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Review article

Osseo-densification for preservation and compaction of alveolar bone in enhancing stability of dental implants: A systematic review

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ABSTRACT

A higher implant failure rate may be associated with a lack of primary stability. Primary stability is a stationary, entirely mechanical parameter that determines when an implant is placed. Several methods have been developed to improve the primary implant's level of stability. However, Osseo-densification (OD) is a revolutionary implant preparation approach that addresses these issues and enhances the main stability of implants inserted into low-density bones. In light of this, the present systematic review was conducted to understand the Osseo-densification for preservation and compaction of alveolar bone in enhancing the stability of the dental implant. Research papers from PubMed, CINAHL, Web of Science, and Web of Science, Medline searched. The most recent literature suggests that using the Osseo-densification drilling protocol increases the overall value of implant insertion torque and, consequently, increases the primary stability of implants. To evaluate the caliber of the contained research, CARE, ARRIVE, and modified CONSORT checklists were employed. 133 full texts were chosen for further investigation after duplicates were removed and titles and abstracts were reviewed of these, 27 entire texts met the inclusion criteria. The thorough literature search identified 6 Case Studies & Case Series, 11 in vivo animal studies, and ten /experimental animal studies that noted the use of the Osseo-densification technique. The data from most recent animal in vivo/in vitro studies and case reports / case series suggest that Osseo-densification drilling protocol increases the overall value of implant insertion torque and, as a result, increases implant primary stability.

Keywords: Implant stability, low-density bone, Osteotomy, Osseo- densification, Primary Stability, Bone compaction.

INTRODUCTION

At present, Osseo integration is thought of as needing to have primary implant stability as a prerequisite [1]. Lack of primary stability may be linked to a higher implant failure rate. This is due to an implant may not achieve successful Osseo integration if primary stability is lacking [1, 3]. The quantity, quality, and design of the accessible bone as well as the macro- and micro-design of the implant all affect the primary stability of dental implants. [4] Primary stability is a stationary, mechanical parameter that determines when an implant is placed and is connected to resistance or friction when inserted into the bone[1,5,6] In addition, it is contingent upon surgical factors, implant design, and patient aspects of bone quality and quantity[3,7]. Several methods have been developed to improve the primary implant's level of stability. These methods include implant design (macro-geometry) and surface modifications (microgeometry), improved insertion torque, the use of a larger implant in an inadequately sized osteotomy, osteotome procedures, the extension of the lateral ridge using expanders of a certain type, and the bone spreader technique Despite the fact that many authors have suggested the concept of measuring primary stability over the years, the two biomechanical parameters currently the most widely accepted and utilized for this purpose are implant Resonance Frequency Analysis (RFA)and insertion torque (IT) measurements[1,6,8]. The most significant difference between these values is that the insertion torque for an implant can only be measured when it is being inserted. There can be no long-term tracking of stability or monitoring of its progress [1]. Recent developments have resulted in the developing of a novel osteotomy approach, as outlined by Huwais and Meyer [8], osseous densification and bone compaction (Osseo densification, OD) that does not involve the removal of the bony matrix; rather, it makes use of the bone's viscoelastic and plastic properties in order to deform under the influence of stress (force) and generate a time-dependent strain (deformation) [8,9]. Osseo-densification (OD) likewise improves the primary stability of implants placed in low-density bones by compensating for the drawbacks of the methods as mentioned earlier [8, 10]. When using OD burs, which are non-subtractive, the soft bone around the implant is compressed laterally, which improves stability and encourages over compression [1,4]. The system consists of multiple drills, each of which can operate in either a clockwise or counterclockwise direction, depending on whether it is used for cutting or Osseo densification [7]. Bone can be preserved by auto grafting bone fragments against the bed walls using a cone-shaped drill with four or more cutting grooves at negative angles. Plasticity and bone expansion are made easier by pumping saline solution. These burs with the speed and tactile control during Osteotomy, making it possible to exercise control over the process of bone densification [7,8,11].

Evidence of the technique's actual clinical efficacy and accuracy is provided through systematic reviews. Considering this, the present systematic review is conducted with an aim to understand the Osseo-densification for preservation and compaction of alveolar bone in enhancing dental implant stability by synthesizing the data from several researches.

MATERIALS AND METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISM) [12] standards are followed for conducting this review. It is registered in the Prospero database (International Prospective Registry of Systematic Evaluation - CRD42021286901). No institutional review board permission was required because of the nature of the current investigation. To find relevant articles, the following keywords were chosen and entered in various combinations with the Boolean operators AND and OR: Osseo integration, implant stability, and implant primary. Bone density, Osseo densification, Densah, insertion torque, and Bone compaction.

Focused PICO question

PICO question was developed to identify the relevant studies to answer: "Does the Osseo-densification procedure for Osteotomy can improve the Primary stability of dental implant by preserving and densifying alveolar bone? 1-Population: Patients/Subjects indicated for Dental implants; 2-Intervention: Osseo-densification procedure for Osteotomy, implant primary stability, implant osteotomy, Bone density, implant surgery, implant placement, bone preservation; Comparison: Conventional Osteotomy; 4-Outcome: Primary stability of dental implant by preservation and densification of alveolar bone.

Search strategy

All research papers outlining the PICO questions were searched for in PubMed, Web of Science, Medline, CINHAL, databases until December 2022. All the pertinent papers were found using the search method. Additionally, all pertinent articles' reference lists were hand-searched as well. In order to find additional related studies, a manual search was carried out on the hosting publishers (Wiley, Science Direct, and Springer) and separately on the renowned implant journals.

Eligibility criteria

Studies must satisfy the subsequent inclusion standards in order to be considered for the systematic review: Articles reported in the English language up to December 2022, studies reported on Osseo-densification in implant stability and bone density (in-vivo animal studies, in-vitro experimental studies, and retrospective studies, clinical case series and case reports). Included in the

exclusion criteria were: Studies that utilized other techniques to increase implant bone stability in addition to a review of the relevant literature, editorial papers, and magazine articles there were no constraints placed on the date of publication in any way

Study selection

Two investigators autonomously reviewed the research title, abstract, and keywords of the pertinent publications (AS and SS) to determine their eligibility using Rayyan systematic review software. Then, all possibly eligible papers' full texts were retrieved and carefully reviewed to find research that matched all inclusion requirements. A list of the articles to be included in this evaluation was established after any disagreements were discussed with the third reviewer (KK).

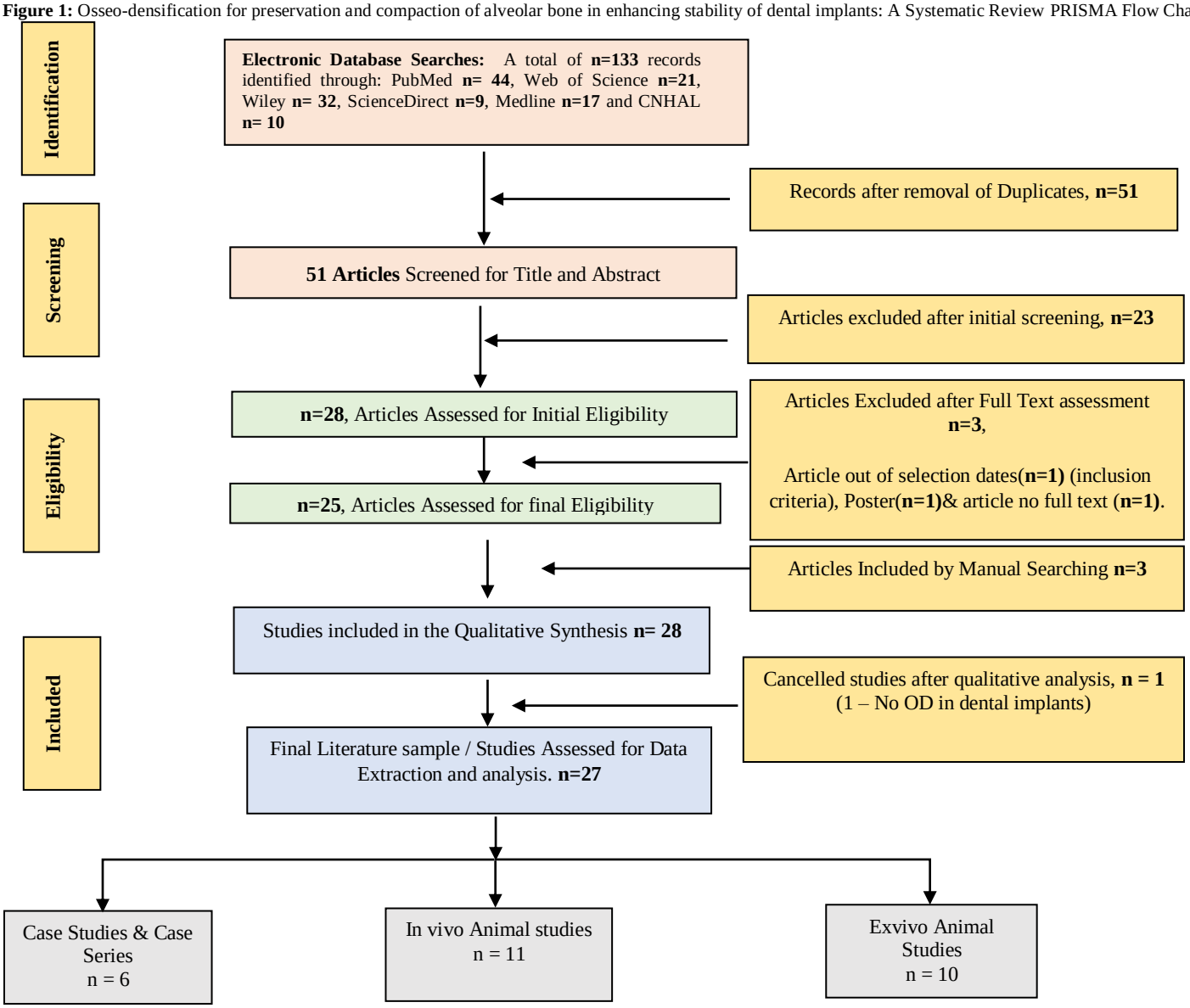
Data extraction

Titles and abstracts of the chosen studies will be independently evaluated by three authors who will screen the titles and select the abstracts for full-text inclusion. In case of any disagreement between the two review authors (AS, MO), it was resolved by two senior authors (KK, SS). Following the inclusion and exclusion criteria, all relevant full-text articles were retrieved using the Mesh terms. The data extracted included: Study ID, Author, Year of publication, Study Design, details of the intervention and comparison conditions, study methodology, result and measurement times, Implant stability value, outcomes, and statistics (Tables 5 & 6).

Risk of bias

Randomized clinical trials and prospective research are scarcely available. As a result, we shall evaluate the following domains wherever possible:1. The creation of random sequences (selection bias); 2. The blinding of participants and staff (performance bias); 3. Incomplete outcome data (attrition bias); 4. Selective outcome reporting (reporting bias); This provided the rationale for our judgment of that domain as at low, high, or unclear risk of bias, which the two main authors did (AS and MO) independently, and the third author (KK) was consulted when there was a discrepancy in judgment.

Figure 1: Osseo-densification for preservation and compaction of alveolar bone in enhancing stability of dental implants: A Systematic Review PRISMA Flow Chart



Data analysis

Data extraction revealed significant heterogeneity among the included papers, preventing the execution of a meta-analysis. Instead, information was gathered into a table to create a descriptive summary detailing the study's characteristics and results.

Quality assessment

The CARE, ARRIVE, and modified CONSORT checklist was used for all included studies to measure the quality of the involved studies in this review. Following the execution of the checklist, the minimum and maximum as well as the average compliance of all the articles were reported. If the article author followed the checklist points for each guideline, they were marked as "Y" and "N," respectively. Things that are inappropriate were indicated with the letter “NA” (Not Applicable). The compliance percentage for each metric was calculated after subtracting "NA" from the total.

Results

The total hits from the original search were 133 (PubMed:44, CINAHL: 10 and Web of Science:21, Wiley: 32, Science Direct: 9, Medline:17). Following the elimination of duplicates and screening of titles and abstracts, 51 full texts (n = 51) were chosen for further review. Of these, 27 entire texts met the inclusion criteria. An overview of the search procedure is shown in Fig. 1(PRISMA Flow Chart). A thorough literature search per inclusion criteria identified 6 Case Studies & Case Series, 11 in vivo animal studies, and 10 *Exvivo / in vitro* animal studies that noted the use of the Osseo-densification technique and were published between 2014 to December 2022.

Quality of included studies

Tables 1, 2, and 3 show the detailed results of CARE, ARRIVE, and Modified CONSORT evidence quality evaluations. Overall mean compliance of case reports was 61%, with a maximum score of 83% [16] and a minimum score of 54% [17]. No case report reported the adverse and unanticipated events during the study. None of the studies reported the patient's perspective on their treatment(s). According to ARRIVE guideline of animal in-vivo studies, mean compliance was 66%, with the highest score of 91% reported by Mello-Machado RC et al [25].and the lowest of 60% by Bradley Lahens et al [21]. Lastly, the modified CONSORT guidelines for animal *Ex-vivo* /experimental for *in-vitro* studies was used to analyze the quality of the study. The overall mean compliance was 59%, with a maximum score of 67% [1,44,45] and a minimum score of 47% [4,41].

Table 1: Checklist: CARE Guidelines for Case Reports and Case Series

A. Title Of the Article	B. Author name C. Year of publication	Title	Key Words	Abstract (no references)				Introduction	Patient Information				Clinical Findings	Timeline	Diagnostic Assessment				Therapeutic Intervention			Follow-up and Outcomes				Discussion				Patient Perspective	Informed Consent	
		1	2	3				4	5				6	7	8				9			10				11				12	13	%
		1	2	a	b	c	d	4	a	b	c	d			a	b	c	d	a	b	c	a	b	c	d	a	b	c	d			
1. To Drill or to Densify? Clinical Indications for the Use of Osseo densification.	Pikos MAet.al[12]. 2019	N	N	Y	NA	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	Y	NA	Y	Y	Y	N	N	Y	N	Y	N	Y	Y	N	N	60%
2. Use of the Immediate Dentoalveolar Restoration Technique Combined with Osseo densification in Periodontally Compromised Extraction Sites.	da Rosa et al[14] 2019	N	N	Y	NA	Y	Y	Y	N	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	N	N	63%
3. The Modified Osseo-densification Visco-Elastic	Puterman I et al[13] 2021	N	N	Y	NA	Y	Y	Y	N	Y	N	N	Y	N	Y	N	Y	NA	Y	Y	Y	N	N	N	N	Y	N	Y	Y	N	N	57%

(MOVE) Sinus Protocol: A Case Series to Illustrate the Combination of Osseo-densification with Viscoelastic Bone Replacement Material.																																
4.Osseodensification—A novel approach in implant dentistry in Seibert Class 1 ridge deficiency: A case report	RathiM et.al[15] 2022	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y	83%
5. Trans-crestal sinus lift with simultaneous implant placement using Osseodensification in posterior maxilla with residual bone height of 4-6 mm.	Elsaid et al[16].2022	N	Y	N	Y	Y	Y	Y	N	Y	N	N	Y	N	N	N	N	N	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	N	Y	54%
6. Socket-shield technique with minimally invasive osteotomy preparation as well as simultaneous sinus lift utilizing Densah Bur, and platelet-rich fibrin membrane followed by immediate implant placement in a symptomatic posterior endodontically treated decayed root stumps site: A case report with 1-year follow-up.	Deshwal R et.al[17] 2022	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	Y	N	Y	74%

Table 2: Checklist: ARRIVE Guidelines for Animal in Vivo Studies

TITLE OF ARTICLE& Study Type	Author name&Year of Publication	Study Design		Sample Size		Inclusion And Exclusion Criteria			Randomization		Blinding	Outcome Measures		Statistical Methods		Experimental Animals		Experimental Procedures				Results		%
		1A	1B	2A	2B	3A	3B	3C	4A	4B	5	6A	6B	7A	7B	8A	8B	9A	9B	9C	9D	10A	10B	
1. Biomechanical and histologic basis of Osseo densification drilling for endosteal implant placement in low density bone. An experimental study in sheep. INVIVO animal study	Bradley Lahens et al[19] 2016	Y	Y	Y	Y	NA	NA	Y	Y	Y	NA	Y	Y	Y	Y	Y	N	Y	NA	NA	Y	Y	Y	89 %
2. New Osseo densification Implant Site Preparation Method to Increase Bone Density in Low-Density Bone: In Vivo Evaluation in Sheep. INVIVO animal study	Paolo Trisi et al[24] 2016	Y	Y	Y	N	Y	NA	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	77 %
3. Temporal Osseointegration: Early Biomechanical Stability Through Osseo densification. Animal model study	Adham M. et al[23] 2018	Y	Y	Y	N	N	NA	Y	Y	Y	NA	Y	N	Y	N	Y	N	Y	NA	NA	Y	Y	Y	69 %
4. The effect of Osseo densification drilling for endosteal implants with different surface treatments: A study in sheep. INVIVO animal study	Bradley Lahens et al[21] 2018	Y	Y	Y	N	NA	NA	Y	NA	N	N	Y	N	Y	NA	Y	N	Y	NA	Y	Y	Y	N	60 %
5. Osseo-densification outperforms conventional implant subtractive instrumentation: A study in sheep.	De Oliveira PG et al[20]. 2018	y	y	y	N	NA	NA	Y	NA	Y	N	Y	Y	Y	Y	Y	N	Y	NA	Y	Y	Y	N	78 %
6. Osteogenic parameters surrounding trabecular tantalum metal implants in osteotomies prepared via Osseo densification drilling. INVIVO animal	Lukasz et al[22] 2019	Y	Y	N	N	Y	Y	NA	N	N	N	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	64 %

study																								
7. Alveolar Ridge Expansion: Comparison of Osseo densification and Conventional Osteotome Techniques. INVIVO animal study	Jimmy Tian et al[26] 2019	Y	Y	Y	N	NA	N	Y	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	78 %
8.A preclinical model links osseo-densification due to misfit and osseo-destruction due to stress / strain	Benjamin R. C et al [18] 2019.	Y	Y	Y	N	Y	NA	Y	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	76 %
9.Osseodensifcation enables bone healing chambers with improved low-density bone site primary stability: INVIVO animal study	Mello-Machado et al[25] 2021	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y	Y	Y	Y	91 %
10. Osseodensification Versus Subtractive Drilling Techniques in Bone Healing and Implant Osseointegration: Ex Vivo Histomorphologic /Histomorphometric Analysis in a Low-Density Bone Ovine Model.	Otto Mullings et al[27] 2021	Y	Y	Y	N	Y	NA	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y	N	78 %

Table 3: MODIFIED CONSORT Guidelines for Animal Experimental Studies

TITLE OF THE ARTICLE	**Author name Year of Publication**	**ABSTRACT**	**INTRODUCTION**		**MATERIALS AND METHOD**								**RESULTS**	**DISCUSSION**	**FUNDING**	**PROTOCOL**	**%**
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	%
1.The effect of Osseo densification and different thread designs on the dental implant primary stability	Abdullah S A et al[4] 2018	Y	Y	Y	N	Y	N	N	N	N	N		Y	Y	Y	N	47 %
2.Histomorphometric Comparison of 3Osteotomy techniques	Frederic B. Slete,et al[9] 2018	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	N	N	Y	N	53 %
3. Effects of Osseo densification protocol on insertion, removal torques, and resonance frequency analysis of Bio Horizons® conical	Cáceres F et al[29.] 2020	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	N	N	60 %

implants. An ex vivo study.																	
4.Effects on Ridge Dimensions, Bone Density, and Implant Primary Stability with Osseo densification Approach in Implant Osteotomy Preparation	Yu-Ting Yeh et al[2.] 2021	Y	Y	Y	Y	Y	N	N	N	N	N	Y	Y	Y	Y	N	60 %
5.Evaluation of the primary stability in dental implants placed in low density bone with a new drilling technique, Osseo densification: an in vitro study	Javier Barberá-Millán et al[1] 2021	y	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	N	Y	N	67 %
6. Application of reverse drilling technique in alveolar ridge expansion.	Chen-Chih Chen et al[42]. 2022	Y	Y	Y	N	Y	N	N	N	N	N	Y	Y	Y	N	N	47 %
7. Comparative Evaluation of Osseo-densification Versus Conventional Osteotomy Technique on Dental Implant Primary Stability: An Ex Vivo Study.	Vinod B et al[43]. 2022	Y	Y	Y	Y	Y	N	N	N	N	N	Y	Y	Y	Y	N	60 %
8. The effect of under-drilling and Osseo densification drilling on low-density bone: a comparative ex vivo study.	Seo DJ et.al[44] 2022	N	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	67 %
9. Evaluation of the Osseo densification Technique in Implant Primary Stability: Study on Cadavers.	Mercier et al[41]. 2022	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	60 %
10.Comparison of heat production and bone architecture changes in the implant site preparation with compressive osteotomes, Osseo-densification technique, piezoelectric devices, and standard drills: an ex vivo study on porcine ribs.	Bhargava N et.al[45.] 2022	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N	N	N	53 %
11. Effect of Osseo densification on the increase in ridge thickness and the prevention of buccal peri-implant defects: an in vitro randomized split mouth pilot study.	Frizzera F et.al[46.] 2022	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	N	67 %

Characteristics of included case reports /Case series

Table *4* summarizes the characteristics of all included studies. Of all the studies were case reports and were published between 2015 to 2022. The majority of studies perform the Osseo-densification technique on maxillary teeth [**Error! Reference source not found.**,14-17] while Rathi et.al[16]used mandibular molar. The preoperative radiographic assessment with the use of CBCT (Cone Beam Computed Tomography) and photographic method was used by Pikos MA et al [**Error! Reference source not found.**]. and Puterman I et al[14], clinical and radiographic

paraments used by Rathi et.al[16], Elsaid et.al[17], Deshwal R et.al[17] and da Rosa JCM et al[15] utilized radiographs. While for the postoperative evaluation, all of them used varied radiographic methods. All the included studies performed a variety of the Osseo-densification technique with lateral sinus augmentation [**Error! Reference source not found.**], crestal sinus augmentation [14, 17] sinus shield [14] and Sinus augmentation with socket shield [17]. The majority of authors] used the type of Osseo-densification Burs (OD Bur-Densah/Varsah), and we mentioned the specification, speed, and diameters of implants used in these studies. To assess the success rate of parametric implant evaluation using bone-to-implant contact, bone volume, torque, and micro-motion RF are crucial factors. Puterman I et al [14] reported using bone volume and micro-motion RF in their study.

In contrast, torque was used to measure the success rate recorded by Rathi M and IyerSR [16] and Micromotion RF by Pikos MA et al [**Error! Reference source not found.**]. The majority of studies [**Error! Reference source not found.**,14] used bone putty as adjunctive regenerative materials. In contrast, Pikos MA et al [**Error! Reference source not found.**] used a Nova bone graft. Elsaid et al [17], in their case series with 7 patients, used a Nano-bone graft along and sinus lift procedure with Osseo densification and were found to have increased residual bone height and bone density. Deshwal et al. used the socket shield technique with OD and sinus lift procedure to maintain a better buccal and palatal wall architecture [17]. Moreover, all the included studies measure primary bone stability as the outcome of their studies *(Table 4)*.

Table 4: Data Extraction for Case Reports / Case Series

1. Article Title. 2. Authors 3. Publication Year 4. Journal Name	**5.Teeth involved for OD 6. Pre-op radiographic Tool.**	**7.Objectives of the study**	**8.Osseodensification (OD)** **a. OD kit used b. Burs Type c. Bur Specification d. Speed used for OD**	**9.Type of implants placed** **a. Type of implant placed. b. Length & Diameter**	**10.Parameters assessed** **a. BIC (BONE TO IMPLANT CONTACT b. BV (BONE VOLUME), c. Torque value d. Micromotion (RF)**	**11. Adjunctive regenerative materials used.**	**12.Post-op evaluation methods used 14.Post op Treatment Outcome**
1. To Drill or to Densify? Clinical Indications for the Use of Osseo densification. 2.Pikos MA et al[12] 3.2019 4. Compend Contin Educ Dent.	5.Case 1: #16, 17 6.Photographs & CBCT	OD with Lateral Sinus Augmentation.	a. Not Mentioned b. OD Burs (No name specific) C& d. Not Mentioned	Not Mentioned.	a. Not Mentioned b. Not Mentioned c. Not Mentioned d. 60Ncm Immediate	Nova Bone graft +PRF + Type Bovine Cross linked collagen membrane and lateral sinus lift procedure (case1). Bone putty Nova-bone - alloplastic (Case2 &3).	13. Primary Implant stability, clinical soft tissue evaluation 14.Implant stability, sinus augmentation (case1 & 2), soft tissue Zenith maintained, satisfactory facial bone volume (case 3)
	5.Case 2: #24, 6.Photographs & Intra-oral X-ray	OD requiring Sinus augmentation					
	5.Case 3: #22 6.Photographs & CBCT	OD with socket-shield approach					
1. Use of the Immediate Dentoalveolar Restoration Technique Combined with Osseo-densification in Periodontally Compromised Extraction Sites. 2.da Rosa JCM et.al.[14] 3.2019 4.Int J Periodontics Restorative Dent	5.Case 1: #16 6.Photographs & CBCT	OD for preservation of bone	a. Varsah OD Kit b. Densah Od Burs c. Not Mentioned d. CCW rotation at 1,100 rpm	a. OD Burs b. Dimensions Not Mentioned	a. Not Mentioned b. Not Mentioned c. Not Mentioned d. 50Ncm primary	Cortico-cancellous autograft (Case 1 & 2)	13.clinical soft tissue evaluation + CBCT 14. Buccal and palatal walls remained stable, with adequate thickness in the tooth #16 (case 1 - 2 years post-op).
	5.Case 2: #25 6.Photographs & CBCT	OD to compact the particulate autogenous graft	a. Varsah OD Kit b. Densah Od Burs c. Not Mentioned d. CCW rotation - slow speed (150 rpm)		a. Not Mentioned b. Not Mentioned c. Not Mentioned d. 40Ncm primary		13.clinical soft tissue evaluation + CBCT 14. stable buccal and palatal walls with adequate thickness (case 2 -2 years post-op).
1. The Modified Osseo-densification Visco-Elastic (MOVE) Sinus Protocol: A Case Series to Illustrate the Combination of Osseo-densification with Viscoelastic Bone Replacement Material. 2.Puterman I et.al.[13] 3.2021	5.Case series 6. Photographs & CBCT.	OD + viscoelastic putty for sinus augmentation and higher primary stability of Implants	a. Not Mentioned b. Densah Od Burs C & d. Not Mentioned	Not Mentioned.	Not Available	viscoelastic putty as alloplastic grafting.	13.IOPA X-RAYS + CBCT 14. Indicated for same-day implant placement in sites that previously required preoperative bone augmentation or lateral wall sinus access. Reduces the extent of surgical invasiveness

4. Clin Adv Periodontics.							associated with implant placement in the posterior maxilla
1. Osseodensification. A novel approach in implant dentistry in Seibert Class 1 ridge deficiency: A case report. 2.Rathi et.al[15] 3.2022 4. Int J Case Rep Images	5. # 46 6. Clinical & Radiographic	OD In Alveolar Ridge Sibert"S Class 1 Deficiency	a. Densah system b. Densah Burs, c.Drilled in Depth 11.5 Mm d.1200rpm	a. Type Not Mentioned b. 10.5mm & 4.5mm	a. Not Mentioned b. Not Mentioned c. Not Mentioned d. 50Ncm primary	--	13.clinical evaluation 14. Primary stability, preservation of alveolar bone and bone expansion in deficient ridges.
1. Trans-crestal sinus lift with simultaneous implant placement using OD in posterior maxilla with residual bone height of 4-6 mm. 2. Elsaid et al[17]. 3. 2022 4. Braz Dent Sci	5.Case series (7 patients) 6. Implant stability using Osstell.	OD With Transcrestal Sinus lift in deficient (4-6mm) bone hight.	a. Densah system b. Densah Burs, c. Drilled in Depth 3.5 mm beyond sinus floor. d.100-200 rpm counter-clockwise	Not Mentioned.	a. Not Mentioned b. Residual ridge height c. Not Mentioned d. implant stability (Ostell)	OD+ Sinus lift+Nano-bone graft	13.IOPA X-RAYS / CBCT 14. Increase in residual bone height was highly significant ($p<0.001$). Highly significant increase in Implant stability quotient (ISQ) &Bonedensity in between intraoperative and 6-months postoperative.
1. Socket-shield technique with minimally invasive osteotomy preparation as well as simultaneous sinus lift utilizing Densah Bur and platelet-rich fibrin membrane followed by immediate implant placement in a symptomatic posterior endodontically treated decayed root stumps site: A case report with 1-year follow-up. 2. Deshwal R et al[18] 3.2022 4. Journal of Indian Society of Periodontology.	5.Case report 6. Clinical and Radiographic assessment.	OD with sinus elevation using socket-shield approach	a. Densah OD kit b. Densah Burs C & d. Drilled with 1200 rpm counter-clockwise with 1.5 mm sinus elevation.	a. Osstem TSIII implant b. 4 mm × 11.5 mm	Clinical evaluation for implant mobility and radiographic assessment for bone level up to 1 year	OD+ Sinus lift+PRF	13.Clinical + Radiography 14.Buccal and palatal architecture was well-maintained around implant as observed clinically and no bone loss Was observed radiographically (CBCT).

Characteristics of included clinical, animal in vivo, animal in-vitro/experimental studies

The outcome of all included in vivo and in vitro animal studies are summarized in *Table 5*. Included studies used various methods to understand the primary stability of implants. They compared the effects of Osseo-densification drilling with conventional drilling and its impact on stability and Osseointegration at different locations and densities of bone. The majority of included studies are animal studies [29-45]. A higher number, including studies, assessed the main objectives of primary stability and torque, and four studies outcome was to measure bone augmentation/bone volume/bone width. A higher number of authors used the Maxillary arch as an appropriate location to see the effect of Osseo-densification. Most of them used histopathological analysis [25-28]one study each used CBCT[4], micro CT scans[18] and Clinical & photographic imaging[45], while, eight studies used biomechanical analysis[44], for outcome results. The use of the Osseo-densification kit (conventional kit) was observed in two studies [18,21], and most authors used the DENSAH bur kit. For the correlation, it is essential to use similar parameters for implant placement, like the type of bur, its specification, and the speed of the bur. However, it was not easy to pinpoint the correlation as six included studie specified these parameters.

Additionally, it was interesting to know the range of RPM used in those studies (800 to 2000). It was observed that the most used implant was tapered screw vent[9,23] while the range of implant length was 10 to 13 mm with a diameter of 3.5mm to 6.2mm. Overall, most of the authors pointed out the increase in BV in samples drilled with OD rather than functional drilling. In addition, it was discovered that the insertion torque was more significant in the CCW and CW drilling methods compared to the R-drilling method [21,21,29]. The experimental group demonstrated significantly superior biomechanical performances, according to the statistics. However, Lahens B et al. [19], Mello-Machado et al [25] reported statistically non-significant insertion torque values. The primary stability achieved through Readings taken from perio-tests has also shown that implants placed in regular drilling osteotomies are noticeably more stable than implants placed in OD osteotomies. This was the case when comparing the two types of implants [4]. Although Coyac BR et

al [18]. And Yeh YT et al [1] reported no significant differences in ISQ after implant placement. Bone-to-implant contact (BIC) values were approximately 50 percent in the R condition, but they increased to more than 60 and almost 70 percent in the CW and CCW conditions, respectively. While Mullings O et al [28]. Noted the higher BIC with the Osseo-densification technique compared to the conventional drilling technique. Witek L et al [22]. And Trisi P et al [24], found no significant difference in BIC with OD and the conventional group. The studies reported that the OD technique increased osseointegration and primary implant stability *(Table 5)*.

Table 5: Data Extraction for Animal in Vivo, Animal Experimental Studies

1.The Article	2.Material and Methods			3.Results - Intra-operative OR Post-operative Parameters assessed	4. Treatment Outcome (Conclusion)
a. Authors b. Year of Publication c. Journal Name	a. Teeth or sites involved and specimen b. Type of study and post-op evaluation	a. Type of OD Kit and Burs b. Speed & OD method used	a. Type of implants. b. Implant length(L) & Diameter (D), c. Parameters assessed. d. Adjunctive regenerative materials & techniques used	a. BV - (Bone Volume), b. TV - (Insertion Torque value - ITV) c. RF - Micro-motion (RF) d. BIC – Bone to Implant Contact e. Additional parameters assessed and results.	a. Post-op assessment Period b. Post-op treatment Outcome
1.a. Bradley Lahens et al.[17] b. 2016 c. J of the mechanical behaviour of Biomedical Materials.	a. 30 implants - conical (15) and parallel walled (15) bilaterally with OD, R, and CW& CCW. b. Animal invivo-Histology evaluation.	a. Densah Universal OD kit with Densah Burs. B. 1100 rpm. R with conventional kit, CW) &CCW with Densah multi fluted tapered burs.	a. Conical (Axis, TAG, Israel) and the parallel (Massif, TAG, Israel), b. L-10 mm&D- 4.2 mm. c. BV, TV & BIC assessed.	A.BV–. BAFO % - 35% for conical implant, 50% for parallel wall Implant. b. TV - 25 Ncm in R, increased to100 Ncm in the CW and CCW conditions. d. BIC - Higher BIC % for both OD (CCW and CW) drilling ($p<0.05$) relative to R technique. BIC 50% in R & 60% and near 70% in the CW and CCW.	a. Assessment period: Six weeks Post implantation. b. Outcome: Similar Osseointegration patterns for both groups. New bone formation in all (R & CW, CCW) where CCW type showed higher.
2.a. Paolo Trisi et al. [22] b. 2016 c. Implant Dentistry	a. 10 cortical Implants. b. Animal invivo-Biomechanical and histological.	A. Densah OD kit with Burs VT1828. b. 12OO rpm.	a. Dynamix implants (Cortex) b. L-10 mm &D-3.8 mm. c. BV, TV & BIC assessed.	a.BV - OD increased the %BV and bone density by 30% - statistically significant. b. TV - Better biomechanical performances (30%– 40% higher)for OD. d. BIC: NS differences between the 2 groups.	a. Evaluation Period: 2 months post-operative. b. Outcome Summary: OD increased implant primary stability and maintained secondary stability and %BV around dental implants inserted in low-density bone.
3.a. De Oliveira PG [18] b. 2018 c.Materials Science & Engineering	A.60 endosteal implants – acid etched (30) and machined (30). b. Animal invivo-Biomechanical evaluation.	a. Densah Universal OD kit with DensahBurs. b. 1100rpm. R with twist drills, CW) & CCW with Densah multi fluted tapered burs.	a. Endosteal implants (acid-etched & machined). b. L-10 mm & D- 4.0 mm. c. BV, TV & BIC assessed.	a.BV - The effect of time in %BAFO showed a significant increase in values from 3 to 6 weeks ($p= 0.014$) and NS for %BAFO over time and drilling ($p= 0.053$). b. TV – NS, ITV between the groups and significant ITV as a function of technique (CCW > CW > R, $p<0.005$). d. BIC - % BIC as a function of time (3 vs 6 weeks), NS ($p= 0.577$).	a. Evaluation period: 3 weeks and 6 weeks. b. Outcome summary: CW and CCW-OD drilling resulted in higher insertion TV, higher %BIC and %BAFO of machined implants, when compared to R drilling of roughened implants in low bone density. Increased early osseointegration in machined surface.
4.a. Bradley Lahens et al, [19] b. 2018 C. J. Biomed. Mater. Res.	a. 6 implants acid-etched (36), machined (36) with R and OD technique. b. Animal Invivo - Histology evaluation.	a.Varsah Universal OD kit with Densah Burs. B.1100rpm. R with twist drills, CW) & CCW with Densah multi-fluted burs.	a. Ti-6AL-4V implants. The implant surfaces provided were textured (grit-blasted / acid etched, and as-machined. b. L-10mm &D-4mm. c. BV, TV & BIC assessed.	a.BV – A significant %BAFO was observed as a function of drilling technique and as a function of time, but no statistical difference was present when BAFO was evaluated as a function of surface treatment. b. TV - Higher for CCW and CW drilling compared to the R-drilling ($p<0.001$). d. BIC - %BIC was significantly increased for OD (CW & CCW) cases for 3-week and 12-week time as compared to R technique.	a. Evaluation Period: at 3-weeks & At 12-weeks, post-op. b. Outcome Summary: Insertion torque, BIC was higher in the CCW and CW drilling compared to the R-drilling. At 12-weeks, new bone formation was observed in all groups extending to the trabecular region. In low-density bone, endosteal implants inserted via OD drilling presented higher stability.
5. A. A S Almutairi et al.[4] b. 2018 c. F1000Research	A.48 implants - thread design: V-shaped, trapezoid, buttress, and reverse buttress (12 each). b. Animal Exvivo study -primary	a. Varsah Universal OD kit with Densah Burs. B.1100 rpm.	a. Custom Made b. L-13 mm. & D - 4.5 mm and a minor diameter of 3.5 mm, a thread pitch of 1 mm, a thread depth of 0.5 mm, and a 4 mm long cutting	c. RF – Periotest readings for primary stability showed implants placed in R drilling were significantly more stable than in OD osteotomies.	a. Evaluation Period: Intra & immediately after insertion. b. Outcome Summary: No statistically significant Periotest readings for the implants in each category placed in either the OD or the regular osteotomies. It was concluded OD is not necessary in situations where

	stability.		flute at the apex. c. RF with Periotest assessed.		there is bone of good quality and quantity.
6. a. Adham M et.al. [21] b. 2018 c. Journal ofOrthopaedic Research.	a. 6 osteotomy in R, CW, CCW (2 implants each). b. Animal invivo - Histology evaluation.	a. Varsah Universal OD kit with Densah Burs. B.1100 rpm with saline irrigation. R with Zimmer Biomet's soft bone drilling protocol, CW&CCW] with Densah Burs.	a.A titanium implant, made of elemental tantalum & a titanium implant containing a tapered screw-vent (TSV) morphology at the apex (Zimmer1, Parsippany). b. L- 1Omm. &D - 3.7 mm. c. BV, TV & BIC assessed.	a.BV & d. BIC – Histomorphometry showed that for OD significantly greater values for BIC and BAFO. b. TV - IT as a function of drilling showed implants subjected to R drilling yielded a significantly lower insertion torque relative to those implanted in OD (CW/CCW) sites ($p < 0.05$).	a. Evaluation Period: 3 weeks post-surgery. b. Outcome Summary: OD protocol allows for higher insertion torque, atemporal stability, and higher degrees of osseointegration.
7. a.Frederic B. Slete, et al [9]b. 2018. c. Implant Dentistry.	a. 18 Osteotomy (6 each of SD, SO, OD) B.Animal invivo - Histomorphometry Analysis.	a. Densah Universal OD kit with Densah Burs. b. No other specifications Mentioned.	a. Tapered screw-vent implant b. L - 13mm &D - 4.7mm. c. BV & BIC assessed.	a.BV - BV% within 2 mm of the implant placement was 62% for OD, 49% for SO, and 54% for standard drilling (SD). d.BIC - OD achieved 60.3% BIC, SO 40.7% BIC, and standard extraction drilling (SD) 16.3% BIC	a. Evaluation Period: Immediately after surgery. b. Outcome Summary: OD technique osteotomy preparation can influence both BIC and percentage of bone volume around the implant.
8. A.Benjamin R. C et al.[16] b. 2019. c.Clin Oral Impl Res	a. Teeth: 70 bilateral maxillary first molar. b. Animal invivo - Histology, Micro CT, Histomorphometry, Immunoassay, FEA.	a. CD with (Salvin, KLS), OD kit notmentioned. b. 1350-2000 rpm.	a. Titanium implants with TiUnite coating. b. Length & Diameter not mentioned. c. TV, RF & BIC assessed.	a. Increasing misfit (smaller osteotomy) increases Insertion torque, decreases micromotion d. BIC – Full contact between implant surface and bone in misfit implants.	a: Animal Sacrifice intervals (Day 3 to Day 28). b. By increasing the degree of misfit, BIC is increased, and it is assumed that such implants will exhibit better primary stability.
9. a. Lukasz Witek et al. [20] b. 2019. C. JMed Oral Patol Oral Cir Bucal.	a. Experimental specimen not mentioned. B.Animal invivo - Histology evaluation.	a. Varsah Universal OD kit with Densah Burs. b. OD Speed: 1100rpm	a. Trabecular metal (TM) (Zimmer®, USA) b. L - 10mm & D - 3.7mm c. BV & BIC assessed.	a.BV – Compared to R drilling, the bone volume with OD is more pronounced. %BAFO showed a significant difference ($p=0.036$) between the CCW and R. d. BIC – Not-significant %BIC in OD or Conventional (R) implant drilling.	a. Evaluation Period: 3 weeks post-surgery b. Outcome Summary: All implants exhibit successful bone formation. OD as a design for improved fixation of hardware was supported by increased levels of stability (primary and secondary).
10. a. Jimmy Tianet al [24]b. Year: 2019 c.JCraniofac. Surg.	a. 12 osteotomy sites (6=OD, 6=SD). b.Animal - Histological evaluation.	a. Varsah Universal OD kit with Densah Burs. b. Not Mentioned	a. Twelve Ti-6Al-4V implants with internal connection (Interlocks International, Boca R, FL) b. L - 13mm& D - 4mm. c. BV, TV & BIC assessed.	a.BV - No difference in BAFO as a function of drilling technique ($P < 0.198$). b. TV - Mean implant ITV of 56.7 Ncm (OD) and 32.5 Ncm (R) group ($P <0.001$). d. BIC - The mean BIC% 62.5% in O group, and 31.4% in the R group	a. Evaluation Period: 4 weeks post-operative. b. Outcome Summary: OD technique increased osseointegration and implant primary stability, respectively.
11.a. Cáceres F et al[7] b. 2020 c. Journal of Oral Biology and Craniofacial Research.	a. 100 osteotomies in type III-IV bone with CD (50) and OD (50) techniques.	a. Varsah Universal OD kit with Densah Burs. OD with Densah and R with Bio Horizons® Tapered surgical system. b. OD (CW, CCW) Speed of 1200 rpm, 50 Ncm torque. CD speed 1200 rpm, 50 Ncm torque.	a.BioHorizons® Tapered Internal implants (Bio Horizons, USA). b. L- 10.5 mm, & D - 3.8 mm. c. TV & RF assessed.	b. TV - Mean ITV for CD: 26 Ncm; OD: 42 Ncm. Mean removal torque for CD: 25 Ncm; OD: 40 Ncm. c. RF - ISQ value for CD: 69.25 and OD: 71.5. All variables were significantly higher ($p \leq 0.05$) in the OD group.	a. Evaluation Period: Immediately after insertion. b. Outcome Summary: The OD technique improves primary stability in the clinical scenario on tapered implants.
12.a. Otto Mullings et al,[27] b. 2021 c. Int J Oral Maxillofac Implants.	a.46 osteotomies with CD and OD (n=23 each). b. Animal invivo - Histology evaluation.	a. Varsah Universal OD kit with Densah Burs.b. OD (2mm pilot and 2.8mm & 3.8mm multi-fluted tapered Densah burs) and regular twist drills for CD. OD speed - 1,100 rpm with saline irrigation.	a. Implant specification Not mentioned. c. Osseointegration & BIC assessed.	a. Higher Osseointegration with Osseo-densification technique. d. BIC - Higher BIC with OD as compared to conventional drilling technique.	a. Evaluation Period: 3 & 6 weeks. b. Outcome Summary: OD group yielded higher osseointegration rates, BIC and BAFO indicating an increased osteogenic potential in osteotomies prepared using the OD technique.
13.a. Mello-Machado et al[23]	a. 20 implants with (nHA) surface, with	a. Varsah Universal OD kit with Densah	a. Titanium dental implants with a	a.BV – No significant group differences.	a. Evaluation Period: 14- & 28-Days post-operative.

b.2021. c.J of Scientific Reports.	SCD and OD technique (n=10each). b. Animal invivo - Histology analysis.	Burs. b. OD Speed 1200 rpm.	nano-sized crystalline nHA coating (Epikut Plus, S.I.N. Implant System, Brazil). b. L -10 mm. &D - 3.5 mm. c. BV, TV & BIC assessed.	b. TV – No significant group differences with respect to final insertion torque and implant stability quotient ($p > 0.050$). d.BIC: BIC values were higher for SCD after 14 and 28 days	b. Outcome Summary: OD technique provided comparable levels of initial implant stability, BIC, and BAFO to the conventional subtractive under-drilling procedure.
14.a.Yu-Ting Yeh et al [2] b. 2021. c. Int J Oral Maxillofac Implants.	a. 24 Implants (12=OD, 12=CD) b. Animal exvivo Histomorphometry analysis.	a. Varsah Universal OD kit with Densah Burs. b. OD Speed 11OO rpm.	a. Straumann Bone Level SLA titanium implants b. L- 10 mm &D - 4.1mm. c. BV, TV & BIC assessed.	a.BV - A significant increase in bone volume for both groups. c. RF - The mean ISQ values for test and control groups were 78.39 (± 5.13) and 77.61 (± 7.12), for OD and CD osteotomy respectively (NS). d. A significantly higher level of peripheral BIC% in the OD group.	a. Evaluation Period: Immediately post insertion. b. Outcome Summary: OD technique increased the bone mineral density and primary BIC. Also, OD or conventional drilling can increase ridge dimensions in narrow alveolar ridges.
15.a.Barberá-Millán J et al.[1] b.2021 c. Med Oral Patol Oral Cir Bucal.	a. 110 conical implants with UD and OD technique (n=55each). b. Animal exvivo– biomechanical Experimental.	a. Varsah Universal OD kit with Densah Burs.	a. Klockner Vega internal connection bone-level implants (Soadco, Escaldes-Engordany, Andorra) b. L - 10 mm, & D - 4 mm. c. TV & RF assessed.	b. TV - The mean insertion torque of the implants was 8.87±6.17 Ncm in UD and 21.72±17.14 Ncm in OD. c. RF –The mean RFA was 65.16±7.45 ISQ in UD and 69.75±6.79 ISQ in OD.	a. Evaluation Period: Immediately post-operative. b. Outcome Summary: As compared with UD technique, the OD technique improves the primary stability of dental implants in low-density bones.
16.a.Mercier et al[38] .b.2022 C.International J of Oral & Maxillofacial Implants.	a. 21 mandibular jawbone models with SD and OD technique (n=29 each). b. Animal exvivo - Biomechanical analysis.	A.Varsah Universal OD kit with Densah Burs. b. Speed 1100 rpm.	c. BV, TV & RF assessed.	a.BV – A significant increase ($P = .026$) in bone density. b. TV - IT values for OD and SD were, respectively, 34.9 Ncm ± 19.1 and 23.6 Ncm ± 9.8. c. RF – A moderate positive correlation ($\rho = 0.527$) for ISQ observed.	a. Evaluation Period: Immediately post insertion. b. Outcome Summary: A significant increase in IT and bone density following an Osseo densification procedure compared to standard drilling.
17.a. Chen-Chih Chen et al[42]. b.2022 c. Journal of Dental Sciences.	a. 27Sawbones models, (5 mm thickness and width 6.75, 7.25& 7.75 mm), osteotomy with SD & OD. b. Animal exvivo - Biomechanical analysis.	A.Varsah Universal OD kit with Densah Burs. C. 1500 rpm for OD and 1600 for SD& 200 rpm for Modified OD drilling.	a. IDEOSS implants (Taiwan) - sandblasted and anode oxidized. b. L - 8 mm, &D- 5 mm. c. BV &insertion depth assessed.	a.BV – Significant ridge expansion with Densah burs in 6.75 mm ($P < 0.05$) width sample. NS for other groups. b. Implant insertion depth of OD group was significantly less than those of other two drilling protocols ($P < 0.005$).	a. Evaluation Period: Immediately post insertion. b. Outcome Summary: The OD method possesses the ability to expand bone ridge but lead to a higher stress in the bone structure, which may affect the insertion depth of the implants.
18.a.Vinod B et al[43]b.2022 c. Cureus.	a. 22 osteotomies with CD and OD technique (n=11 each)). b. Animal exvivo – Biomechanical analysis.	AVarsah Universal OD kit with Densah Burs for OD & Conventional drills for CD. c. 800-1500 rpm for OD.	a. Adin implant, b. L- 10 mm, & D - 4.2 mm. c. TV & RF assessed.	b. TV: Insertion torque of 47.7 Ncm for OD group and 34.1 Ncm for CD group. c. RF – Mean ISQ of 62.82 for OD & 54.77 for CD group.	a. Evaluation Period: Immediate post insertion. b. Outcome Summary: Osteotomy prepared by OD method showed higher IT, RTV, and ISQ values than the CD group.
19.a.Seo DJ et.al[44] b.2022 c. Applied Sciences.	a. 87 dental implants with SD, CD, OD, OD-C & OD-CCW. b. Animal exvivo – Biomechanical analysis.	a. Varsah Universal OD kit with Densah Burs with Densah Bur for OD b. 1400 rpm, and insertion torque 50 Ncm (CD and OD-C), 800 rpm, &30 Ncm (OD-CC).	a. Osstem tapered implants. b. L - 10 mm & D- 4.5 mm. c. Post implant insertion primary implant stability & bone density assessed.	a. Primary stability: OD and under-drilling technique increased the IPS (81.25 & 74.25 ISQ), compared with conventional drilling technique (66.25 ISQ). b. Bone density: OD technique with the counter-clockwise direction had higher HU gaps (648-685) than the standard drilling(587-616HU) and OD technique with clockwise direction (602-606HU).	a. Evaluation Period: Immediate post insertion. b. Outcome Summary: OD technique with counter-clockwise direction is effective to increase IPS and bone mineral density in low-density bone.
20.a. Bhargava N et.al[45]b.2022 c. Odontology.	a.60 implant with OD, SCO, PST and CD (n=15 each). b. Animal exvivo - Histology evaluation.	a. Densah Universal OD kit with Densah Bur for OD, conventional drills for CD, concave tips (2-4mm) for SCO and NSK piezoelectric surgery unit for PST protocol. b. For CD & OD (1100rpm),	Anon-specificImplants. b. L-12mm & D-4mm. c. BV, TV, RF & BIC assessed.	a.BV – Highest in OD (37.26 ± 4.13mm) and lowest for SCO (33.84 ± 3.84 mm). b. ITV- ITV significantly higher with the OD method (71.67 ± 7.99 Ncm) in comparison to drills (CD), osteotomes (SCO), and piezo (PST). c. RF: ISQ values greatest in CD (76.17 ± 0.90) and lowest in SCO (71.50 ± 11.09). d. BIC - %BIC was highest for	a. Evaluation Period: Post osteotomy. b. Outcome Summary: High primary stability and decrease in temperature during implant site preparation with OD technique. The results support the use of OD technique for implant site preparation.

				SCO (39.83 ± 3.14%) & lowest for CD(30.73±1.65%).	
21.a.Frizzera F et.al[46]b.2022 c. BMC Oral Health.	a. 10 mandible specimen, bilateral implant with CD and OD technique (10 each). b. Animal exvivo - Clinical and photographic analysis.	a. Densah Universal OD kit with Densah Bur for OD, Cutting Burs (CTL twist drills) for CD. B. For CD & OD (800 rpm and 20 Ncm of torque).	a. Morse Implants. b. L-10mm & D-4.5mm. c. BV, TV assessed with Clinical (IT, ISQ) and photographic (Image software).	a.BV – Height, width of ridge was significantly higher with OD & Bone defects were lower with OD as compared to CTL. b. ITV- ITV significantly higher in the OD group (49.9±11.45 N/cm2) compared to the CTL group (40.4±8.07 N/cm2), p<0.05.	a. Evaluation Period: Post insertion. b. Outcome Summary: Increased buccal ridge thickness after site preparation and implant placement with OD compared to CTL. OD increased the ridge thickness through expansion and reduced buccal bone defects after implant installation.

DISCUSSION

This scientific literature review investigates whether preparing Osseo-densification as an effective technique for enhancing implant stability is valid. This investigation will be carried out to determine whether this method should be used. Comparing the journals has been difficult because of the variation in methodology. Nevertheless, this investigation has provided us with a comprehensive view of the outcomes achieved by the Osseo-densification technique and the applications for which it could be put. In 2015, Huwais came up with a brand-new technique called Osseo-densification in response to deficiencies in earlier methods of increasing the primary stability of implants [8,10]. Densah burs are specially designed to drill bits used to perform this procedure. These drill bits syndicate the benefits of osteotomes with tactile control and expansion [31].

Due to the osteoblasts nucleating near the implant, it is possible to anticipate that this technique will result in higher osseointegration in locations with greater BIC and BAFO [31,32]. In an Osseo-densified site, an autografted bone layer is formed around the implants; this closeness leads to a faster rate of osseointegration[10, 23]. The analysed studies produce contradictory results; some studies, but only a few kinds of literature confirm this method and provide statistically pertinent values [10,23,24,26,33]. However, other studies did not report any value demonstrating the scientific variation compared to the more traditional approach [24]. While the traditional Osteotomy is classified as a subtractive surgical procedure[35] , because it involves the extraction of autologous bone from the site where the implant is going to be placed, while the Osseo-densification process compacts the bone that is there[10,19]. Most of the analysed studies confirm the Osseo-densification, which significantly ensures the primary stability of the implant [9].

There are isolated case reports of OD scattered throughout the published research[**Error! Reference source not found.**,14,15,16], targeting the evidence of this technique and providing positive results comparing the traditional method with OD[35]. Many alveolar preparation techniques have been developed to enhance the primary stability of the implant and the results of osseointegration. These techniques aim to improve the implant's interface with the bone surrounding it [36]. Due to the limited amount of OD research that has been published to far, it is difficult to assess the effectiveness of this treatment with respect to the enhancement of primary stability. This literature primarily consists of studies and only contains a small number of cases examined serially or individually [33]. Various animal studies [40-44] confirmed the method's effectiveness in poor bone density. The current analysis also highlighted differences between the two OD drill procedures, which are counter clockwise and clockwise, in terms of insertion torque and BIC % following three weeks of healing in low-density bone. The evidence highlighted this difference. The counter clockwise drilling approach has demonstrated in clinical practice to significantly enhance the density of the local bone with concurrent bone compaction and three-dimensional bone expansion[19,21,26].It also aids in promoting the primary stability that takes place after the insertion of dental implants [24,26]. In general, most authors mentioned an increase in Bone Volume in samples drilled with OD instead of conventional drilling (CD) [4,8,9,17,18-28,31]. Frizzera F et al [45] reported significantly increased ridge height and width with OD technique compared to conventional techniques. These findings were similar to previous reports of animal histological results [22,40,41,44]. In addition, it was discovered that the CCW and CW drilling produced a higher insertion torque compared to the R-drilling technique [21,21].

Mullings O et al [28] observed that the BIC was significantly higher when using the Osseo densification technique than the conventional drilling technique. Mello Mechado et al [25]. Reported that the percentage of BIC was significantly increased for OD (CW & CCW) cases for 14 days and 28 days compared to the standard technique. Witek L et al [22]. And Trisi P et al [24]. Found no significant difference in BIC with OD and the conventional group. The insertion torque that is delivered to the implant directly affects its primary stability. Applying more than 25Ncm of insertion torque is unnecessary to place an implant successfully[38]. An insertion torque of at least 32Ncm is needed to impose an initial load on an implant, however in areas with poorer bone density, this value can go up to 45Ncm. As a result, osseous densification of the osteotomy site would enormously benefit and dramatically increase the implant's success over time in areas with relatively low bone density

[24].According to the published research, a dental implant rehabilitation procedure requires an insertion torque value of 35Ncm in order to achieve the best possible primary stability and long-term predictability[38,39].Numerous studies have demonstrated the osteotomes technique's viability to improve primary stability while maintaining bone tissue. OD has the same goals as osteotomes but accomplishes them through an innovative approach related to recent technological advances [31]. According to the findings of a histochemical study, an increase in bone density was only observed in the periapical region, whereas the lateral walls exhibited no obvious signs of transformation. According to the majority of case series reports, in vivo animal studies, and ex-vivo animal studies, osseo-densification is a cutting-edge osteotomy technique that preserves alveolar bone and promotes the stability of implants, particularly in low density bone[1,1,4,9,18,19-26,28,29-45]. Long-term implant survival is anticipated with this method.

CONCLUSION

Although the limited number of research papers that are now accessible, data from the most recent literature suggests that using the Osseo-densification drilling protocol increases the overall value of implant insertion torque and, as a result, increases the primary stability of implants. Osseo-densification publications are scarce and only found in animal research and clinical cases with short-term follow-up in the literature. This prevents us from objectively evaluating the benefits offered by the technique that was treated. Using this technique, the bone immediately surrounding the implant's graft site is "compacted" and "respected", which gives it the potential to be helpful in situations where the autologous bone is of low quality. Even though the findings regarding the Osseo-densification technique with specific drills are unremarkable and "immature," they still need to be read extremely cautiously. The need for incorporating the technique of bone compaction into the standard practice of implant surgery should increase in line with the start of new investigations on humans and animals in vivo with long-term follow-up. The required research must be conducted using additional randomized controlled trials and prospective cohorts in order to completely establish the clinical outcome of this approach in the clinical context.

Patents

No Patents for this manuscript.

Supplementary Materials

The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Figure S1: title; Table S1: title; Video S1: title.

Author Contributions

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Kamlesh Kumar Garg [2], Mostafa Hussein Omran[4], Shoeb Yakub Shaikh [6]: Conceptualization, formal analysis, supervision, validation

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The authors declare no conflict of interest for this research work.

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