

# Impact Of Osseo densification On Primary Stability of Implants Placed After Indirect Sinus Lift Without Bone Graft – A Systematic Review

Dr. K Aishwarya<sup>1</sup>, Dr. Sanjayagouda B Patil<sup>2</sup>, Dr. Kiran Kumar H. S<sup>3</sup>, Dr. Shivamurthy Shadakshari<sup>4</sup>,  
Dr. Chilakala Ravallika Reddy<sup>5</sup>, Dr. Prashant Kumar<sup>6</sup>, Dr. Shreya Anilkumar Ghattad<sup>7</sup>, Dr. Apoorva B Raj<sup>8</sup>  
<sup>1,2,3,4,5,6,7,8</sup> *Sri Hasanamba Dental College and Hospital*

**Abstract**—Implant placement in the posterior maxilla is often challenging because of inadequate residual bone height (RBH), poor bone quality, and reduced primary implant stability. Traditionally, lateral sinus floor elevation has been considered the standard treatment for patients with severe posterior maxillary atrophy; however, it frequently necessitates delayed implant placement owing to insufficient primary stability. Although conventional transcresal sinus elevation techniques, including osteotomes, balloon-assisted elevation, and piezosurgery, provide a less invasive alternative with fewer complications, they primarily increase bone height without significantly improving bone density, often requiring a staged implant approach. Osseo densification (OD), introduced by Huwais in 2013 using Densah burs, has emerged as an innovative osteotomy preparation technique that preserves and compacts bone while creating an autografting effect. This systematic review evaluated the effectiveness of OD in transcresal sinus floor elevation for implant rehabilitation in the posterior maxilla. The available evidence indicates that OD enhances bone density, improves bone-to-implant contact, and achieves greater primary implant stability, thereby facilitating simultaneous sinus augmentation and implant placement. Compared with conventional techniques, OD is associated with shorter treatment duration, reduced surgical morbidity, and a lower incidence of complications, including sinus membrane perforation and intraoperative bleeding. However, appropriate case selection remains essential, as severe posterior maxillary atrophy (RBH  $\leq 3$  mm) may increase the risk of membrane perforation. Overall, the findings suggest that osseo densification is a predictable, minimally invasive, and effective alternative for transcresal sinus floor elevation, offering improved clinical outcomes and faster rehabilitation. Nevertheless, further high-quality randomized controlled trials with standardized protocols and long-term follow-up are required to establish definitive clinical guidelines and

confirm the long-term success of this technique in posterior maxillary implant rehabilitation.

**Index Terms**—Osseo densification, Implants, Primary stability, Sinus lift

## I. INTRODUCTION

Prosthetic dentistry aims to replace missing teeth and contiguous tissues while maintaining proper oral functions, patient comfort, health, and aesthetics with artificial substitutes. Prosthetic options for replacement ranges from removable to fixed prosthesis. However, the use of removable dentures may lead to a sense of patient insecurity, reduced chewing capacity, altered taste, and low self-esteem. Thus, the treatment approach has shifted towards fixed prostheses and implants due to their high success rate, which has improved the quality of life for many patients. The success rate seems to be correlated to the amount and the quality of bone. Even though implants have recently gained attention over removable and fixed prostheses as a treatment option, various anatomical, physiological, and psychological factors in patients can make it contraindicated.

Anatomical limitations often represent a contraindication to implant therapy. After tooth loss, however, severely atrophic residual alveolar ridges are quite common. Especially in patients who have been edentulous for a long period of time. Reduced alveolar bone height in posterior areas of the maxilla pose a great a challenge for dentists. Treatment of the posterior edentulous maxilla is still a challenge for the implantologist, due to reasons like pneumatization of the maxillary sinus, poor bone density, volume, and difficult access.<sup>1</sup> This, in turn, may prevent the

placement of implants of adequate length. A minimum of 10 mm of vertical bone height is usually required for predictable implant success.<sup>2</sup> Furthermore, the bone which forms around the osseointegrated implants in this region, does not show very high density, thus in several cases the implant which has successfully osseointegrated may lead to failure after loading in this region.<sup>3</sup>

To address these problems, maxillary sinus elevation surgery was developed to increase the height of bone available for implant placement in the posterior maxilla. The procedure has also been referred to in the literature as maxillary sinus augmentation, maxillary sinus lift, and subantral augmentation. Sinus elevation surgery for implant placement was initially described by Boyne James and Tatum in 1980.<sup>4,5</sup>

#### Anatomy of Maxillary sinus

Maxillary sinus also called antrum of highmore is usually the largest of paranasal sinuses, measuring an average of 12.5 mL in volume. The maxillary sinus is four-sided pneumatic space that is lodged inside the body of the maxilla. The base of the sinus is facing medially toward the nasal cavity; the apex is pointed laterally toward the body of zygomatic bone. The floor of the maxillary sinus is usually above three posterior maxillary molars and sometimes extends to the apices of premolars. The maxillary sinus provides drainage through the opening called ostium which opens in to middle meatus of the nasal cavity (Fig.1).<sup>6</sup>

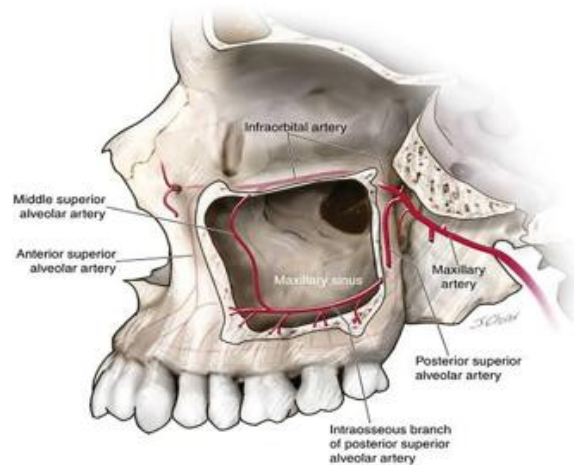


Figure.1 Anatomy of maxillary sinus.

The maxillary sinuses are lined with a thin bilaminar mucoperiosteal membrane known as the Schneiderian membrane, which comprises ciliated pseudostratified

columnar epithelium (respiratory epithelium) on the lumen side and a single-cell osteogenic periosteal layer (cambium layer) on the bone side (fig.2). The infraorbital nerve runs in a posterior-anterior direction in the middle of the maxillary roof. In most cases the canal floor is composed of thick bone; however, in some cases the canal floor is not present, leaving only a thin layer of mucosa between the nerve and the sinus cavity. The sinus ostium, located in the superior aspect of the medial sinus wall superior to the uncinate process, opens into the ethmoid infundibulum located in the middle meatus along the lateral nasal wall. Thin, bony septae that span from the lateral sinus wall to the medial sinus wall may be present in up to 37% of patients with 22.5% of those in the anterior third of the sinus, 45.9% in the middle, and 31.5% in the posterior. One or two septae are present in 89% of patients with septae. The presence and location of septae may affect a treatment plan, and failure to identify them preoperatively may result in pre operative complications.<sup>7</sup>

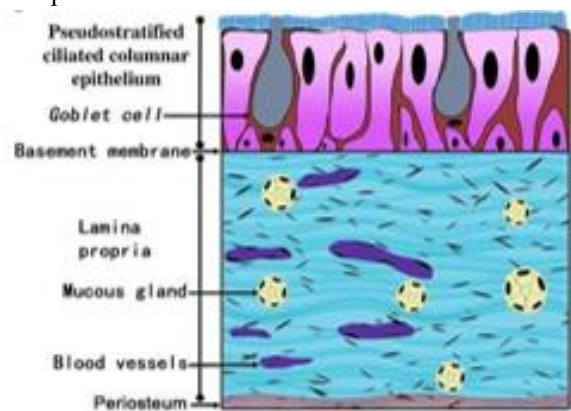


Figure.2 Histology of maxillary sinus.

Radiographic methods that are in the use for sinus evaluation are:

1. Conventional methods
  - a. Panoramic radiograph.
  - b. Water's view.
  - c. Submentovertex.
  - d. True lateral skull.
2. Advanced methods.
  - a. Computerized tomography (CT).
  - b. Magnetic resonance radiography (MRI).
  - c. Computed tomography (CBCT).

Even though water's view (face down or modified) is routinely indicated for sinus detection, cyst such as

densities are better illustrated in orthopantomogram (OPG) or computed tomography (CT) scan. The important criterion for selecting OPG or CT scan than water's view is for assessing remaining alveolar bone from the floor of sinus to the crest as it cannot be illustrated in water's view. Magnetic resonance imaging is sensitive in the diagnosis of pathologic conditions in the maxillary sinus mucosa. It can be considered as good adjunct for additional information for definitive diagnosis.<sup>8</sup>

#### Subantral classification and treatment options

Misch organized treatment options depending on available bone height between the floor of the antrum and crest of the residual ridge in the region of the ideal implant location (table.1 and fig.3).<sup>10</sup>

Table 1: Subantral classification and management

| Classification (subantral-SA) | Bone height and width                                                                                                          | Management                                                              | Graft                                                            | Implant placement                                                                                                                                                        |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SA-1                          | 12 mm height (adequate) from crest to floor of sinus. Bone width if inadequate, bone augmentation or osteoplassty recommended. | Conventional implant placement. Ridge splitting to increase bone width. | Inter positional graft to increase width.                        | Implant left to heal for 4-8 months.                                                                                                                                     |
| SA-2                          | 10-12 mm remaining bone.                                                                                                       | Indirect sinus lift procedure with osteotome.                           | Green stick fracture of sinus floor and lifted along with graft. | Implant placed and loading after 6-8 months. If apical bone formation could not be revealed in radiograph wait another 2 months and follow progressive loading protocol. |
| SA-3                          | Atleast 5 mm of vertical bone.                                                                                                 | Direct sinus lift by lateral window technique.                          | Autogenous or alloplast graft in sinus lifted space.             | Implant delayed for 2-4 months.                                                                                                                                          |
| SA-4                          | <5mm of residual alveolar ridge.                                                                                               | Same as SA-3                                                            | Same as SA-3                                                     | Implant delayed for 6-10 months.                                                                                                                                         |

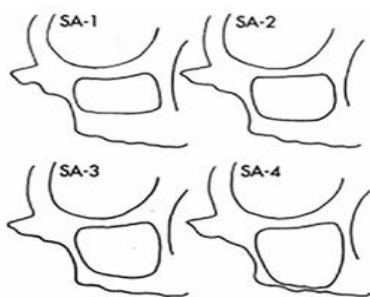


Figure. 3 Subantral classification.

#### Methods of maxillary sinus lifting

It can be entered from four different regions to the sinus area:

1. Superior-lateral wall (Caldwell-Luc): Entry from the anterior of the zygomatic arch.
2. Mid-lateral wall: Entered between alveolar crest and zygomatic arch.

#### Anatomic considerations

In general, three anatomic locations are utilized to enter the antrum.

1. The classic superior position of the Caldwell-Luc opening just anterior to zygomatic buttress.
2. A mid maxillary entrance between the level of the crest of the alveolar ridge and the level of the zygomatic buttress.
3. A low position along the anterior surface of the maxilla, at the level of existing alveolar ridge.<sup>9</sup>

3. Inferior-lateral wall: It is entered from alveolar crest level (Direct sinus lift/ lateral window technique/external lifting).

4. Krestal osteotomy (indirect sinus lift/closed technique/internal lifting).<sup>11</sup>

Osseo densification drilling for trans crestal sinus floor elevation

Osseo densification (OD) has emerged as a predictable and reproducible technique for facilitating trans crestal sinus floor elevation.<sup>32</sup> Since it compacts and autografts bone along the osteotomy walls and its apex rather than removing it, this approach not only enables sinus lift via the crestal preparation but also allows to improve the overall bone density, which is particularly beneficial in the posterior maxilla where bone quality is often compromised. The recommended technique for transcrestal sinus augmentation through OD

involves utilizing the OD burs with copious irrigation.<sup>33</sup> Sinus graft via osseodensification drilling differs significantly. Osseodensification facilitates safely breaching the sinus floor, lifting the membrane off the body bed and simultaneously compacting autogenous bone from the osteotomy walls into the lifted space up to 3 mm (fig.10).

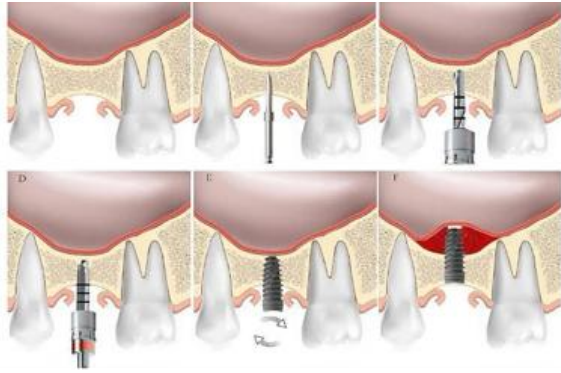


Figure.10 Maxillary sinus lift followed by immediate implant placement using osseodensification concept.

#### Advantages

1. Increase in bone mineral density.
2. During osteotomy preparation it condense and preserve bone through autografting compaction.
3. Autografting of bony particles, creating a smoother OD hole.
4. Primary stability, bone density and BIC are increases.

#### Limitations

1. OD doesn't work as cortical bone lacks plasticity.
  2. Prevent the densification of xenografts.
- OD is a specialized procedure for osteotomy preparation that is inherently bone preserving. Unlike conventional osteotomy, it uses specialized high-speed densifying burs to prepare osteotomy and autograft bone in the phase of plastic deformation. This results in an expanded osteotomy with preserved and dense compacted bone tissue that helps maintain ridge integrity and allows implant placement with superior stability. Use of densah drills in OD led to the formation of undersized osteotomy when compared to conventional drills. It helped improve bone density and also increased the percent of bone value and increased bone-to-implant contact, thereby improving implant stability.<sup>34</sup>

This systematic review aims at literature review of published research articles related to primary stability

of implant placed after indirect sinus lift using osseodensification (OD) without bone graft in prosthodontics.

## II. METHODOLOGY

### Study Design

- This systematic review will follow the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and reproducibility.
- It will include an extensive literature review of published research articles related to primary stability of implant placed after indirect sinus lift using osseodensification (OD) without bone graft in prosthodontics.

A combination of in vivo studies involving prospective, retrospective case control studies, randomized clinical trials will be included.

### Structured Question

The systematic review will address the following research question:

In patients receiving dental implants for prosthodontic rehabilitation of maxillary posterior region, how does indirect sinus lift done using osseodensification concept without bone graft would affect the primary stability, and long-term prosthetic clinical success?

The review will focus on:

- Primary stability of implants placed after indirect sinus lift using osseodensification concept without bone graft.
- Effect of osseodensification in increasing bone density.
- Compare the primary stability of implants placed after different techniques of sinus floor augmentation (e.g., Osteotome, Piezoelectric, Hydraulic sinus lift techniques).
- Long-term clinical outcomes of implants placed after indirect sinus lift using osseodensification in prosthodontics.

### Picot analysis:

The study protocol will be designed with an aim to answer the P.I.C.O.T format questions in the following way:

Patients receiving dental implants in prosthodontics (partially edentulous in posterior maxilla) needing

implant-supported prostheses.

Intervention:

The focus of this review is to study the impact of osseodensification on primary stability of implant placed after indirect sinus lift without bone graft and to analyze the recent scientific literature on indirect sinus lift (e.g., Osteotome, Piezoelectric, Hydraulic sinus lift techniques) and its clinical applications in applied prosthodontics.

Comparison: To evaluate and compare the primary stability of implants placed after different techniques of sinus floor augmentation (e.g., Osteotome, Piezoelectric, Hydraulic sinus technique)

Outcome: The review aims to evaluate

Primary Outcomes: Primary stability.

Secondary Outcomes: Prosthetic success, long-term clinical outcomes.

Time: This study has collected articles till January, 2025

Eligibility Criteria

Inclusion criteria:

Type of Studies: Randomized controlled trials (RCTs), clinical trials and systematic reviews (osseodensification including primary stability).

Publication Date: Articles published until January 2025.

Language: Articles published in English.

Study Focus: Studies evaluating primary stability of implants placed in posterior maxilla after indirect sinus lift using osseodensification concept without bone graft in prosthodontics.

Outcome Measures:

- Primary stability of implants placed in posterior maxilla using osseodensification concept.
- Effect of osseodensification (in improving bone integration).
- Clinical success rates (implant survival, prosthetic complications).

Exclusion criteria:

1. Studies not involving osseodensification.
2. Studies focusing on orthopaedic implants instead of dental implants.
3. Studies with insufficient methodology or lacking quantitative data.
4. Review articles pertaining to the present topic.
5. Systematic reviews pertaining to the present topic.

6. Articles published in a different language other than English.

### III. LITERATURE SEARCH STRATEGY

For obtaining the required articles for the present systematic review, a comprehensive bibliographic search of the following electronic data bases will be done: A PRISMA statement guideline with predetermined search strategy will be used. Along with this the search will be also carried out in the reference lists of the eligible studies, review articles, key journals.

The electronic databases included in the study will be:

1. Pubmed/ MEDLINE
2. Google Scholar
3. Cochrane library
4. Scopus
5. Research gate

The time frame utilized to conduct the search included all the studies published until December 2024, without any particular beginning limit. Furthermore, hand search will be performed in the reference sections of studies included (cross-referencing).

Mesh terms used for the search/ Keywords used:

The search strategy will involve combinations of the following keywords using Boolean operators (AND/OR):

- "Osseodensification"
- "Primary stability" OR "Implant anchorage"
- "Indirect sinus lift" OR "Closed sinus lift"
- "Sinus lift elevation" OR "Sinus augmentation"
- "Bone graft" OR "Auto graft"
- "Prosthodontics" OR "implant-supported prostheses"

The data extraction and study selection procedure will be carried out independently by one investigator and reviewed by another to ensure accuracy.

Study selection & screening:

Step 1: Title & Abstract Screening

- Articles will be screened based on relevance to primary stability of implants placed after indirect sinus lift using osseodensification.

Step 2: Full-Text Review

- Selected articles will be analyzed for eligibility based on inclusion criteria.

### Step 3: Quality Assessment

The included records were assessed by two review authors independently using the Joanna Briggs Institute (JBI) Critical Appraisal Tool or Cochrane Risk of Bias Tool to assess the study quality and any differences in opinion between the two reviewers were discussed until agreement was reached. Third review author was also be consulted when needed. Further search in google scholar will be carried out again to ensure that all the relevant articles are included.

### Data extraction & synthesis

A standardized data extraction form will be used to collect key information from each study.

Data extraction will be independently done by two reviewers using a specific format. The specific information will be extracted in the following manner: year of publication, baseline data, study population,

various available methods, follow up period.

Qualitative Synthesis:

Key findings will be summarized narratively.

Quantitative Analysis:

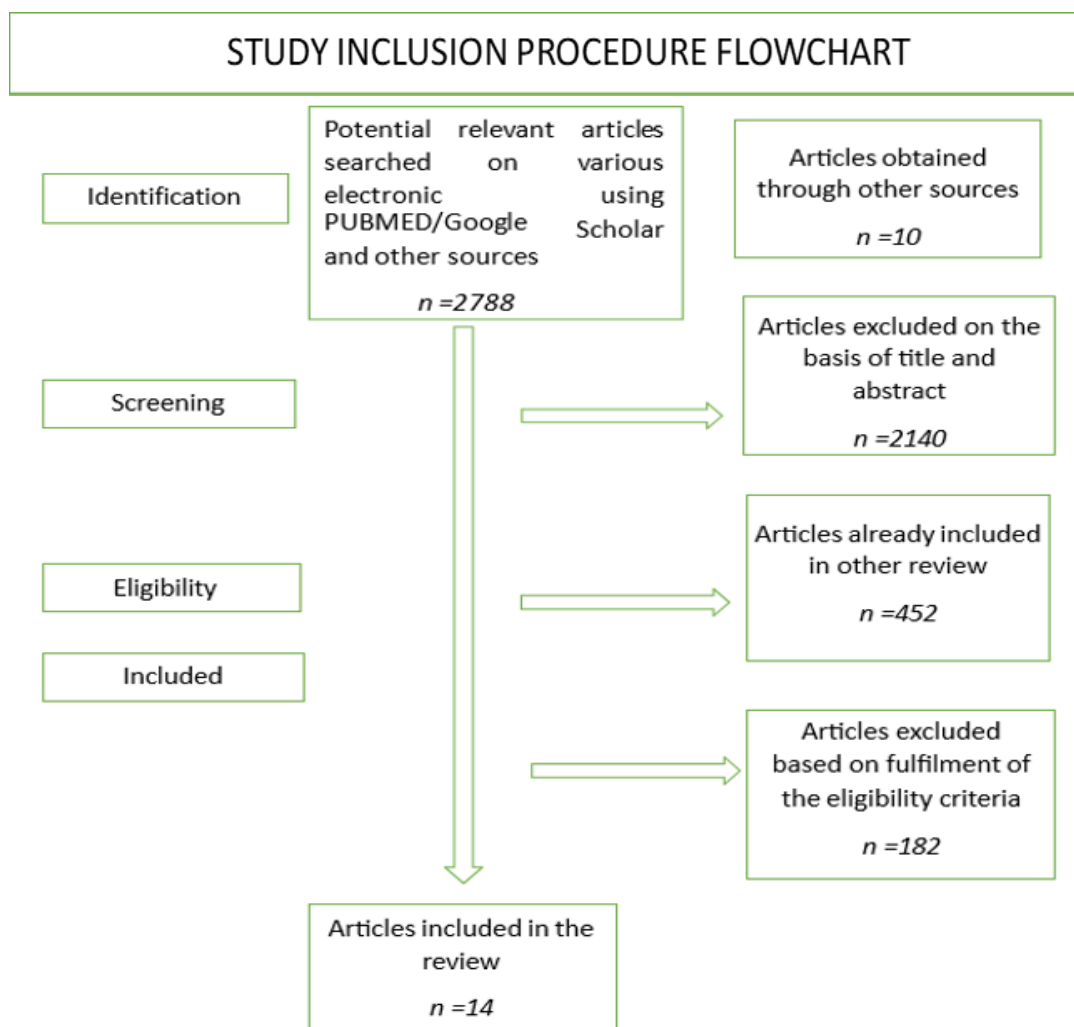
If sufficient data is available, a meta-analysis will be performed using statistical software (e.g., RevMan).

### Risk of bias & quality assessment

To ensure reliability, each study will be evaluated using:

- Randomization Methods (for RCTs)
- Blinding & Control Groups
- Follow-Up Duration
- Reporting of Outcomes

The GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) system will be used to assess the strength of evidence.



## IV. DISCUSSION

The current systematic review was performed to systematically evaluate the publications concerning primary stability of implant placed after indirect sinus lift using osseo densification without bone graft in prosthodontics and the overall success rate of implants used to rehabilitate the posterior maxilla to that of conventional implant placement following other techniques of sinus augmentation procedures.

In this study, studies on osseo densification were reviewed until January 2024 by dividing the data into five tables, and the description of each study is as follows.

Table No 2: A brief summary of some of the in-vitro studies included in the review.

| Sl. No | Investigators Year and Type of the study | Aim of the Study                                                                                                                                                                                                          | Method                                                                                                                                                                                                                                                                                                                                                 | Comparision                                                                                                                                                                                                                                                                                                                     |
|--------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Arafat S W et al in 2019 <sup>35</sup>   | To evaluate crestal sinus floor elevation with either osteotome or osseo densification in posterior atrophic maxilla.                                                                                                     | Twenty-four crestal sinus floor elevations were performed in patients with $\geq 5$ mm residual bone height: 12 with osteotome (Group 1) and 12 with osseo densification (Group 2). Outcomes at 6 and 12 months were clinically and radiographically assessed, including implant stability, marginal bone loss, and bone density                       | It was concluded the use of osseo densification technique would increase primary stability which could be attributed to the enhancement of bone quality and bone-implant contact by preserving the bulk of bone.                                                                                                                |
| 2      | Hindi A R et al in 2020 <sup>36</sup>    | To evaluate the effect of implant site preparation in low-density bone using osseo densification method in terms of implant stability changes during the osseous healing period and peri-implant bone density using CBCT. | Study included 24 patients who received 46 dental implants that were implanted in low-density bone using the osseo densification method. CBCT was used to measure the bone density pre and postoperatively and implant stability was measured using Periotest immediately after implant insertion and then after 6 weeks and 12 weeks postoperatively. | Of 46 implants, 43 osseointegrated (93.5% survival). Bone density increased significantly. Primary stability decreased at 6 weeks then improved at 12 weeks, with no significant difference between primary and secondary stability. Osseo densification yielded high primary stability and increased peri-implant bone density |
| 3      | Aref S et al in 2021 <sup>37</sup>       | To evaluate the effect of osseodensification implant site preparation technique on the initial stability of implant retained maxillary overdentures using Osstell device.                                                 | Six fully edentulous patients were divided into two groups: Group I received 12 maxillary implants using osseo densification, and Group II received 12 implants using conventional drilling. Primary stability was assessed with an Osstell device immediately post-placement.                                                                         | It was concluded that osseo densification technique (Densah burs) showed better effect on implant stability than conventional technique and can be considered in situations when immediate loading of implants is planned.                                                                                                      |
| 4      | Millán J B et al in 2021 <sup>38</sup>   | To evaluate primary implant stability using a new drilling technique termed osseo densification.                                                                                                                          | Implants of group 1 were placed using a new drilling technique termed osseo densification (OD), which was compared with the group 2 implants were placed using conventional under-drilling (UD) method utilized for low-density bones.                                                                                                                 | It was concluded that the implant insertion torque and resonance frequency analysis values were significantly higher in OD group than in UD. Therefore, compared with UD, OD improves primary stability in low-density bones.                                                                                                   |
| 5      | Bergamo E et al in 2021 <sup>39</sup>    | To compare the insertion torque (IT) and temporal implant stability quotients (ISQ) of                                                                                                                                    | Fifty-six patients (150 implants) received narrow, regular, or wide implants of varying lengths in                                                                                                                                                                                                                                                     | ISQ values were consistently higher for osseo densification (OD) than standard drilling                                                                                                                                                                                                                                         |

|    |                                         |                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                 |
|----|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                                         | implants placed via OD or subtractive drilling (SD).                                                                                                                                                                                                             | maxillary (anterior/posterior) or mandibular (posterior) sites. Osteotomies followed manufacturer protocols. Insertion torque (IT) and implant stability (ISQ) were measured at placement, 3, and 6 weeks. Osseo densification (OD) showed significantly higher IT than standard drilling (SD) across all arches, sites, diameters, and lengths—except for short implants.                                                    | (SD) across all arches, sites, and implant dimensions (except short implants). ISQ decreased at 3 weeks but returned to baseline by 6 weeks, remaining above 68 for OD throughout. OD showed superior insertion torque and stability over time compared to SD.                                                                  |
| 6  | Aloorker S et al in 2022 <sup>40</sup>  | A split-mouth study on 10 patients placed bilateral maxillary posterior implants: the left side used sequential osteotomy, and the right used multifluted tapered burs (Densah™).                                                                                | A cone-beam computed tomography (CBCT) was taken preoperatively, immediately after implant placement, and 3 and 6 months after implant placement. The bone density and crestal bone levels were measured.                                                                                                                                                                                                                     | No significant difference was observed in crestal bone levels between osseo densification and conventional sites. However, osseo densification increased residual bone width and maintained it up to 6 months, with significantly higher peri-implant bone density, supporting primary stability and improved osseointegration. |
| 7  | Rodda A et al in 2022 <sup>41</sup>     | A case report of a 60-year-old female who had root stumps in relation to upper left first maxillary molar was presented.                                                                                                                                         | She wanted an implant to replace the root stumps, however, on cone-beam computed tomography (CBCT) examination the sinus was pneumatized and required augmentation. The root stumps were extracted and after a six-month waiting window, she was treated with an indirect sinus augmentation procedure using Densah burs after which an implant (5 mm x 8 mm) was placed with good osseointegration at three-month follow-up. | The Densah bur facilitated sinus lift procedure is a good option for pneumatized sinuses with inadequate residual bone height.                                                                                                                                                                                                  |
| 8  | Mohrez M et al in 2023 <sup>42</sup>    | A case report of 52-year-old male presented to the oral and maxillofacial surgery department with a main complaint of chewing difficulties in the right posterior area maxilla (teeth numbers: 26 and 27) was presented.                                         | A cone-beam computed tomography (CBCT) imaging showed that the residual bone height ranged between 1 and 4mm and the width ranged between 9 and 12mm in the area of teeth numbers 16 and 17. The treatment plan was to extract the teeth (16 and 17) and conduct internal sinus lifting and bone grafting using the OD burs with immediate implantation.                                                                      | It was concluded that osseo densification can be considered as a promising technique for direct sinus floor elevation.                                                                                                                                                                                                          |
| 9  | Mahmoud H B et al in 2023 <sup>43</sup> | A study was conducted to assess the clinical and radiographical outcomes of implant placement in the posterior maxilla with insufficient residual vertical height by sinus lifting, either by osseo densification (OD) or conventional osteotome (OS) technique. | Ten patients underwent 16 crestal sinus lifts (residual height 5–7 mm) with simultaneous implant placement: Group I (OD) – 6 patients, 8 implants; Group II (OS) – 4 patients, 8 implants. CBCT was done pre-op, immediately, and at 6 months; ISQ was measured at placement and 6 months. Data were statistically analyzed.                                                                                                  | Torque was significantly higher and pain significantly lower in the OD group than the OS group. Apical bone density changes were insignificant in both groups. In the OS group, marginal bone loss increased significantly at 6 months. Both techniques achieved good clinical outcomes at 6-month follow-up.                   |
| 10 | Potdukhe S S et al in                   | A systematic review and meta-analysis were conducted to                                                                                                                                                                                                          | A systematic review (2000–2022) searched PubMed, EBSCO,                                                                                                                                                                                                                                                                                                                                                                       | The evidence obtained from quantitative analysis of the                                                                                                                                                                                                                                                                         |

|    |                                          |                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                          |
|----|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 2023 <sup>44</sup>                       | evaluate the difference in primary implant stability and increase in bone height in indirect sinus lift using osseo densification and the osteotome technique. | Cochrane, and Google Scholar for studies on primary implant stability and bone height gain in indirect sinus lifts using osseo densification (OD) vs. osteotome (OS) techniques. From 8521 titles, 9 studies were included qualitatively and 5 quantitatively. Meta-analysis showed no significant difference in bone height gain, but OD achieved higher primary implant stability than OS.                                                                                                         | studies determined that the osseo densification group showed higher primary implant stability than the osteotome group. However, for mean increase in bone height, there was no statistically significant difference between the groups.                                                                                 |
| 11 | Othman R A A et al in 2024 <sup>45</sup> | To evaluate the primary stability of dental implants placed in closed sinus lifting using osseo densification technique.                                       | Ten patients (aged 40–70) with $\leq 5$ mm residual bone under the maxillary sinus underwent implant placement. Stability (ISQ), bone height, and density were assessed over 9 months. Mean ISQ increased from $71.00 \pm 9.64$ (primary) to $72.70 \pm 7.59$ at 3 months and $76.70 \pm 6.20$ at 9 months, showing a significant improvement.                                                                                                                                                       | It was concluded that osseo densification (OD) technique using Densah Burs is a different method of treating crestal sinus floor elevation that also has the potential to greatly reduce the amount of time needed to place dental implant at the posterior maxilla while reducing trauma and postoperative discomforts. |
| 12 | Gaspar J et al in 2024 <sup>21</sup>     | a narrative review was presented on osseo densification technique in crestal maxillary sinus elevation                                                         | This article reviewed the evolution of implant site preparation and evidence on osseo densification, emphasizing its role in sinus floor augmentation. It proposes three protocols for sinus lift with implant placement, discusses Schneiderian membrane perforation risks by residual bone height, and summarizes implant and patient-reported outcomes.                                                                                                                                           | They concluded that integration of this technique into contemporary practice represents a paradigm shift, offering a minimally invasive and efficient solution for addressing the challenges of posterior maxilla, with improved patient reported outcomes and low complication rate.                                    |
| 13 | Kolhe V et al in 2024 <sup>46</sup>      | Analyzised new bone formed after indirect sinus lift using Densah bur at 6 months and 1 year postoperatively                                                   | Fifteen healthy adults ( $\geq 18$ yrs) with edentulous posterior maxilla and $\geq 3.5$ mm residual bone height underwent osseo densification (OD) for implant placement to support fixed restorations. Patients had adequate bone width and no metabolic bone disorders or related medications. Implant stability was evaluated using Periotest.                                                                                                                                                   | It was concluded that osseo densification (OD) is a dependable and simple method that does not require specific equipment for the treatment of low-density edentulous areas, particularly in patients with osteoporosis.                                                                                                 |
| 14 | Salari A et al in 2024 <sup>47</sup>     | A narrative review was presented on osseodenstification, a new approach in transcresal sinus lift.                                                             | Maxillary sinus floor elevation can be performed using various techniques, including osseo densification (OD). This review analyzed literature on OD burs for sinus lift, comparing their advantages and disadvantages to other methods. The unique counterclockwise, non-cutting design of Densah burs compacts bone, elevates the Schneiderian membrane, reduces surgery time and complications, increases bone density, and improves implant stability and success in low-density maxillary bone. | It was concluded that this method is considered as an alternative technique to invasive and time-consuming open sinus lift, especially in cases where the maxillary residual bone height is too low.                                                                                                                     |

In the posterior maxilla, when the residual bone height is less than 5 mm, external sinus lifting is always the best method to secure sufficient bone height for implantation. However, implantation is always delayed because of the low density of the bone, the lack of primary stability, and the Bone-to-Implant Contact (BIC) of the implants in this area. Some techniques use the transcrestal approach to increase the bone height in such cases (osteotomes, balloon, piezosurgery, etc.). The use of the crestal approach techniques increases the bone height without improving the quality of the bone, so implantation was also delayed. Osseo densification (OD) is a new technique developed by Huwais in 2013<sup>21</sup>.

OD can be done by using specially designed burs (Densah burs). The usage of Densah burs can elevate the sinus membrane more than 8 mm and also improves the primary stability of the implants placed in the posterior maxillary region.<sup>22</sup> Millan JB<sup>38</sup> et al and Bergamo E et al<sup>39</sup> in 2021 mentioned that when compared to conventional under-drilling, implants placed after osseo densification showed significantly higher insertion torque and resonance frequency values at baseline and also over time irrespective of sites, arches, and implant dimensions (except for short implants).

Osseo densification is a novel approach that has significantly advanced the field of implant dentistry, particularly in the context of transcrestal maxillary sinus floor elevation. This technique involves the use of specially designed burs that compact and densify bone along the osteotomy walls, thereby enhancing implant primary stability and facilitating osseointegration in low-density bone. The implant primary stability is a crucial factor to achieve implant osseointegration. High primary implant stability is critical in immediate loading protocols, and it was reported that implant micromotion above 50–100  $\mu\text{m}$  potentiated peri-implant bone resorption or implant failures.<sup>23</sup> Salari et al<sup>47</sup> in 2024 reported in a review that there was significant difference in crestal bone resorption and failure rate for inserted implants with low insertion torque values. They also demonstrated the ability of OD burs to increase BIC% for dental implants placed in low-density bone compared to traditional osteotomies, which can help improve osseointegration. Aref S et al<sup>37</sup> in 2021 concluded that osseo densification showed a better effect on primary stability than conventional techniques and can be

considered in situations when immediate loading of implants is planned.

Unlike conventional osteotomy, it uses specialized high-speed densifying burs to prepare osteotomy and autograft bone in the phase of plastic deformation. An osteotomy preparation procedure is recognized as osseo densification, which is a novel, biomechanical, non-excavation method and requires specially designed densifying burs known as Densah burs. This drill increases the primary stability via non-subtractive drilling unlike traditional drills. Densifying burs have the advantage during osteotomy to control the tactile feedback and speed of drills. The OD process produces a layer of autograft around the implant with an osteotomy surface.<sup>48</sup> Hindi AR et al<sup>36</sup> in 2020 stated that there was a significant increase in peri-implant bone density after implant placement using the osseo densification technique. The reason behind the conception of OD is that autologous bone contact through an endosteal device accelerates osseointegration because of osteoblasts nucleating on instrumented bone adjacent to the implant and increased primary stability because of interlocking between the device and bone. A study conducted by Aloorker S et al<sup>40</sup> in 2022 found that osseo densification increased residual bone width and significantly decreased the time needed to place the dental implants.

Secondary stability of bone and dental implants by the process of osseointegration is vital for the success of implant placement. The maxillary posterior region with low bone density affects histomorphometric parameters such as the percentage of bone-implant contact and bone volume. However, the increase of bone density by osseo densification has improved these negative effects, thereby having a potentiating effect on secondary stability.<sup>23</sup>

A recent randomized clinical trial was conducted by Gaspar J et al<sup>49</sup> in 2024 they concluded that OD is more effective than the lateral window (LW) technique in sinus lift elevation (SLE) with simultaneous implant placement when residual bone height is  $\leq 4$  mm and has significantly improved outcomes in terms of pain experience, impact on self-perceived quality of life, surgery duration, postoperative edema, and analgesic intake. Postoperative symptoms self-reported by patients such as edema, hematoma, and epistaxis were all significantly more prevalent in the LW group. Farina

R et al<sup>50</sup> in 2018 also observed a significantly lower incidence of swelling, bruising, and nasal bleeding with transcresal SLE compared to the classical LW approach. However, the surgical act of tapping the osteotome should not be underestimated since it may cause more postoperative discomfort during the first days of healing.<sup>51</sup>

The results of this systematic review emphasize a shorter and faster treatment modality to achieve optimum primary stability and improved bone height and width of implants placed after indirect sinus lift without bone graft using osseo densification in the posterior maxilla. Therefore, establishing standardized criteria that incorporate this technique would be beneficial for structuring further investigations and would permit comparisons in future research endeavors.

## V. SUMMARY

Implant treatment success or failure is determined by several factors including patient health status, surgeon skill, implant design, osteotomy site preparation, and design of the prosthetic reconstruction. In the posterior maxilla, when the residual bone height (RBH) is less than 5 mm, external sinus lifting was always the best method to secure sufficient bone height for implantation.<sup>52,53</sup> However, the implantation was always delayed because of the low density of the bone and the lack of primary stability, and the Bone-to-Implant Contact (BIC) of the implants in this area.<sup>54</sup> Some techniques used the transcresal approach to increase the bone height in such cases (osteotomes, balloon, piezosurgery, etc.). These techniques were more favorable because they were simpler and caused fewer complications than the lateral approach technique.<sup>55</sup> The use of the crestal approach techniques increased the bone height without improving the quality of the bone, so the implantation was also delayed. Osseo densification (OD) is a new technique developed by Huwais in 2013.<sup>21</sup> OD can be done by using specially designed burs (Densah burs). The use of the Densah burs allows densifying, condensing, preservation and autografting the bone in all directions, which enhances the BIC<sup>56</sup>, and it also reduces the risk of complications such as sinus membrane perforation and bleeding compared to other techniques, so the implantation could be done in the same lifting and grafting procedure through the

transcresal approach. Densah burs does not work with cortical bone as cortical bone lacks plasticity but the minimum width should be more than 4 mm and the RBH should be at least 7 mm.<sup>57</sup> The usage of Densah burs can elevate the sinus membrane more than 8 mm, and also improve the bone quality, so the implants were inserted in the same elevating and grafting stage without using a collagen membrane.<sup>58</sup> On the other hand, the other transcresal lifting techniques elevated the sinus membrane between 4 and 12 mm also without using collagen membrane but the implantation was delayed because of the lack of primary stability.<sup>59</sup> Finally, using the OD concept in transcresal sinus lifting for the severely absorbed posterior maxilla increases the bone height and the bone-to-implant contact percentage, so the implantation could be done in the same lifting procedure, which reduces the treatment period. It also produces fewer complications than the lateral approach. OD burs have been shown as a safe alternative with high predictability for transcresal sinus floor elevation, even though severe posterior maxillary atrophy (RBH  $\leq 3$  mm) presented as a risk factor for increased membrane perforation rate.

The findings of this systematic review highlight the shorter and faster method of implants placement alongside sinus lifting procedure with the new concept of osseo densification. This concept has shown significant primary stability, improved bone density, compared to the conventional techniques of sinus lifting in posterior maxilla. Consequently, the development of standardized criteria that encompass this technique would be advantageous for organizing future studies and facilitating comparisons in subsequent research efforts.

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