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A Comparative Evaluation of Crestal Bone Loss around Implant Placed With Osseodensification versus Conventional Drilling: A Systematic Review

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Abstract

Introduction: Minimizing crestal bone loss is a critical factor for the long-term success and stability of dental implants. Conventional drilling techniques often result in bone removal, potentially compromising bone density around the implant site [1]. In contrast, osseodensification—a novel technique using specially designed burs—aims to preserve and compact bone during osteotomy preparation. This systematic review was conducted to compare crestal bone loss around implants placed using osseodensification versus conventional drilling techniques.

Methodology: A comprehensive literature search was performed in PubMed, Google Scholar, ScienceDirect, and Cochrane databases for studies published between January 2004 and May 2024. Additional manual searches were conducted in relevant journals and reference lists. Studies were selected based on predefined inclusion and exclusion criteria. Two independent reviewers screened the titles, abstracts, and full texts, and a third reviewer resolved any discrepancies. Data were extracted and analyzed qualitatively and quantitatively. Risk of bias was assessed using Cochrane ROB 2 for RCTs and Newcastle-Ottawa and Downs-Black tools for observational studies.

Results: A total of 654 articles were initially identified. After removing duplicates and screening, 7 studies met the inclusion criteria and were included in the final review. Most studies reported reduced crestal bone loss in implants placed using osseodensification compared to conventional drilling, particularly during early healing and up to 12 months post-placement. Quantitative synthesis revealed a statistically significant reduction in mean crestal bone loss in the osseodensification group.

Discussion: The findings suggest that osseodensification enhances primary stability and promotes bone preservation around the implant neck, likely due to bone compaction and improved bone-implant contact. However, variations in implant systems, follow-up periods, and measurement techniques among studies necessitate cautious interpretation. Despite some heterogeneity, the overall trend supports the clinical benefit of osseodensification in reducing crestal bone loss.

Conclusion: Within the limitations of this systematic review, osseodensification appears to be a superior technique in minimizing crestal bone loss around dental implants when compared to conventional drilling. Further long-term, multicenter randomized controlled trials with standardized protocols are recommended to validate these findings.

Keywords: Crestal Bone, Dental Implant Therapy, Osseodensification, Reduces Micromotion

Introduction

Dental implant therapy has become a widely accepted and predictable treatment modality for the rehabilitation of partially or completely edentulous patients. Long-term success of dental implants is not only determined by osseointegration but also by the preservation of crestal bone levels around the implant site.[1] Crestal bone loss remains a common clinical concern, particularly during the early healing phase, and is influenced by various biological and mechanical factors, including surgical technique, implant design, and host response.[2]

Successful dental implant therapy largely depends on achieving and maintaining osseointegration, with crestal bone preservation being a critical factor in long-term implant success. [3] Among the many variables influencing this outcome, surgical drilling technique plays a pivotal role in determining the initial stability of the implant and the quality of the surrounding bone. [4,5]

Conventional drilling techniques utilize a subtractive approach that removes bone to create an osteotomy, often compromising bone density and risking thermal injury or microfractures. [1,6] In contrast, osseodensification (OD) is a novel, non-subtractive drilling method that compacts bone around the osteotomy site using specially designed densifying burs. This technique is proposed to enhance primary stability, preserve bone volume, and potentially reduce crestal bone loss by promoting autografting and osteoblast activity. [4,7]

Emerging evidence suggests that osseodensification may provide superior outcomes in terms of implant stability and marginal bone preservation, especially in low-density bone regions. However, the available literature shows variability in clinical findings, with some studies reporting significant advantages while others show comparable results with conventional techniques. [3,8]

This systematic review aims to evaluate and compare the crestal bone loss around dental implants placed using osseodensification versus conventional drilling methods. By synthesizing available clinical data, this review seeks to provide a clearer understanding of the impact of these surgical techniques on peri-implant bone preservation and long-term implant success.

Several clinical studies have compared the outcomes of implants placed using osseodensification and conventional drilling protocols, with particular emphasis on peri-implant bone changes. However, a consolidated and critical analysis of available evidence is essential to determine whether osseodensification provides a significant clinical advantage in preserving crestal bone.

Mechanisms of Osseodensification

Osseodensification is a biomechanical and biological process that enhances implant site preparation through controlled mechanical compression rather than bone removal. Specialized drills compact the bone, inducing microfractures that trigger adaptive bone remodeling, a response driven by the bone's natural plasticity. [4,7] This process stimulates osteoblast activity, promoting new bone formation and increased mineralization around the implant site. Additionally, osseodensification enhances angiogenesis, improving blood supply and fostering an environment supportive of healing and osseointegration. The result is a denser, more stable bone matrix that provides superior implant anchorage, reduces micromotion, and strengthens long-term clinical outcomes, marking a significant advancement in implantology. [2,8]

Materials and Method

A comprehensive systematic review was carried out. This study followed the "Preferred Reporting Items for Systematic Reviews and Meta Analyses 2020 (PRISMA 2020), the Cochrane Handbook for Systematic Reviews of Interventions, version 5.1.0, and 4th Edition of the JBI Reviewer's Manual" and was registered at PROSPERO under registration code CRD42024510507.

Review Questions

1. What is the effect of implant placement with osseodensification on crestal bone loss?
2. What is the effect of implant placement with conventional drilling on crestal bone loss?

PICO Framework

- **Population (P):** Patients with dental implants
- **Intervention (I):** Implants placed using osseodensification
- **Comparison (C):** Implants placed using conventional drilling
- **Outcome (O):** Crestal bone loss around implants

Search Strategy

A comprehensive literature search was conducted in PubMed, Google Scholar, and ScienceDirect, covering studies published from January 2004 to May 2024. The reference lists of included articles and related systematic reviews were screened for additional studies.

Search terms were identified through a concept table based on the PICO format using MeSH terms and free-text keywords, combined with Boolean operators and other search modifiers (e.g., truncation, phrase searching).

Inclusion Criteria

- Human in vivo studies, including randomized controlled trials (RCTs), clinical trials, case reports, and case series
- Studies published in English from 2004 to 2024

Exclusion Criteria

- In vitro or animal studies
- Review articles, systematic reviews
- Studies not clearly reporting outcome measures or surgical technique
- Pilot or preliminary studies

Selection Process

The selection process followed PRISMA 2009 guidelines. Two independent reviewers screened all retrieved records (n = 654) for title, abstract, and full-text eligibility. Disagreements were resolved by discussion or by consulting a third reviewer.

- **Title screening:** 585 articles excluded
- **Abstract screening:** 25 articles excluded
- **Full-text screening:** 14 articles excluded

A total of 7 studies met the inclusion criteria and were included in the qualitative and quantitative synthesis. Duplicate entries were removed using Mendeley Desktop software. A concept table was prepared based

on the PICOS criteria of the review question and the search strategy was formulated according to it. (Table 1)

Data Extraction

Two reviewers independently extracted data using a standardized form. Extracted details included:

- Author and year of publication
- Study design
- Number of patients and implants
- Patient age range
- Follow-up duration
- Implant site and surgical protocol
- Implant success rate

Data Analysis

Data from included studies were tabulated and analyzed descriptively. Quantitative synthesis (meta-analysis) was conducted if data homogeneity permitted. Extracted data were managed using Microsoft Excel.

Risk of Bias Assessment

Risk of bias was independently assessed by two reviewers based on study design:

- **RCTs**: Cochrane Risk of Bias Tool (ROB 2)
- **Observational studies**: Newcastle-Ottawa Scale and Downs-Black Checklist

Results

Study Selection

A total of 654 articles were initially identified through electronic (PubMed = 33, Cochrane = 13, Google Scholar = 606) and manual searches (n = 2). After duplicate removal, 631 articles were screened by title and abstract. Following full-text assessment, 7 studies met the inclusion criteria and were included in the final analysis. The PRISMA 2009 flow diagram illustrates the selection process. (Figure 1x)

Study Characteristics

Details of the 7 included studies are summarized in Table 2. These studies varied in design, including randomized controlled trials, prospective cohort studies, and clinical comparative studies. All studies included human subjects with implants placed using either osseodensification or conventional drilling techniques, and followed up over variable time periods ranging from 3 months to 24 months.

Assessment of risk of bias in included studies

This assessment was conducted by using the recommended approach for assessing risk of bias using Cochrane ROB2. The tool is particularly useful to those undertaking systematic reviews that include randomized studies using the tool RevMan 5.4.1

We used the two-part tool to address the seven specific domains

- Bias due to randomisation
- Bias in allocation concealment
- Bias in blinding of participants & personnel
- Bias in blinding of outcome
- Bias due to missing data/incomplete data
- Bias in selective reporting
- Other bias

The signalling questions are broadly factual in nature and aim to facilitate judgements about the risk of bias.

There was a good reliability between the two reviewers with a high kappa coefficient ($k>0.89$)

We completed a 'Risk of bias' table & summary for each included study.

The risk of bias has been summarized in the traffic light plot [Table 3] and the summary plot [Figure 2].

Crestal Bone Loss Outcomes

Across all included studies, crestal bone loss was consistently lower in the osseodensification group compared to the conventional drilling group. While the absolute values varied depending on implant system, site, and follow-up duration, the difference in crestal

bone preservation was statistically and clinically significant in 5 out of 7 studies. Key findings included:

- Greater initial bone density and compaction in osseodensification cases
- Improved implant stability and reduced marginal bone remodeling over time
- Studies with longer follow-up periods (12–24 months) continued to show favorable outcomes in osseodensification cases
- Implant success rates were reported as comparable between both groups, though marginally higher in osseodensification in some studies

Implant Success and Follow-up

Implant success rates in both groups ranged from 94% to 100%. Patients lost to follow-up were minimal and accounted for in the statistical analysis of each study. No major adverse outcomes were reported specifically related to the osseodensification technique.

Discussion

This systematic review synthesizes current clinical evidence comparing crestal bone loss around implants placed using osseodensification (OD) versus conventional drilling techniques. The reviewed literature consistently demonstrates the promising therapeutic potential of OD across various clinical scenarios.

According to study conducted by Anjum Sultana et al showed that ,the primary stability and crestal bone levels of implant placed with osseodensification was found to be slightly higher than implants placed using conventional drilling strongly indicated that OD drilling technique had no negative influence on bone healing as compared to traditional drilling. This can be due to Osseous densification preserves bone bulk in two ways: compaction of cancellous bone due to viscoelastic and plastic deformation and compaction of autografting of bone particles along the length and at the apex of osteotomy.[1] According to Marwa Kothayer et al, showed that Densah bur drilling significantly increased primary implant stability compared to conventional drilling. This may be due to the claim that this technique preserve bone by two ways, first by compacting cancellous bone by its plastic deformation second by autografting of bone particles at the apex and length of osteotomy[. Osseointegration or secondary stability is affected by the quality and quantity of bone at bone -implant interface. Osseodensification leads to increase bone at implant surface by increasing bone mineral density in peri-implant area. This explained why secondary stability of implants placed by Densah bur drilling was slightly higher than when the conventional drilling burs were used The results of this study for marginal bone loss after 6 months follow up match that of other studies in which there was no significant difference between both types of drills used was no significant difference between both types of drills used. [2] According to study conducted by Mai Atef Hassan, results showed statistically significant difference when comparing bone density at 7 months and 12 months in osseodensification group, however in the conventional group statistically significant difference when comparing bone density of base line and 12 months. This may mean rapid healing, bone growth and remodeling in osseodensification group than conventional group which was clarified by Trisi et al.,32 study on sheep. Results showed that the intragroup comparison of marginal bone loss (MBL) showed statistically significant difference in the osseodensification group when comparing MBL base line and 7 months, also MBL base line and 12 months. However, there was no statistically significant difference between MBL at 7 &12 months. On the other hand, in the conventional group, there was statistically significant difference between MBL values at different evaluation

period. [3] According to article given b Siddhant Aloorker radiographic bone density was found to significantly difference. Higher bone density found around implants placed with osseodensification technique than the conventional one. This could be attributed to the fact that the osteoblasts were nucleating on instrumented bone which is in close approximation with the implant surface. Due to the presence of a layer of autografted bone around the implants in the area of osseodensification, the proximity allowed a quicker rate of osseointegration process. Comparison of crestal bone levels between both the group was not significant. [4] According to article given by Heba Abo-Elfetouh Elsheikh et al, Based on results, preparing the implant bed using the undersized drilling technique with the same drills of similar geometry to the implant being inserted provides a superior implant primary stability than using bone expanders or Densah burs, so the undersized technique could be the technique of choice for an early loaded dental implant in the posterior maxilla as it is an easy technique without certain precautions during osteotomy preparation and does not need additional drills or additional cost to the patients. [5] According to article by Dr. Yashasri Chatru, conducted study for radiologically evaluated marginal bone loss around dental implants which shows there is a decrease in crestal bone levels after 6 months from the baseline in both the groups. However, implants placed using osseodensification showed comparatively higher crestal bone levels after 6 months. [6] Shaimaa Lotfy Mohammed et al conducted study on Osseodensification Versus Conventional Drilling Technique on The Bone Height Changes of Implant Retained Maxillary Overdentures. The results showed that, there was statistically in-significant difference in the marginal bone height loss between the two studied group during the follow up period. However, the buccolingual width of the residual bone was increased after osseodensification and remains in the increased dimension for at least six months After six months, there was reported the least bone loss around the implants in Osseodensification group than the conventional drilling. [7]

Several studies, including those by Arafat and Elbaz [9] and Aloorker et al [4] highlighted enhanced implant stability and radiographic bone density following OD, particularly in challenging maxillary posterior regions. Bergamo et al.[10] further supported these findings with reports of higher insertion torque and ISQ values when OD was employed, reinforcing its biomechanical benefits. Similarly, Mohammad and Ahmed, and Ibrahim et al. [11,12] observed reductions in crestal bone loss and improved stability, suggesting superior early osseointegration with OD.

However, not all studies reported statistically significant differences. Sultana et al [1] and Chatru et al. [6] found that while OD may offer slightly better outcomes, the differences in crestal bone preservation were not always statistically significant. Elsheikh et al. [5] even reported superior stability with undersized drilling over OD in specific cases. These discrepancies underscore the nuanced influence of bone density, implant site, and surgical technique on clinical outcomes.

From a biological perspective, OD works by preserving and compacting autogenous bone particles during osteotomy preparation, which facilitates improved bone-to-implant contact (BIC) and enhances peri-implant bone density. Histologic insights from Lahens et al. [13] and clinical studies on overdenture implants by Mohammad and Ahmed [7] affirm this mechanism, suggesting better osseointegration due to increased osteoblast activity and bone mineral density around the implant.

The included studies also examined bone remodeling over time. For instance, Mai Atef Hassan [3] reported more rapid bone healing and remodeling in OD-treated sites, especially evident in longitudinal comparisons of marginal bone levels. Studies like that of Shaimaa Lotfy Mohammed[7] noted stable buccolingual bone width and reduced marginal bone height loss in the OD group, reinforcing OD's role in dimensional bone preservation.

Despite encouraging outcomes, not all evidence uniformly supports OD's superiority. Heterogeneity in study designs, implant systems, follow-up periods, and sample sizes introduces variability. Furthermore, while OD is mechanistically advantageous, its cost-effectiveness and complexity compared to simpler techniques like undersized drilling remain open for discussion

Conclusion

Within the limitations of this systematic review, the following conclusions can be drawn:

The primary objective of this review was to evaluate and compare crestal bone loss around dental implants placed using osseodensification (OD) versus conventional drilling techniques. An extensive electronic search of PubMed, Cochrane Library, and Google Scholar databases, along with a manual search of institutional journals, was conducted for articles published between January 2004 and May 2024 by two independent reviewers.

Based on the findings from the included studies, it can be concluded that:

- Osseodensification technique results in reduced crestal bone loss compared to conventional drilling, indicating its clinical superiority for implant placement, particularly in regions with low bone density.
- While variations in implant surface treatments did not show statistically significant differences in crestal bone preservation, the technique of osteotomy preparation played a more decisive role in influencing outcomes.
- Osseodensification demonstrated a clear advantage in terms of enhancing primary stability, increasing bone-to-implant contact, and preserving bone architecture, all of which are critical for long-term implant success.
- The clinical performance of implants placed using the OD technique was consistently favorable across studies, supporting its adoption as a preferred approach in both routine and compromised cases.

In summary, osseodensification represents a promising surgical protocol that enhances implant integration and minimizes crestal bone loss. However, further well-designed randomized controlled trials with larger sample sizes and longer follow-up durations are necessary to substantiate these findings and establish definitive clinical guidelines.

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Legend Tables and Figures

Table 1: Concept Table

Pico	Population	Intervention	Comparison	Outcome
1	Patients with dental implants	Implants placed with osseodensification	Implant placed with conventional drilling	Crestal bone loss around implants

Table 2: Characteristics of the included studies

Sn.	Author and year of publication	Study design	Number of patients	Age of patient [range]	Implant site	No. of implants placed	Patients with test group(implant placed with osseodensification)	patients control group	Follow up duration [range]	Crestal bone loss
1	Anjum Sultana et al 2020	In- Vivo Comparative study	20 patients	-	Edentulous maxillary anterior region	20	10	10	0, 3,8 months	T-more crestal bone levels than C group
2	Marwa Kothayer et al 2020	Split-mouth study clinical study	10	45-60 years	Bilateral posterir Maxilla	20	10	10	6,12 months	C-1.36 ± 0.21 T-1.2 ± 0.18
3	Mai Atef Hassan et al 2021	Split-mouth study clinical study	7	40-59 years female	bilateral posterir Maxilla	14	7	7	0,7,12 months	C-2.45 ± 0.60 T-2.46 ±1.05
4	Siddhant Aloorker et. al 2022	Split-mouth study clinical study	10	-	Edentulous bilateral maxillary posterior region	20	10	10	0, 3,6 months	T-13.411±1.9 C13.345±2.057
5	Heba Abo-Elfetouh Elsheikh et al - 2022	Randomised Control Trials	20	20 years or more	posterir Maxilla	36	12	12	0, 4 weeks, 6 months 1,2 3 years	C-1.03 ± 0.14 Mesially, 1.02 ± 0.19 Distally T-1.12 ± 0.08 medially 1.07 ± 0.09 distally
6	Dr. Yashasri Chatru et al 2023	Clinico-radiographic study	16	18-55years	Edentulous posterior region with D3 & D4 bone	16	8	8	0, 3,6 months	C-more crestal bone loss s than T group
7	Shaimaa Lotfy Mohammed et. al 2023	Split-mouth study clinical study	10	50-65 years	Complete edentulous both ridges	40 (4 implnats in each patient)	20 (2 implnats in each patient)	20 (2 implnats in each patient)	0,6,12 months	T-1.01±0.125 C- 1.115 ±0.137

Table 3: Traffic light plot for Risk of Bias

Studies (year)	Randomization process	Allocation concealment	Blinding of participants & personnel	Blinding of outcome	Incomplete outcome data	Selective reporting	Other Bias
Yashasri Chatru et al 2023	+	−	?	?	+	+	?
Shaimaa Lotfy Mohammed et al 2023	?	?	?	?	−	?	?
Siddhant Aloorker et al 2022	+	−	?	+	−	+	+
Mai Ateh Hassan et al 2021	+	+	+	−	?	−	?
Heba Abo – El fetouh et al 2022	+	+	+	+	+	?	+
Marwa Kothayer et al 2020	?	+	?	?	+	+	?
Anjum Sultana et al 2020	+	+	+		+	−	+

+/Green Colour: Low Risk of Bias

?/Yellow Colour: Some Concerns

−/Red Colour: High Risk of Bias

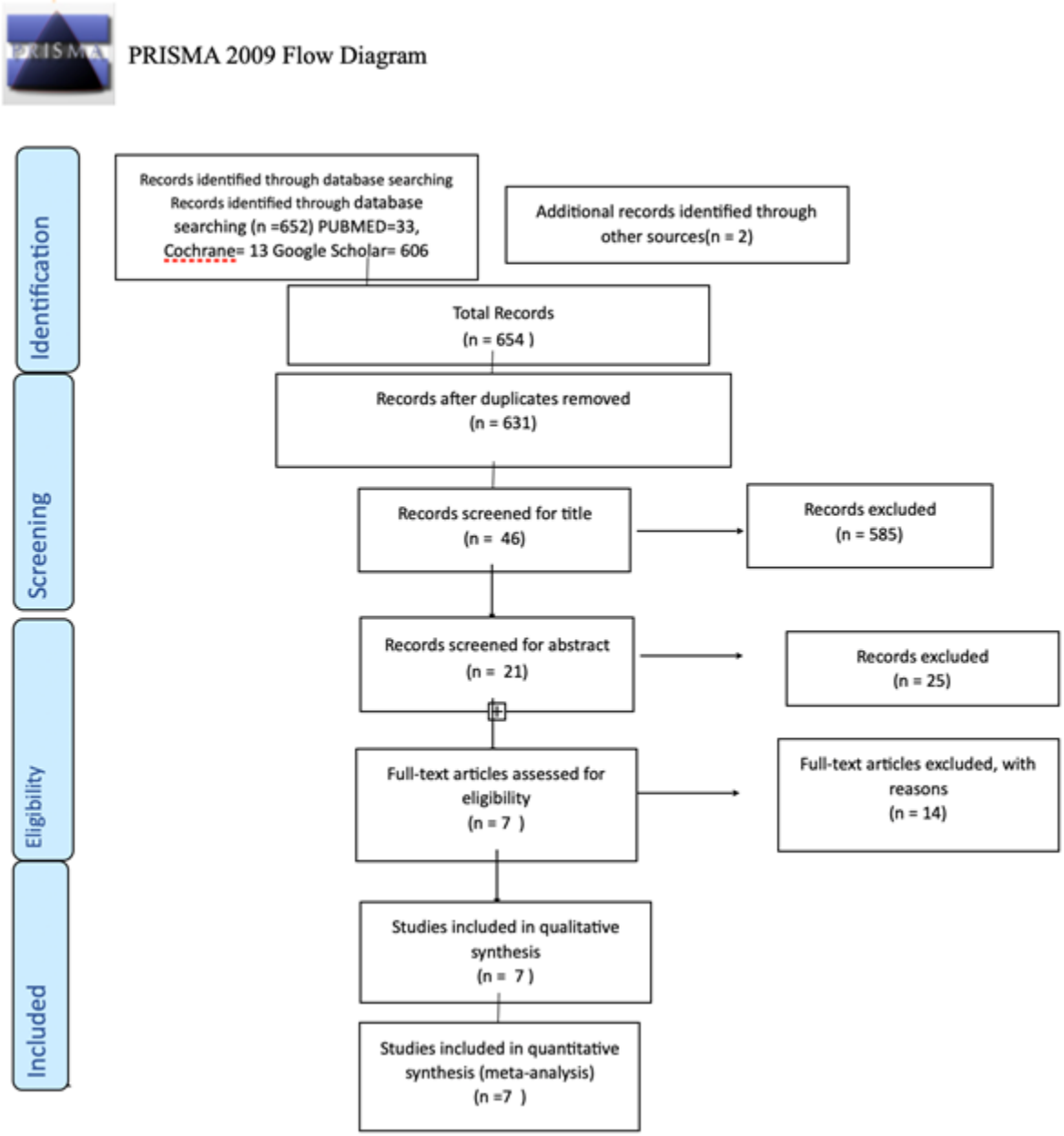

Figure 1: The Preferred Reporting Items for Systematic Reviews and Meta Analyses flowchart

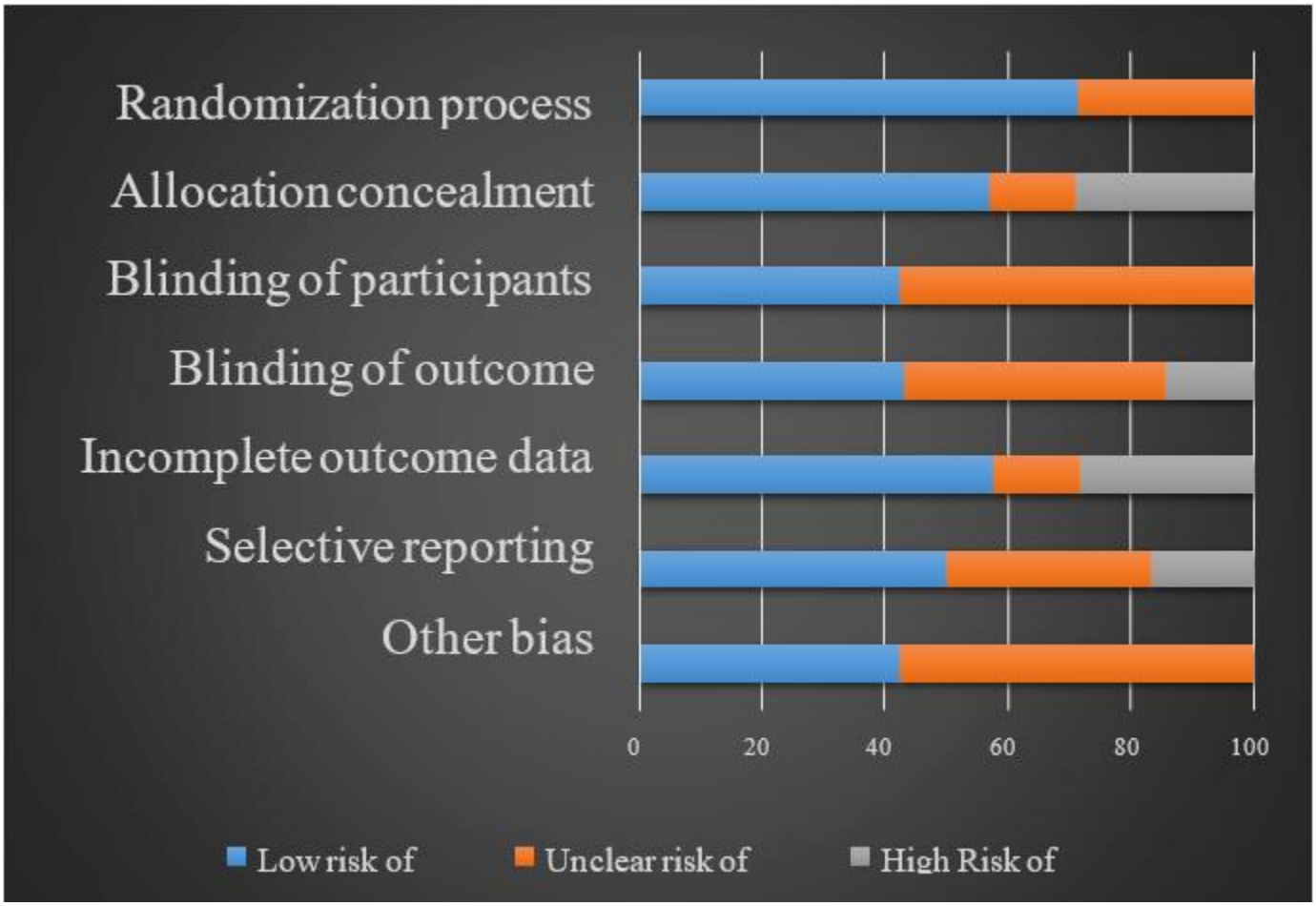

Figure 2: Summary plot for Risk of Bias