Implant survival, bone remodeling and implant stability of Neoss implants: a systematic review of the literature

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This systematic review of the published literature on Neoss dental implants shows minimal bone resorption (average 0.6 mm after 5 years), high implant survival (CSR 96.8% after 5 years) and excellent primary and secondary stability in all types of bone.

INTRODUCTION
There are hundreds of different implant systems available on the market worldwide. The preference for one system over another could be based on anything from scientific evidence, clinical handling, inventory, and cost to preference of referring dentists.

However, the clinical safety and performance remains the only factor that ultimately defines the clinical suitability of an implant system.

The aim of this systematic review is to assess the current scientific evidence on Neoss dental implants regarding implant survival, bone remodeling and implant stability.

MATERIALS AND METHODS
A bibliographical electronic research was carried out using PubMed/Medline and Google Scholar, identifying all published articles that report on clinical follow-up data on Neoss dental implants.

Electronic database searches were conducted in August 2017 and included all available data up to that point. The search term for the PubMed/MedLine search was “neoss OR ((proactive OR bimodal) AND dental implant)”. For the Google Scholar search, the search term “neoss implant” was used. No restrictions were applied to the electronic searches. In addition to the online sources, the content of the Neoss internal literature database was screened.

To be eligible for further analysis, the publications should report at least one-year clinical follow-up data on Neoss implants. Studies with shorter follow-up were included in the initial stability assessment if ISQ data was available.

The following exclusion criteria applied: less than 10 patients followed; no separate reporting on Neoss implants; technique descriptions; case reports; review articles; language not English.

RESULTS
The search yielded 430 articles. After the elimination of duplicates and the screening of titles and abstracts, full texts were retrieved for 142 articles for further evaluation. Twenty-two articles met the inclusion criteria and were included in the implant stability analysis.

The analyzed articles (Table 1) present the combined clinical outcome of more than 2350 Neoss implants in more than 830 patients, studied in 18 independent clinical studies with a follow-up time of 1 to 6 years. The combined data covers all major indications and treatment protocols.

Implant survival
The combined CSR in the identified literature was 97.4% after 1 year and 96.8% after 5 years. The CSR for Bimodal...
| Study                      | Study type                     | Topic                          | Implant type       | Follow-up time | Sub-groups | No. of patients | No. of implants | Survival rate (CSR) | Bone loss (mm) |
|----------------------------|--------------------------------|-------------------------------|--------------------|----------------|------------|----------------|----------------|----------------------|----------------|------------------|
| Zumstein 2012              | Retrospective controlled       | GBR vs. non-GBR               | Bimodal, Straight  | 4-5 years      | Non-GBR   | 50             | 183            | 95.0%                | 0.4            |                  |
| Zumstein 2008              |                                |                               |                    |                | GBR        | 57             | 126            | 98.2%                | 0.4            |                  |
| Sennerby 2016              | Retrospective case series      | Long-term follow-up on ProActive | ProActive, Straight | 60 months      |            | 49             | 102            | 99%                 | 0.8            |                  |
| Degasperi 2012             | Retrospective case series      | Immediate placement, early loading, full-arch | ProActive, Straight | 1-6 years      |            | 43             | 258            | 96.5%                | -              |                  |
| Andersson 2015             | Retrospective controlled       | Immediate placement, early loading, full-arch | ProActive, ProActive, Tapered | 1-6 years      | Bimodal ProActive | 50             | 284            | 93.7%                | 0.8            |                  |
|                           |                                |                               |                    |                | ProActive   | 116            | 168            | 89.7%                | -              |                  |
|                           |                                |                               |                    |                |             |                |                | 96.4%                | -              |                  |
| Acham 2017                 | Randomized controlled trial    | Overdenture on Locators       | ProActive          | 3 years        |            | 20             | 80             | 100%                 | -              |                  |
| Vanden Bogaerde 2016       | Randomized controlled trial    | Early implant stability       | Bimodal, ProActive, Straight | 3 years        | Bimodal ProActive | 11             | 22             | 95.5%                | -              |                  |
|                           |                                |                               |                    |                | ProActive   | 11             | 11             | 100%                 | 0.4            |                  |
|                           |                                |                               |                    |                |             |                |                | 90.9%                | 0.6            |                  |
| Dahlin 2013                | Prospective case series        | Multi-center                  | Bimodal, Straight  | 1 year         |            | 177            | 590            | 97.8%                | 0.6            |                  |
| Becker 2013                | Prospective case series        | One-stage, delayed load       | Bimodal, Straight  | 14 months      |            | 76             | 100            | 93%                 | 0.6            |                  |
| Sennerby 2012              | Prospective case series        | Two-stage surgery             | Bimodal, Straight  | 1 year         |            | 90             | 218            | 98.6%                | 0.6            |                  |
| Zwaan 2016                 | Retrospective case series      | Tapered implants              | ProActive, Tapered | 1 year         |            | 97             | 163            | 96.9%                | 0.52           |                  |
| Akts 2015                  | Retrospective case series      | Bar-retained overdenture on 4 implants | Not reported       | 3 years        |            | 10             | 52             | 100%                 | -              |                  |
| Vanden Bogaerde 2010       | Prospective case series        | Immediate loading             | Bimodal, Straight  | 18 months      |            | 21             | 69             | 98.5%                | 0.7            |                  |
| Zumstein 2016              | Retrospective controlled       | GBR vs. non-GBR               | ProActive, Straight | 1 year         | Non-GBR    | 50             | 159            | 98.7%                | 0.7            |                  |
|                           |                                |                               |                    |                | GBR        | 67             | 92             | 98.3%                | -              |                  |
| Di Lallo 2014              | Prospective controlled         | Sinus lift                    | ProActive, Straight | 1 year         |            | 25             | 38             | 100%                 | -              |                  |
| Alsabeeha 2011             | Randomized controlled trial    | Overdenture on single implant | Bimodal, Straight  | 1 year         |            | 12             | 12             | 100%                 | 0.23           |                  |
| Wiesner 2010               | Randomized controlled trial    | Connective tissue grafts      | Bimodal, Straight  | 1 year         |            | 10             | 20             | 100%                 | 0.7            |                  |
| Andersson 2008             | Retrospective case series      | Two-stage surgery             | Bimodal, Straight  | 1 year         |            | 44             | 102            | 98.1%                | 0.7            |                  |
| Volpe 2013                 | Retrospective case series      | Sinus lift, osteotome method  | Bimodal, Straight  | 16 months      |            | 20             | 29             | 100%                 | 0.7            |                  |
| Pagliani 2012              | Prospective case series        | Bone grafting                 | Bimodal, Straight  | 1 year         |            | 19             | 34             | 97.1%                | 0.5            |                  |

Table 1: Summary of identified data. *Some implants in the Andersson data are also part of the Sennerby data.*
implants was 97.0% after 1 year and 96.0% after 5 years. The overall CSR for ProActive implants was 97.8% after 1 year and 97.5% after 5 years (Figure 1).

**DISCUSSION**

**Implant survival**

The combined CSR in the identified literature was 96.8% after 5 years. The identified studies contain normal day-to-day use as well as more demanding treatments such as guided bone regeneration (GBR), immediate loading after total tooth extraction, and sinus lift procedures. The diversity of included studies therefore reflects the clinical reality of implant use. The CSR of Neoss implants (97.4% after 1 year and 96.8% after 5 years) compares well with systematic long-term data which showed 94.6% CSR. Neoss data is mostly short-term (1 year) but it is established that the vast majority of implant losses occur during the first year. Therefore one-year data is usually a good estimation of longer term success. The long-term studies show high survival rates after the first year further supporting the long-term success of the Neoss implant system.1,3,5-8,13

Bimodal implants account for a higher percentage of the implant losses. The cumulative survival rates after 5 years were 96.0% for Bimodal implants and 97.5% for ProActive implants (Figure 1). The lower survival rate for Bimodal implants could be explained by lower survival rates in difficult cases. Zumstein et al. showed that Bimodal im-

**Bone remodeling**

The weighted mean bone loss in all studies was 0.62 mm after 1 year, and 0.60 mm after 5 years (Figure 2). No differences in bone loss were seen between Bimodal implants and ProActive implants (0.58 mm vs. 0.62 mm after 1 year).

**Implant stability**

The weighted mean ISQ at time of implant insertion in all studies was 73.1 (range 68.1 – 76.7). The mean insertion ISQ of each included study is shown in Figure 3. No differences in RFA at insertion were seen between Bimodal implants and ProActive implants (mean 73.1 vs. 73.1).
plants had a tendency of lower survival rate in GBR sites (93.5%) than in non-augmented bone (98.2%). When the same research group repeated the same study setup with ProActive implants, no difference was seen between GBR (98.6%) and non-GBR sites (98.9%).

Andersson et al. studied immediate loading of full arch reconstructions after total tooth extraction. They found that the survival rate for this difficult treatment modality was less successful using Bimodal implants (89.7%) than with ProActive implants (96.4%). Hence, the present data indicate that the successful usage of Bimodal implants is further improved by the ProActive surface which enables more predictable treatment outcomes in difficult cases.

**Bone remodeling**

The weighted mean bone loss in all studies was 0.62 mm after 1 year, and 0.6 mm after 5 years. This implies very stable bone levels after minimal bone remodeling during the first year (Figure 2).

The data indicate less bone loss for the Neoss implant system than what is shown in a systematic long-term review of multiple implant systems by Moraschini et al., which reported a mean bone loss of 1.3 mm, and also less than what is shown in a systematic review of the TiUnite implant surface (mean 0.9 mm after 5 years).

It has little clinical implication if the bone level around an implant is 0.3 mm or 0.9 mm. However, the mean value is interesting because it indicates if there is a high percentage of cases that have lost a lot of bone. High percentage of cases with bone loss more than 2 or 3 mm will result in a higher mean bone loss value and higher standard deviations.

Derks et al. studied the prevalence of peri-implantitis in a Swedish population. From the national implant data register, 900 randomly selected patients treated with implants 9 years earlier were invited to a free-of-cost examination. Implants were Straumann (32.6%), Nobel Biocare (39.4%), Astratech (18.4%) or other brands (9.4%). Derks et al. found that 9.9% (157 of 1578) of all implants had lost more than 2 mm bone from baseline to 9 years and that 4.9% (78 of 1578) had lost more than 3 mm.

In the studies that report frequency data on bone loss on Neoss implants, 5.1% (46 of 894) have lost more than 2 mm and 1.1% (10 of 894) have lost more than 3 mm after 1 year. After 5 years, 5.1% (7 of 136 implant) have lost more than 2 mm and 0.7% (1 of 136) more than 3 mm.

Compared to Derks et al., the percentage of Neoss implants with more than 2 mm bone loss is nearly halved (5.1% vs. 9.9%). This indicates that Neoss implants have a lower percentage of high bone loss cases than the main competitor implants. Since peri-implant bone loss is one of the prerequisites for peri-implantitis, low incidence of bone loss means low incidence of peri-implantitis.

One can argue that the Derks data is over a longer follow up (9 years vs. 5 years), but the bone levels are usually relatively stable after the first year. It should also be noted that the Derks data might underestimate the amount of bone loss in their study since they accepted radiographs as late as 2 years after surgery as baseline radiographs and therefore any bone loss that occurred before the baseline radiograph is not taken into account.

**Implant stability**

The state of the art knowledge defines ISQ > 70 as high implant stability. This is a level that enables immediate and early loading of single tooth reconstructions. The weighted mean insertion ISQ in all studies was 73.1, with all but three studies having an average ISQ > 70 (Figure 3). It can therefore be concluded that high initial implant stability is generally achieved with the Neoss implant system.

The available data suggests that the primary stability is generally maintained or even increased during the first year after implant placement. All available data points are plotted in Figure 4 and a trend of increasing stability over time during the first year is clearly seen.

No difference in initial stability was seen between Bimodal and ProActive implants. However, a comparative study by Vanden Bogaerde et al. showed that ProActive implants maintain significantly higher stability during the healing phase than Bimodal implants.
CONCLUSION
This systematic review of the published literature on Neoss dental implants shows minimal bone resorption (average 0.6 mm after 5 years), high implant survival (CSR 96.8% after 5 years) and excellent primary and secondary stability in all types of bone. The data also shows that the ProAc active surface has increased secondary stability and increased clinical success in difficult cases compared to the Bimodal surface.

REFERENCES


