A meta analysis for evaluation of marginal bone level changes at dental implants

ABSTRACT
Aim: The aim of this study was to assess the marginal bone level changes at dental implants after 1 year in function.
Methods: Detailed searches from PubMed databases were made. A MEDLINE search (PubMed) published in the English language from 1980 to December 2018 was included in this study.
Results: The electronic database research (MEDLINE) produced 166 corresponding articles. One hundred and twenty studies were excluded on the basis of abstract while the 46 researches were used chosen for full-text examination after the title and abstract testing, and 41 studies were excluded that did not meet the requirements of our inclusion and exclusion criteria. A total of 5 studies for a quantitative analysis were taken into account.
Conclusion: Within the limits of the study, the mean marginal bone loss (MBL) was found to be 0.56 mm. A statistically significant difference in the MBL was found between the various studies.
Keywords: Dental implants, marginal bone loss, meta-analysis, prospective study, randomized control study

INTRODUCTION
Tooth loss can be caused by periodontal disease, abscess formation, trauma, or vertical tooth fracture. Common consequences of tooth loss include progressive alveolar bone resorption and ultimately decreased masticatory function. Hence, there are several ways for the rehabilitation of the edentulous arch, the most important being the endosseous dental implants.[1‑3]

Friedman PK (2000) has established the conventional loading of implant.[1,4] Authors suggested a waiting period of 3–6 months for the proper osseointegration.[5] Loading before this healing phase will ultimately lead to hindrance in stability and implant failure.[6] This failure in the implant stability ultimately leads to marginal bone loss (MBL). The success rate of well-osseointegrated implant is evaluated by the MBL found after the implantation.[7,8]

Many factors that lead to MBL involve – microgap,[9] surgical trauma,[10] peri-implantitis,[11,12] occlusal overload,[13,14] bacterial colonization,[15] biologic width formation,[16] implant–abutment interface design,[17] and implant surface topography.[18]

According to Wieland M et al. (2004), a successful implant should sustain <1.5 mm of bone loss during the 1st year in function and <0.2 mm annually thereafter. Further, to

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The biologic width has consists of approximately 1 mm of connective tissue, 1 mm of epithelium, and 1 mm or more of sulcular depth, around natural teeth, so, the reformation of biologic width around dental implants contribute to early implant bone loss. This process starts immediately after Stage 2 surgery. The dimension and position of the biologic width which are related to the degree of early implant bone loss during surgical healing phase may be determined by the location of the microcap if present, or implant crest module designs such as surface textures, implant–abutment interface designs in 2 part implants, and the location of a junction between rough and polished surfaces. Therefore, it would appear that among all possible contributing factors, reformation of biologic width, occlusal overload, microgap, and implant crest module are most likely contributing causes for early implant bone loss phenomenon.

The aim of this study was to evaluate the marginal bone level changes after 1 year of function through a systematic screening of the literature.

**METHODS**

This review was performed according to the Preferred reporting items for Systematic Reviews and Meta-Analyses statement. The focused question serving for literature search was structured according to the:

PICO format:
- **P** – Patients with implants
- **I** – After loading
- **C** – Bone loss after 1 year compared to no MBL
- **O** – Marginal bone loss.

A MEDLINE search (PubMed) was conducted, and works published in the English language from 1980 to December 2018 were included in the review.

The following terms were used in different combinations for search: “dental implants,” “prospective studies/randomized studies,” “long-term or 1-year follow-up,” and “marginal bone loss.”

Titles and abstracts were screened, and full text analysis was performed in relevant publications [Table 1].

### Table 1: Comparative investigation of various studies for marginal bone loss changes of dental implants

| Authors          | Type of study                                                                 | Number of patients/implants | Conclusion                                                                 |
|------------------|-------------------------------------------------------------------------------|----------------------------|--------------------------------------------------------------------------|
| Nemli et al.     | Evaluated the implant survival and the crestal bone loss with a follow-up period of 3 years | 72 patients/255 implants   | Survival rate of 97.6%. At 6, 12, and 24 months after prosthetic loading, mean marginal bone losses observed were 0.35±0.14 mm, 0.47±0.15 mm, and 0.59±0.16 mm[28] |
| Formoso et al.   | Evaluated the alteration in the marginal bone level radiographically that was restored according to platform-switched concepts | 54 patients/77 implants    | Mean bone loss with standard platform implant was 0.42 mm and 0.01 mm for platform-switched implants. Statistically significant difference found in marginal bone loss[31] |
| Cappiello et al. | Evaluated the bone loss around the platform-switched implants positioned at crestal level | 45 patients/131 implants   | Radiographic study was performed, and after 12 months, the data collected showed vertical bone loss between 0.6 mm and 1.2 mm for the test group (mean: 0.95±0.32 mm), while for the control cases, bone loss was between 1.3 mm and 2.1 mm (mean: 1.67±0.37 mm). This data showed the role of microgap between implant and abutment in the remodeling of peri-implant crestal bone. Hence, platform switching reduces crestal bone resorption and increases long-term success of the implant[29] |
| Kapoor et al.    | Evaluated the crestal bone loss around platform-switched implants              | 12 patients/20 implants     | Radiographs were obtained at 3, 6, and 12 months after loading that showed mean bone loss of 0.76±0.1265 mm on mesial side and 0.72±0.1481 mm on distal side after 1 year. Hence, the platform-switched implants lead to better preservation of crestal bone[30] |
| Beriberi et al.  | Examined the marginal bone level in healed ridges and extraction sockets in maxilla after 5 years follow-up of implants with immediate loading protocol | 36 patients/42 implants     | The marginal bone loss after implant placement was 0.26±0.16 mm for 1 year and 0.26±0.171 mm for 3 years and 0.21±0.185 mm for 5 years in healed ridges. Significant marginal bone loss has been found on the mesial side of the implant[32] |
Inclusion criteria
• The implant system should presently be available on the market. Duplicate systems without documentation were not accepted
• The studies should include all relevant data records: radiographic data and clinical and histologic evaluation on change in marginal bone level up to 1 year of implant placement
• Case studies or case reports with a minimum of five patients included, as well as controlled clinical trials, were accepted
• One stage as well as two stage surgeries were included
• Study design criteria included in publication search: randomized control study and follow-up of 1 year after implantation, mean MBL, and survival rate.

Exclusion criteria
• Advanced surgery, for example, sinus lift procedures and bone augmentation procedures
• Immediate implant loading.

The following variables were extracted from the identified articles: type of study, number of patients included, number of implants placed, implant sites (maxilla/mandible and anterior/posterior), type of prosthesis, healing time before loading, number of lost implants, implant survival rate, mean marginal bone level change (MBLC), and standard deviation (SD) observed for over 1 year of placement.

Data analysis
Selection of eligible studies are on the basis of inclusion and exclusion criteria.

The statistical analyses were carried out by a statistician in the form of blobbogram/forest plot. Mean and SD values from each study were used to assess pooled mean MBLCs and 95% confidence interval (CI) for each implant system. As SD data were unavailable for a number of studies, it was assumed that SDs between studies were homogeneous. Consequently, the common SD was assessed based on all available SD data.

To account for the difference in the number of subjects between the different studies, weighted mean values and 95% CI were also assessed. Differences in MBLC values between systems were tested for statistical significance using the unpaired t-test. \( P < 0.05 \) was considered statistically significant.

RESULTS
The electronic database research (MEDLINE) produced 166 corresponding articles. One hundred and twenty studies were excluded on the basis of abstract while the 46 researches were used chosen for full-text examination after the title and abstract testing, and 41 studies were excluded that did not meet the requirements of our inclusion and exclusion criteria. A total of 5 studies for a quantitative analysis were taken into account.

All the studies were prospective with a follow-up period of not <1 year. All the studies had included the patients between 25 and 75 years. Total 525 implants were evaluated to find the mean bone loss at 1-year interval.

For quantitative data evaluation, a meta-analysis was conducted. The 5 studies were included for comparison of data. The mean peri-implant bone loss was around 0.56 mm with \( Z = 7.48 \) and \( P = 0.01 \). Data were only submitted for postimplant bone loss, which had been analyzed in the meta-analysis. There was only significant heterogeneity for bone loss (tau value = 0.03, \( P = 0.041 \), \( I^2 = 99.8\% \)), which resulted in the use of the model of random effects.

DISCUSSION
The most important success criteria for the prosthetic rehabilitation of the implant are the prevention of the MBL. The loss of the marginal bone leads to hindrance to the stabilization of the implant, ultimately leading to implant failure. This systematic review aims toward the MBL after 1 year in function. This meta analysis was made to find out from the prospective 1 year studies follow ups that for conclude that how much extent of the MBL takes place. The systematic review identified 5 relevant studies published till 2018.

This study concluded with a point estimate that 0.56 mm of mean MBL is seen at 1 year of function. The major part of the MBL occurred during the 1st year after prosthetic loading, whereafter it gets stabilized. Hence, it becomes evident that MBL around dental implants under favorable conditions is comparable with that of natural teeth.

The number of studies done in this context is also very few. Many of the \( I^2 \) estimates calculated in this meta-analysis are considered high and that is the reason behind the considerable heterogeneity between the studies.

Hence, we recommend that further studies should be done regarding this context as the studies are very less regarding MBL at 1 year.

CONCLUSION
Within the limits of the study, the mean MBL was found to be 0.56 mm. A statistically significant difference in the MBL was found between various studies.
There are no conflicts of interest.

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