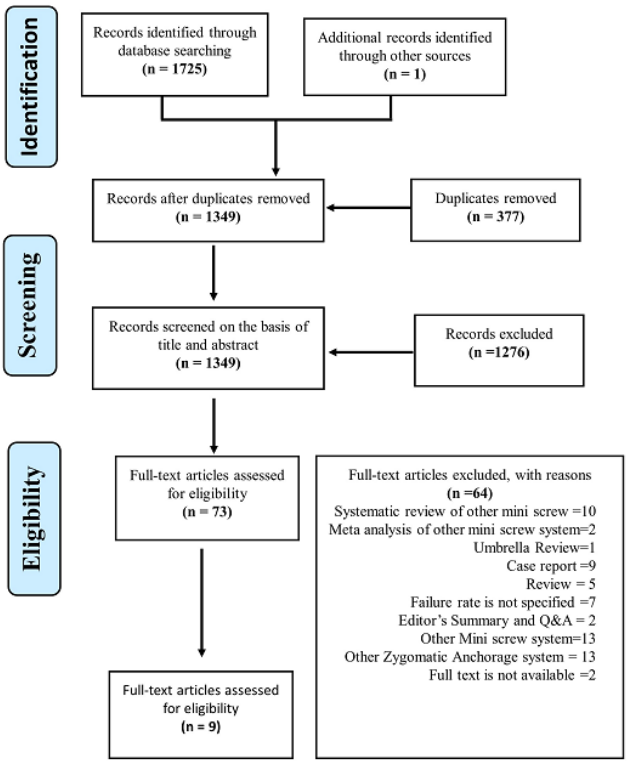

Figure 1: Flow chart of the selection of the studies.

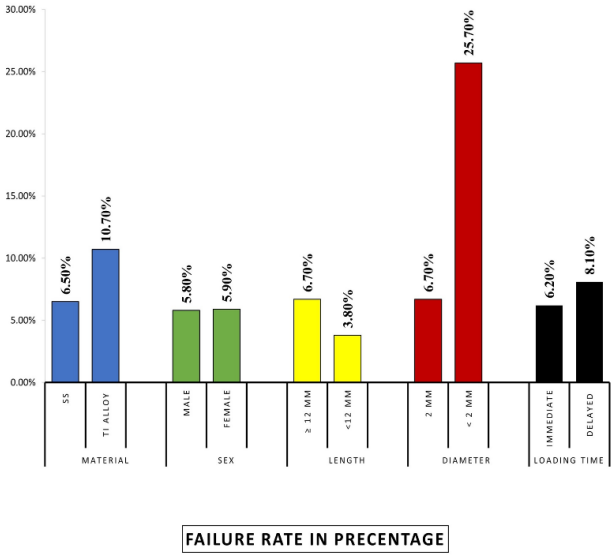

Figure 2: Average failure rate of IZC miniscrew, graph.

3.1. Quality assessment

Quality assessment criteria to evaluate the studies were decided by two reviewers (HN and SGR) authors in accordance with guidelines. The quality assessment of

Search strategies for electronic databases

Databases of published trials	Search strategy used
Cochrane Database of Systematic Reviews searched via The Cochrane Library (searched till 1 January 2022) www.thecochranelibrary.com	('infrazygomatic crest miniscrew' OR 'miniscrew'/exp OR miniscrew) AND ('failure'/exp OR failure OR successes) implant) OR (Infra-Zygomatic Crest micro implant)) OR (Infra-Zygomatic Crest Screws)) OR (Infra-Zygomatic Crest bone Screws)) OR (Infra-Zygomatic Crest min Screws)) OR (Infra-Zygomatic Crest mini bone Screw)) OR (Infra-Zygomatic Crest orthodontic Screw)) OR (Infra-Zygomatic Crest TAD)) OR (Infra-Zygomatic Crest temporary anchorage device)) OR (Zygomatic Crest mini implant)) OR (Zygomatic Crest micro
Embase (searched till 1 January 2022) https://www.embase.com/welcome.jsp#search	implant)) OR (Zygomatic Crest Screws)) OR (Zygomatic Crest bone Screws)) OR (Zygomatic Crest min Screws)) OR (Zygomatic Crest mini bone Screw)) OR (Zygomatic Crest
Ovid database (searched till 1 January 2022) http://ovidsp.ovid.com	orthodontic Screw)) OR (Zygomatic Crest TAD)) OR (Zygomatic Crest temporary anchorage device)) OR (Zygomatic Screws)) OR (Zygomatic bone Screws)) OR (IZC mini implant)) OR (IZC micro implant)) OR (IZC min Screws)) OR (IZC mini
MEDLINE searched via PubMed (searched till 1 January 2022) www.ncbi.nlm.nih.gov/sites/entrez/	bone Screw)) OR (IZC orthodontic Screw)) OR (IZC TAD)) OR (IZC temporary anchorage device)) OR (Zygomatic mini implant)) OR (Zygomatic micro implant)) OR (Zygomatic
Scopus (searched till 1 January 2022) www.scopus.com	Screws)) OR (Zygomatic bone Screws)) OR (Zygomatic min Screws)) OR (Zygomatic mini bone Screw)) OR (Zygomatic orthodontic Screw)) OR (Zygomatic TAD)) OR (Zygomatic temporary anchorage device)
Willey library (searched till 1 January 2022) https://onlinelibrary.wiley.com/	
Google scholar (searched till 1 January 2022) https://scholar.google.com/	orthodontic + mini-implants +mini screw+ izc OR infra-zygomatic crest implant OR infra-zygomatic crest bone screw

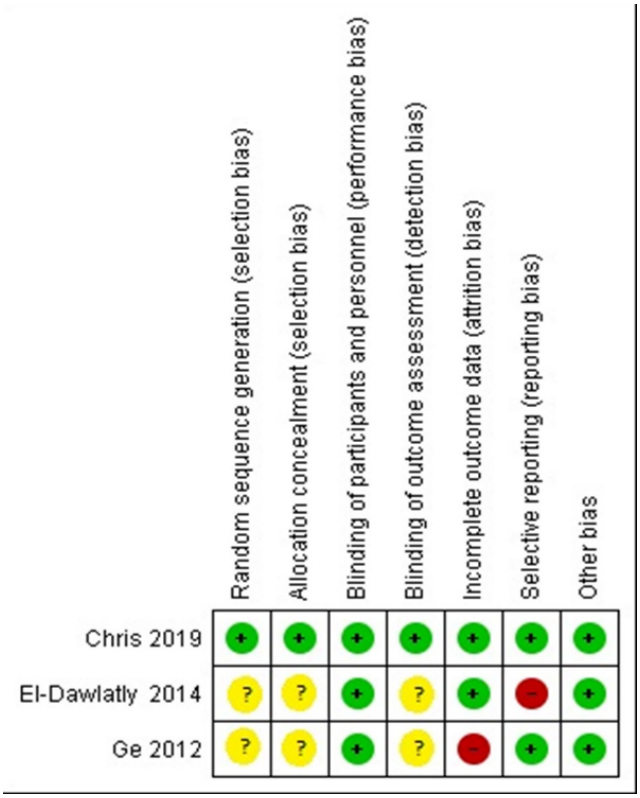

Figure 3: Risk of bias summary for RCT, high risk of bias (red), low risk of bias (green), and unclear risk of bias (Yellow).

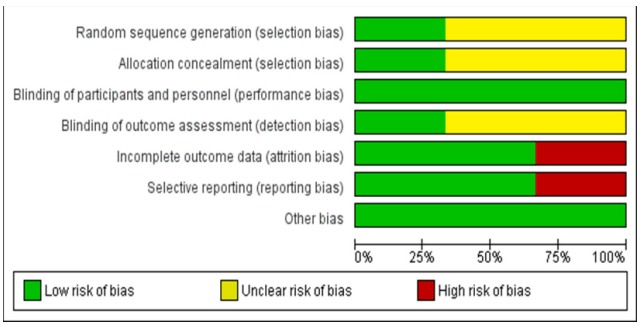

Figure 4: Risk bias graph.

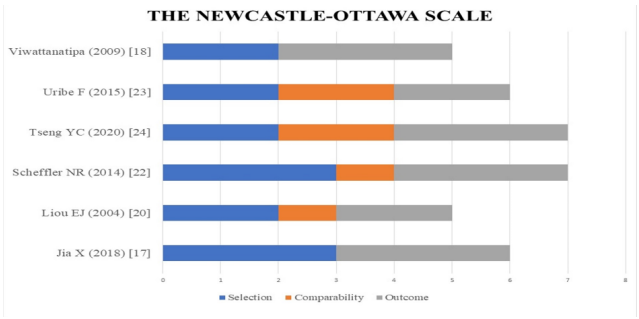

Figure 5: The Newcastle-Ottawa scale for the assessment of the quality of the non-randomized studies.

List of journals and additional bibliographic database

Journals searched manually from1 January 2015 to 1 January 2022:

1. 1) American Journal of Orthodontics and Dentofacial Orthopedics
1. 2) Angle Orthodontist.
1. 3) British Journal of Orthodontics
1. 4) European Journal of Orthodontics
1. 5) Progress in Orthodontics
1. 6) Seminars in Orthodontics

Bibliographic databases manually from1 January 2015 to 1 January 2022:

1. 1) Dissertation data (www.theses.com)
1. 2) Grey Literature in Europe (www.opengrey.eu)
1. 3) Clinical Trial Registry (www.ClinicalTrials.gov)
1. 4) ISRCTN registry (https://www.isrctn.com)
1. 5) Dissertation and Theses Dissemination (http://www.proquest.com)
1. 6) Grey literature (www.opengrey.eu).

selected studies was done according to guidelines described in the Cochrane Handbook for Systematic Reviews. Nine of the included studies were 3 RCTs, 2 PCS, 2 RCS, one retrospective pilot study and one retrospective observational study. Two reviewers independently assessed the quality of included nine studies. The 3 RCT were: Chris H (2019),[15] El-Dawlatly MM (2014)[18], Ge YS (2012).[20], assessed using Cochrane tool for Risk of Bias (RoB version 5.1/5.2) in which six domains were assessed namely random sequence generations (selection bias), allocation concealment selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment(detection bias), incomplete outcome data (attrition bias) and selective reporting (reporting bias). These were all assessed as at overall moderate risk of bias[23] (Figure-3, Figure-4). The remaining studies were retrospective and prospective cohorts studies assessed using the Newcastle Ottawa Scale[24] and were classified as 'fair' (Figure-5, Supplementary file-3).

4. Discussion

Nowadays, miniscrew has become part of routine orthodontic practice. As we know the different types of skeletal anchorage system which includes mini implants, mini screw, mini plate, infra-zygomatic crest (IZC) bone screw having different indication and efficiency. Among these IZC miniscrew is the most versatile type of screw with better treatment outcome. This systematic review included nine studies in which IZC miniscrew is used for orthodontic anchorage. This systematic review estimated the IZC miniscrew failure rate to be 9.45% (with 95% CI [58.91; 93.82]) which is less than (16.7%) the previous reported systematic review and meta-analysis.[25] The reported failure rate of IZC miniscrew in this study is approximately equal to the failure rate of orthodontic

List of communications

No	Study	Reason of Inquiry	person	Inquiry date	Status
1.	El-Dawlatly MM, Abou-El-Ezz AM, El-Sharaby FA, Mostafa YA. Zygomatic mini-implant for Class II correction in growing patients. J Orofac Orthop. 2014;75(3):213-225. doi:10.1007/s00056-014-0214-z	To know about randomisation process.	Dr. Yehya Ahmed Mostafa,	09-09-2020	Response pending
2.	Ge YS, Liu J, Chen L, Han JL, Guo X. Dentofacial effects of two facemask therapies for maxillary protraction. Angle Orthod. 2012;82(6):1083-1091. doi:10.2319/012912-76.1	To know about randomisation process.	Dr Yuan Shu Ge	09-09-2020	Response pending
3.	Jia X, Chen X, Huang X. Influence of orthodontic mini-implant penetration of the maxillary sinus in the infrazygomatic crest region. Am J Orthod Dentofacial Orthop. 2018;153(5):656-661. doi:10.1016/j.ajodo.2017.08.021	To know about the failure rate of IZC miniscrew with different length	Dr. Xiaofeng Huang	09-09-2020	Response pending
4.	Liou EJ, Pai BC, Lin JC. Do miniscrews remain stationary under orthodontic forces?. Am J Orthod Dentofacial Orthop. 2004;126(1):42-47. doi:10.1016/j.ajodo.2003.06.018	To know about the of IZC miniscrew material and placement hight [movable mucous or attached gingiva]	Dr Eric J. W. Liou	09-09-2020	Response pending
5.	Scheffler NR, Proffit WR, Phillips C. Outcomes and stability in patients with anterior open bite and long anterior face height treated with temporary anchorage devices and a maxillary intrusion splint. Am J Orthod Dentofacial Orthop. 2014;146(5):594-602. doi:10.1016/j.ajodo.2014.07.020	To know about the of IZC miniscrew material, placement hight [movable mucous or attached gingiva], and other risk factors.	Dr. Nicole R. Scheffler	09-09-2020	Response pending
6.	Tseng YC, Tsai CC, Cheng JH, et al. Recognizing the peak bone mass (age 30) as a cutoff point to achieve the success of orthodontic implants. Odontology. 2020;108(3):503-510. doi:10.1007/s10266-019-00476-w	To know about the failure rate of IZC miniscrew with different length and associated risk factors.	Dr. Chun-Ming Chen	09-09-2020	Response pending
7	Uribe F, Mehr R, Mathur A, Janakiraman N, Allareddy V. Failure rates of mini-implants placed in the infrazygomatic region. Prog Orthod. 2015;16:31. doi:10.1186/s40510-015-0100-2	To know about the failure rate of IZC miniscrew with different diameter and length	Dr. Flavio Uribe	10-9-2020	Response pending

Risk of bias and study quality assessment using the newcastle-ottawa scale (NOS)

	Selection				Comparability		Outcome		NOS score	Overall assessment
Study	Representativeness of exposed cohort	Selection of nonexposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at the start of the study	Comparability of the cohorts	Assessment of outcome	Was follow-up long enough?	Adequacy of follow-up		
Jia X (2018)[19]	1	0	1	1	0	1	1	1	6	Fair
Liou EJ (2004)[22]	1	0	1	0	1	0	1	1	5	Fair
Scheffler NR (2014)[24]	1	0	1	1	1	1	1	1	7	Good
Tseng YC (2020)[26]	1	0	1	0	2	1	1	1	7	Good
Uribe F (2015)[25]	1	0	1	0	2	1	1	0	6	Fair
Viwattanatipa(2009)[20]		0	1	0	0	1	1	1	5	Fair

miniscrews placed in the inter radicular area between the maxillary first molar and second premolar with an overall 9.2% failure rate and the orthodontic miniscrews inserted between the maxillary lateral incisor and canine an overall 9.7% failure rate reported in previous reported systematic review and meta-analysis.[25]

Three studies mention about the material used in the study among them one study compares stainless steel (SS) IZC with Titanium (Ti) Alloy IZC, one use only SS IZC and one use only Ti Alloy IZC. Average failure rate for SS IZC is 6.5%(with 95% CI [3.4-9.8])[15,16] and Average failure rate of Ti alloy is 10.7% (with 95% CI [7.2-14.2]).[15,21] Chang CH et al. (2019)[15] reported 5.7% failure rate for 2mm diameter Ti Alloy IZC, failure rate for Ti Alloy is high in this systematic review because Viwattanatipa N et al. (2009)[21] reported 47.2% of failure rate for (1.2mm) Ti Alloy screw in IZC region.

Six studies[15,16,18–22] mentioned clearly about the failure rate according to the length of the screw. The failure rate of IZC screw length ≥12 mm is 6.7% (with 95% CI [3.2-10.1])[15,16,20–22] and failure rate of IZC screw length <12 mm is 3.8% (with 95% CI [1.3-7.1]).[18,19] It may be due to the very less sample size in <12mm length group which is 17 times less than the comparing group.

In four studies IZC screw of 2mm diameter is used, the average failure rate for 2mm diameter IZC screw is 6.7%(with 95% CI [1.3-7.1]).[15,16,20–22] In three studies[18–22] diameter of the IZC screw is <2mm, average failure rate for these studies is 25.7%(with 95% CI [19.8-30.5]). Large diameter screw shows less failure rate because the screw surface area is more which provide better retention as well as anchorage.

In this systematic review, we find no significant correlation between the failure of IZC screw and sex. Average failure rate for male is 5.8% (with 95% CI [2.4-9.1])[15,16] and for females it is 5.9% (with 95% CI [2.1-8.8]).[15,16,18,20–22]

Average failure rate of delayed loading is 8.1% (with 95% CI [4.9-12.1]).[16,18,20–22] which is slightly higher than the immediate loading IZC screw failure rate 6.2% (with 95% CI [3.1-7.2]).[15,16,18–22] Self-drilling screw are loaded most of the time immediately. For Self-tapping screw mucoperiosteal flap is elevated. A guiding path is made with pilot drill followed by placement of the screw. IZC screws loaded after healing is completed. If oral hygiene is not maintained properly, inflammation of surgery site may occur, which may be the cause of a higher failure rate in delayed loaded screws.

Chang CH et al. (2019)[15] assessed the failure rate based on the soft tissue at the site (i.e. attached gingiva [AG] and movable mucosa [MM]). Failure rate for AG is 6.2% and for MM is 6.5%. Tseng YC et al. (2020)[14] reported failure rate of IZC implants was significantly low in the patients having age below 30 years 7.7%, then in the patients having age more than 30 years 26.1%. There is a controversy about the relation of age with failure. Some authors have reported a low success rate of miniscrew for young individuals.[26,27] on another side, some authors[28–30] says age has no relation

Table 1: Characteristics of included studies

SN.	Author	Study design	Setting	Manufacturer	IZC type	Angle of Placement	loading	Length in (mm)	Diameter in (mm)	Total mini screw place	Failed	Failure Rate%	95%-CI
1	Tseng YC(2020)[14]	RCS	University	-	Self-drilling	-	-	8/9/10/11/12	1.2/1.5/2	166	17	10.20%	132.68-199.32
2	Chris H(2019)[15]	RCT	University	Newton's A Ltd, Hsinchu City, Taiwan)	Self-drilling	60^0-70^0	Immediately loaded	12	2	772	49	6.30%	675.96-868.04
3	Jia X(2018)[16]	RCS	University	A1, Penghua,Taiwan	Self-drilling	-	loaded after 1 months	12 to 17	2	60	2	3.30%	56.08-63.92
4	Uribe F(2015)[17]	RPS	University	Lomas (Mondeal Tuttligen, Germany), Imtec (Unitek 3M, Monrovia, California), Aarhus (Medicon, Tuttligen, Germany), Dual Top (RMO,Denver, Colorado)	Self-drilling (n=33)Self-tapping (n=22)	40^0-70^0	Immediately loaded	6to8/9	1.5 or1.8/2 or2.3	55	12	21.80%	31.48-78.52
5	El-Dawlatly MM(2014)[18]	RCT	University	OsteoCare™ Implant System, London, UK	Self-tapping	55^0-70^0	loaded after 3 months	9	1.8	20	1	5%	18.04-21.96
6	Scheffler NR(2014)[19]	ROS	private orthodonticpractice	Ormco, Orange, Calif)	-	-	Immediately loaded	8	1.4	32	1	3.10%	30.04-33.96
7	Ge YS(2012)[20]	RCT	University	ShenGang, ZhangHua, Taiwan	Self-tapping	55^0-70^0	loaded after 2 weeks	14	2	48	10	2%	28.40-67.60
8	Viwattanatipa (2009)[21]	PCS	University	Osteomed, Dallas, Tex				8/10 or 12	1.2	53	25	47%	4.00-102.00
9	Liou EJ(2004)[22]	PCS	NA	Leibinger, Freiburg, Germany	Self-tapping	-	loaded after 2 weeks	17	2	32	0	0%	Not reported

Table 2: Factor effecting the failure rate of IZC screw

Risk Factor		Number of studies included	Total No	failed	% of failed	95%of CI
Failure rate of IZC screw based on Material	Failure Rate SS	2	446	29	6.50%	3.4-9.8
	Failure Rate Ti	2	439	47	10.70%	7.2-14.2
Failure rate of IZC screw based on Sex	Male	2	172	10	5.80%	2.4-9.1
	Female	4	712	42	5.90%	2.1-8.8
Failure rate of IZC screw based on length	≥ 12 mm	4	912	61	6.70%	3.2-10.1
	<12 mm	2	52	2	3.80%	1.3-7.1
Failure rate of IZC screw based on diameter	2 mm	4	912	61	6.70%	3.6-9.4
	< 2 mm	3	105	27	25.7%	19.8-30.5
Failure rate of IZC screw based on loading time	Immediately loading	2	804	50	6.20%	3.1-7.2
	Delayed loading	4	160	13	8.10%	4.9-12.1

with failer of the mini implant. Jia X et al.[16] reported that 7.8% of IZC miniscrews were penetrated into the maxillary sinus. The incidence of inter radicular screws 9.8% was much lower than the sinus perforation rate of IZC miniscrews.[31] Jia X et al.[16] report 3.3% failure rate for IZC, which is much low failure rate. The high success rate of IZC mini-implant in this study may be due to the larger length and double cortical plates penetration of the miniscrews.

5. Conclusion

Miniscrews are a stable anchorage for orthodontic tooth movement, and zygomatic buttress of the maxilla is a suitable region for skeletal anchorage device placement. The failure rate of IZC miniscrew was low (9.5%), which suggests that IZC miniscrew are clinically reliable. Better anchorage provides by Penetrating of IZC miniscrews through double cortical bone.

5.1. Data availability

The data underlying this article are available as supplementary material.

1. **Supplementary file-1:** Search strategies for electronic databases, list of manual searched Databases.
2. **Supplementary file-2:** List of communications with corresponding authors.
3. **Supplementary file-3:** Risk of Bias and Study Quality Assessment using the Newcastle-Ottawa Scale (NOS).
4. **Supplementary file-4:** PRISMA Checklist.

6. Abbreviations

AG: Attached gingiva; CI: Confidence interval; IZC: Infra zygomatic crest; MM: Movable gingiva; PCS: Prospective cohort study; RCS: Retrospective cohort study, RCT: Randomized clinical trial; SS: Stainless Steel; Ti: titanium.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Nanda RS, Kierl MJ. Prediction of cooperation in orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 1992;102(1):15–21.
2. Sandler J, Murray A, Thiruvenkatachari B, Gutierrez R, Speight P, 'brien O, et al. Effectiveness of 3 methods of anchorage reinforcement for maximum anchorage in adolescents: A 3-arm multicenter randomized clinical trial. *Am J Orthod Dentofacial Orthop*. 2014;146(1):10–20.
3. Samuels RH, Brezniak N. Orthodontic facebows: safety issues and current management. *J Orthod*. 2002;29(2):101–107.
4. Diar-Bakirly S, Feres MF, Saltaji H, Flores-Mir C, El-Bialy T. Effectiveness of the transpalatal arch in controlling orthodontic anchorage in maxillary premolar extraction cases: A systematic review and meta-analysis. *Angle Orthod*. 2017;87(1):147–158.
5. Stivaros N, Lowe C, Dandy N, Doherty B, Mandall NA. A randomized clinical trial to compare the Goshgarian and Nance palatal arch. *Eur J Orthod*. 2010;32(2):171–176.
6. Rebellato J, Lindauer SJ, Rubenstein LK, Isaacson RJ, Davidovitch M, Vroom K. Lower arch perimeter preservation using the lingual arch. *Am J Orthod Dentofacial Orthop*. 1997;112(4):449–456.
7. Costa A, Raffainl M, Melsen B. Miniscrews as orthodontic anchorage: a preliminary report. *Int J Adult Orthodon Orthognath Surg*. 1998;13(3):201–209.
8. Melsen B, Costa A. Immediate loading of implants used for orthodontic anchorage. *Clin Orthod Res*. 2000;3(1):23–28.
9. Roberts WE, Nelson CL, Goodacre CJ. Rigid implant anchorage to close a mandibular first molar extraction site. *J Clin Orthod*. 1994;28(12):693–704.
10. Kanomi R. Mini-implant for orthodontic anchorage. *J Clin Orthod*. 1997;31(11):763–767.
11. Park HS. The skeletal cortical anchorage using titanium microscrew implants. *Korean J Orthod*. 1999;29:699–706.
12. Moher D, Liberati A, Tetzlaff J, Altman DP, Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339.
13. Higgins JP, Green S. John Wiley & Sons. 2011.
14. Tseng YC, Tsai CC, Cheng JH. Recognizing the peak bone mass (age 30) as a cutoff point to achieve the success of orthodontic implants. *Odontology*. 2020;108(3):503–510.
15. Chang CH, Lin JS, Roberts WE. Failure rates for stainless steel versus titanium alloy infrazygomatic crest bone screws: A single-center, randomized double-blind clinical trial. *Angle Orthod*. 2019;89(1):40–46.
16. Jia X, Chen X, Huang X. Influence of orthodontic mini-implant penetration of the maxillary sinus in the infrazygomatic crest region. *Am J Orthod Dentofacial Orthop*. 2018;153(5):656–661.
17. Uribe F, Mehr R, Mathur A, Janakiraman N, Allareddy V. Failure rates of mini-implants placed in the infrazygomatic region. *Prog Orthod*. 2015;16:31–31.
18. El-Dawlatly MM, Abou-El-Ezz AM, El-Sharaby FA, Mostafa YA. Zygomatic mini-implant for Class II correction in growing patients. *J Orofac Orthop*. 2014;75(3):213–225.
19. Scheffler NR, Proffit WR, Phillips C. Outcomes and stability in patients with anterior open bite and long anterior face height treated with temporary anchorage devices and a maxillary intrusion splint. *Am J Orthod Dentofacial Orthop*. 2014;146(5):594–602.
20. Ge YS, Liu J, Chen L, Han JL, Guo X. Dentofacial effects of two facemask therapies for maxillary protraction. *Angle Orthod*. 2012;82(6):1083–1091.
21. Viwattanatipa N, Thanakitcharu S, Uttraravichien A, Pitiphat W. Survival analyses of surgical miniscrews as orthodontic anchorage. *Am J Orthod Dentofacial Orthop*. 2009;136(1):29–36.
22. Liou EJ, Pai BC, Lin JC. Do miniscrews remain stationary under orthodontic forces? *Am J Orthod Dentofacial Orthop*. 2004;126(1):42–47.
23. Higgins JP, Altman DG, Gøtzsche PC. The Cochrane Collaboration's tool for assessing risk of bias in randomized trials. *BMJ*. 2011;343.
24. Wells GA, Shea B, O'connell D, Peterson J, Welch V, Losos M, et al. 2000.
25. Mohammed H, Wafaie K, Rizk MZ, Almuzian M, Sosly R, Bearn DR. Role of anatomical sites and correlated risk factors on the survival of orthodontic miniscrew implants: a systematic review and meta-analysis. *Prog Orthod*. 2018;19(1):36–36.
26. Lee SJ, Ahn SJ, Lee JW, Kim SH, Kim TW. Survival analysis of orthodontic mini-implants. *Am J Orthod Dentofacial Orthop*. 2010;137(2):194–199.
27. Chen YJ, Chang HH, Huang CY, Hung HC, Lai EH, Yao CC. A retrospective analysis of the failure rate of three different orthodontic skeletal anchorage systems. *Clin Oral Implants Res*. 2007;18(6):768–775.

28. Antoszewska J, Papadopoulos MA, Park HS, Ludwig B. Five-year experience with orthodontic miniscrew implants: a retrospective investigation of factors influencing success rates. *Am J Orthod Dentofacial Orthop*. 2009;136(2):158–159.
29. Kuroda S, Sugawara Y, Deguchi T, Kyung HM, Takano-Yamamoto T. Clinical use of miniscrew implants as orthodontic anchorage: success rates and postoperative discomfort. *Am J Orthod Dentofacial Orthop*. 2007;131(1):9–15.
30. Wu TY, Kuang SH, Wu CH. Factors associated with the stability of mini-implants for orthodontic anchorage: a study of 414 samples in Taiwan. *J Oral Maxillofac Surg*. 2009;67(8):1595–1599.
31. Motoyoshi M, Sanuki-Suzuki R, Uchida Y, Saiki A, Shimizu N. Maxillary sinus perforation by orthodontic anchor screws. *J Oral Sci*. 2015;57(2):95–100.

Author biography

Hemwati Nandan, Consultant https://orcid.org/0000-0003-1874-6321

Srinivas Gosla Reddy, Director

Ashi Chug, Additional Professor

Ashutosh Dixit, Associate Professor

Pragjyoti Jha, General Dentist

Cite this article: Nandan H, Reddy SG, Chug A, Dixit A, Jha P. Failure rate of infra-zygomatic crest (IZC) bone screws in orthodontics: A Systematic review. *J Contemp Orthod* 2024;8(2):114-124.