Evaluation of Floss Remnants After Implant Flossing in Three Different Implant Conditions: A Preclinical Study

TITLE:

# Evaluation of Floss Remnants After Implant Flossing in Three Different Implant Conditions: A Preclinical Study


ABSTRACT AND KEYWORDS:

Purpose. The aim of this preclinical study is to evaluate whether implant flossing could leave floss residues in three different implant-prosthetic conditions.

Materials and Methods. By mean of an anatomical model three different condition have been studied: correct connection between implant and abutment and complete insertion of the implant threads into the plaster (control group); misfit of about 220-230 µm between implant platform and abutment in absence of any threads exposure (misfit group); partial exposure of implant threads but absence of misfit (threads group). Twenty-one micro-structured tapered threaded implants were divided among the three groups. Each sample was subjected to a flossing procedure using spongy floss, standardized in terms of movement, frequency, time and pressure. Subsequently, a stereomicroscope examination with a standardized magnification of 10x was performed in order to highlight the possible presence of floss residues on implant surface.

Results. No floss residue was ever detected for the control group. Both misfit and thread groups showed floss residues discernible in two different types: microfilaments and amorphous particles. Statistical analysis showed a significant difference for the presence of floss remnants between the control group and the other two experimental groups ($p = 0.005$). No difference was observed between misfit and threads group.

Conclusion. This study shows that exposed threads and misfit can induce the release of floss residues during maintenance procedures.

Oral Hygiene, Dental Implants, Implant Flossing, Spongy Floss, Implant maintenance

ARTICLE TEXT:

## INTRODUCTION

The clinical use of dental implants has become highly predictable in recent decades, improving the quality of life in patients by restoring both functional and aesthetic support. [1,2]

Between the high reliability, it is important to realize that not all implants that survive are necessarily successful. Successful implants are those that remain fully functional and healthy within the oral cavity.

Peri-implantitis is pathological condition associated with implant failure and is becoming rather prevalent. Several studies have shown that patients with poor plaque control and erratic maintenance display an increase risk of developing peri-implantitis.[3,4,5] It is therefore prudent to prevent bacterial colonization by having a very accurate oral hygiene. After implant placement, a strict follow-up regime with a dental professional should be implemented in order to monitor the implant and surrounding teeth for inflammatory disease.[6]

The dental professional should continually encourage the patient to adhere to consistent home oral care in order to prevent any peri-implant, inflammation and in turn increase the success of their implants.[7]

It is very important to underline that implant rehabilitation implicates new anatomic conditions. The relation among the implant and surrounding tissues, as well as the prosthetic rehabilitation, require specific considerations about hygienic care.

One of the most frequently prescribed hygienic devices for home oral care is the dental floss, in particular the stiffened-end spongy floss is quite commonly used thanks to its adaptability.

Narrow interproximal spaces, tilted structures and sub-marginal areas are only some of the anatomical situations where specialists suggest its use.

Very few studies have been published supporting this ordinary prescription, generally mutualized by the dental care or supported by strictly personal experience.[8,9] The evidence regarding implant care is indeed still sparse especially when compared to that for natural teeth.[10]

Some authors have recently raised some concerns about implant flossing. [11,12] Cases of trapped floss fibers around implants with clear signs of peri-implant disease have been reported suggesting a potential role for the clinical manifestation.

The presence of retained floss fibers could favor plaque retention acting like floss ligatures for experimental peri-implantitis on animal studies.[13] On the other side, eventual floss remnants can also induce a direct immune reaction by the host. Condition that potentially correlates to the peri-implantitis theory described by Albrektsson et al.[14] The authors emphasize the primary role of the immune system imbalance in peri-implant marginal bone loss. By this theory, the dental implant is perceived by the immune system as a foreign body, and consequently the presence of additional foreign bodies, such as prosthetic cement or eventually floss remnants can lead to greater bone loss.

Several physical-mechanical aspects have been implicated in this clinical circumstance about implant flossing, such as the incongruous implant-abutment connectionor the implant rough surface exposure.

According to these considerations, the aim of this in-vitro study was to evaluate whether the generally recommended use of spongy floss around dental implants could represent a dangerous procedure in unexposed or exposed implant surfaces and in implants with a wrong fixture to abutment connection. The null hypothesis is that no difference in remnants on the 3 implant-conditions herein evaluated is observed, i.e. the spongy floss works in the same way.

## METHODS

In this in-vitro pilot study twenty-one micro-structured tapered threaded implants with an internal trilobate connection (Replace Select Tapered TiUnite, NP 3.5 x 10 mm, Nobel Biocare®) were selected. This implant was chosen for its macro ~~and microstructural~~ characteristics, which can be considered representative of the most commonly used implants.

Implants were equally and randomly divided into three groups. According to the study group in which they were assigned, implants were differently immersed in dental plaster (picodent® quadro-rock® plus) contained into plastic boxes (6x5x3 cm).

Seven implants with the corresponding abutments correctly inserted were completely fixed in the plaster with the exception of the smooth neck (control group) (Fig. 1-A). Seven implants with corresponding abutments positioned to create a small misfit (inadequate adaptation of the abutment on the implant) of approximately 220-230 µm, with the limit of the stereomicroscope

resolution, were completely fixed in the plaster with the exception of the smooth neck (misfit group) (Fig. 1-B). Seven implants with a correct implant-abutment connection were fixed in the plaster leaving four threads exposed (threads group) (Fig. 1-C).

Subsequently, the implants of each group were exposed to the cleaning movement of the spongy part of the multifilament floss (Superfloss®, Oral-B). In particular, the spongy floss was manually adapted by forming a loop with the crossed ends at the implant-abutment connection or the eventual exposed implant surface. In this position, the circular criss-cross movement was induced by applying a controlled pressure of 150-200 Newton, which was measured with an appropriate stress and tension gauge (stress and tension gauge 25-250 g, Dentaurum, Germany) connected to one end of the floss. Standardized movements were made both in terms of speed, with a cadence dictated by a professional metronome (metronome Taktell small, Wittner, Germany), and in number of movements for a total of 10 tractions in a total time of 10 seconds carried out by a single researcher. Particular attention was placed during the floss movement in not approaching the plaster.

After this, in order to evaluate the possible presence or absence of floss remnants, an experimental stereomicroscope analysis (with a standard magnification of 10x) was carried out. The stereomicroscope (Carl Zeiss stereomicroscope Stemi 2000-C, FL S configuration with KL 1500 electronic) connected to AXIO CAM MC system was used to collect pictures of eventual remnants of spongy floss fibres on the study samples after the simulated hygiene procedures. The outcome of the study, i.e. the floss residues, were dichotomously detected (presence\absence) and described on the basis of their shape. Measurements were performed by using a specific software (ImageJ1).

Sample size

A pilot sample of 3 implants reproducing the experimental conditions was used to estimate the non-inferiority margin.

At a significance level $\alpha = 0.05$ for a one-sided test, an 80% power, a non-inferiority margin equal to 40% and an allocation ratio equal to 1:1, a total sample size of 14 implants was needed (7 in each of the two experimental groups). A control group of 7 implants was also created.

Statistical Analysis

Cross tabulations were used to describe the observed results. Chi-square test and Fisher test were performed aiming to evaluate differences in material presence respectively among the three groups and between floss and amorphous floss particles in the two experimental groups. The level of significance $\alpha$ was a priori set at 0.05.

RESULTS

After flossing, all implants were analysed (Table 1).

All dental implants in control group did not show any floss remnants both on the smooth surface of the neck than next to the implant-abutment connection.

Misfit group implants showed the presence of floss material remnants in 85.7% of cases. In particular, in the misfit space, spongy floss microfilaments were found only in 1 implant, another 1 implant showed amorphous particles (ranging from 50 to 600µm), whereas 4 implants presented

both microfilaments and amorphous particles (Fig. 2). Only 1 implant was free of any spongy floss material.

Threads group showed remnants of spongy floss in 57.1% of the implants. In particular, spongy floss microfilaments were observed in 1 implant, whereas amorphous particles were present in other 2 (Fig. 3). Both microfilaments and amorphous particles of spongy floss fibres were observed on 1 implant. Differently, no microfilaments or amorphous particles were detectable on exposed surfaces, around the smooth neck or at the abutment-implant connection of 3 implants.

The observed differences about spongy floss remnants (microfilaments and amorphous particles) among the three groups were statistically significant (Chi-square test =10.691, p=0.005). The null hypothesis was therefore rejected.

No significant difference was found between samples of misfit and threads groups (Fisher's exact Test shows a value of p = 0.2861).

## DISCUSSION

From the present study no floss remnants have been detected on control group implants.

Therefore, presupposing a potential pathogenicity of this remnants to peri-implant surrounding tissues, the use of spongy floss seems to represent a safe procedure in a "regular state" implant.

Differently, the spongy floss left residues in 85.7 % of the misfit group's implants and in 57.1% of the threads group.

The misfit in a finalized implant rehabilitation can be due to several conditions such as mechanical inconsistency and anatomical impediment. In particular, it is represented by the incomplete

149 insertion of the abutment to the implant, as well as the absence of an ideal matching between the
150 abutment and the prosthetic crown.

151 In order to limit the misfit occurrence, a combination of visual, tactile and radiographic
152 examinations should be performed.[15]

153 The scientific literature about implant-supported fixed denture reports a wide range of values (from
154 10µm to 160µm) to consider the misfit technically acceptable. However, as clearly stated by two
155 recent systematic reviews,[15,16] it is still lacking the effective role of misfit on clinical outcome.
156 Therefore, the extent at which it is considered tolerable remains unclear.

157 The present work used a standardized value of 220-230 µm and put in evidence a new negative role
158 of the misfit. It is quite rational to think that, not only the presence of it, but also its dimension can
159 influence on the effective ability to trap floss remnants. Further studies focused on different gap
160 dimensions are consequently strongly recommended.

161 Threads exposure is the other clinical aspect investigated in this study. Its presence can be a
162 consequence of either para-physiological or pathological conditions. The eventual bone remodelling
163 (following implant placement)[17] as well as the bone resorption (caused by inflammatory peri-
164 implantitis or foreign body response) [14,18] are the prevalent conditions.

165 Irrespective by its origin, the threads exposure is also the result of a clinical condition able to trap
166 floss remnants. In this specific circumstance, macro and micro-texture of implant can play a role on
167 the final result. It is therefore rational to suggest future investigations on this field.

168 In the present work a clear distinction between two kinds of floss remnants has been made:
169 amorphous particles and microfilaments. This distinction comes for the assumption that the two
170 forms of residues may have different clinical implications. The first consideration is that amorphous
171 particles can be more prone to a spontaneous expulsion in respect to microfilaments. To support

172 the above consideration, it is necessary to remind that all clinical cases up to date described were
173 characterized by the detection of filamentous remnants.[11,12] On the other hand, it must be taken
174 into account that this is probably due to the fact that microfilaments display a more direct and
175 intuitive correlation to the dental floss. Consequently, it is not known which is the real role of this
176 particles, and investigations about this topic are strongly advocated.

177 In accordance to the manufacturer statements, the spongy floss used for this research is composed
178 by nylon fibres covered by coloured and aromatized wax.

179 Amorphous particles herein detected could probably correspond to wax remnants, and this
180 consideration is supported by the findings of van Velzen et al. (2016).[12] In a preclinical set, the
181 authors analysed the implant surface after flossing and detected the presence of organic material
182 through spectrophotometry, plausibly wax.

183 In this study, where the prevalence of microfilament and amorphous particles between the two
184 investigated conditions has been observed, it could be speculated that flossing on exposed threads
185 may tend to release more amorphous residues. Otherwise, sliding floss against misfit may tend to
186 cause tearing and the consequent release of microfilaments. The absence of a statistically
187 supported difference limits any further consideration, but it can be rational to deepen this aspect in
188 further studies on broader samples. Other aspects that advocate for future investigations are the
189 floss typology and the flossing movement.

190 To the best of our knowledge, the etiopathogenetic role of these residues has not yet been
191 discovered. However, the presence of trapped floss remnants in subgingival area may be a fertile
192 environment for bacterial invasion and proliferation. From this consideration, it can be assumed
193 that dental floss residues can promote the retention of bacteria and have an action quite similar to
194 that of experimental ligatures[13] or biofilm-retaining factor like are luting cementum residues.[19,20]

Among the pathogenic hypothesis, it can't be neglected the host response to those remnants acting as foreign bodies. This aspect finds an interesting correlation with the peri-implantitis theory described by Albrketsson et al.[14]

From the cases reported on the literature, it can be observed that the removal of these residues generally leads to clinical improvements. Van Velzen et al. (2016)[12] report that in the last 3 years of clinical practice they have encountered 10 patients with persistent peri-implantitis, previously treated with a non-surgical and surgical protocol for the maintenance of implants (to which all of their patients with peri-implantitis are treated). Among those 10 patients, after exploratory surgery, all implants showed the presence of remnants of dental floss adhering to the rough part of them. Interestingly, after a careful removal and debridement of the peri-implant site, nine of ten cases resulted in an improvement in peri-implant conditions 6 months later (i.e. absence of bleeding on probing and reduction of probing pocket depth).

These results are supported by long-term observations of a clinical case report describing a peri-implantitis treated with an endoscopic access. [11] Trapped filaments around several implants were thoroughly removed leading to a complete resolution of the peri-implantitis with a 6-years stable result.

## CONCLUSION

This preclinical study has clearly demonstrated how implant treads exposure and abutment-implant misfit can both favour the release of remnants from a spongy floss.

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FIGURES:

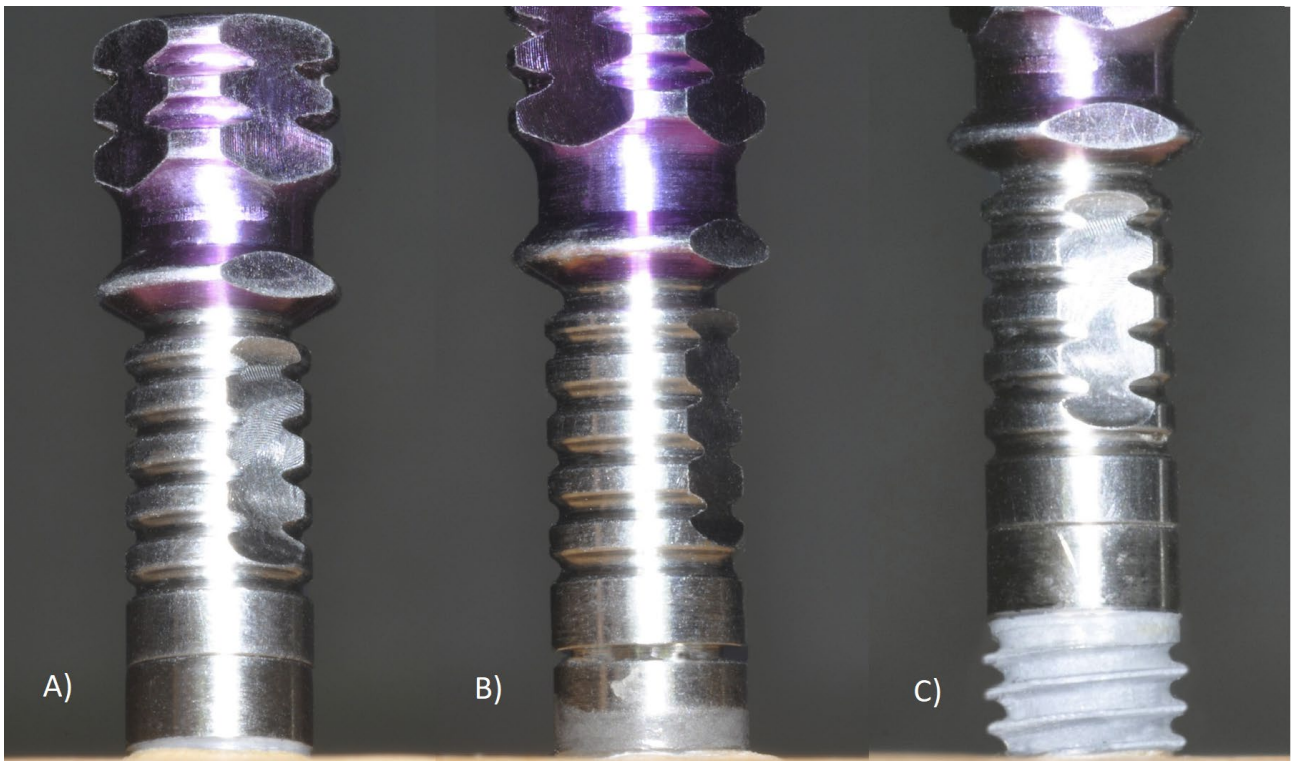


Fig. 1 Image of the three implant conditions studied that reproduce A) control group; B) misfit group; C) threads group

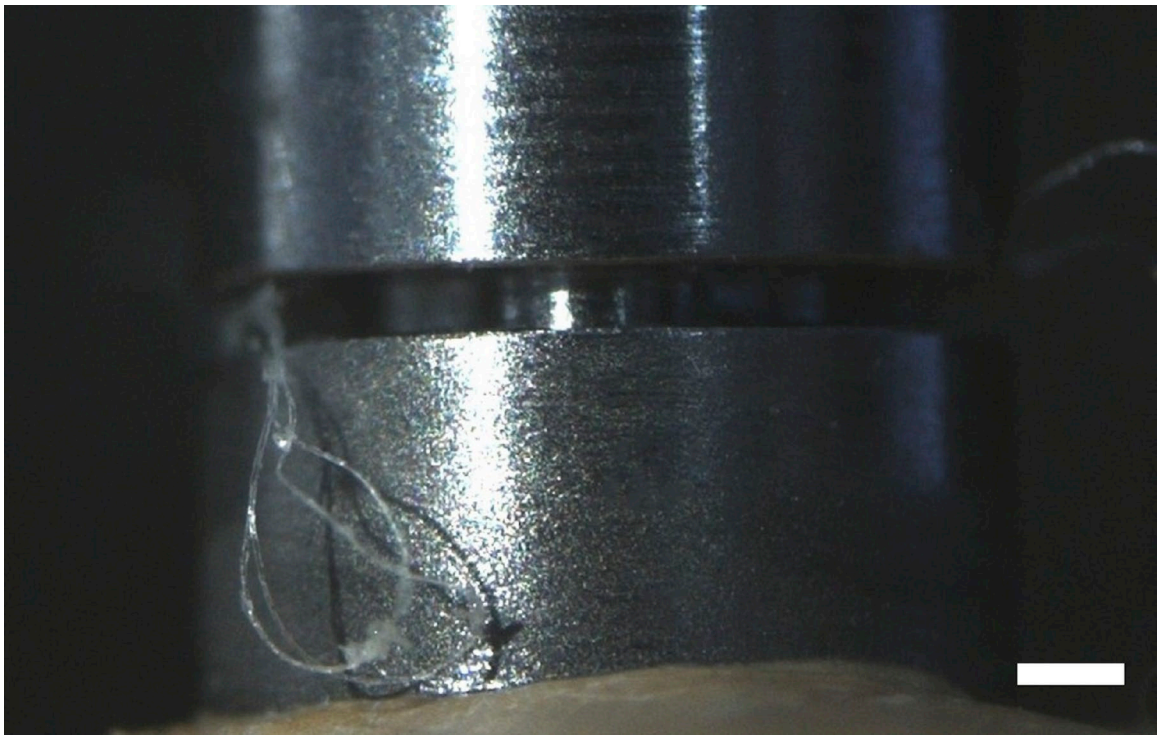

Fig. 2 Microscopic image (10x) showing both microfilaments and amorphous particles at the misfit level. White bar = 400 µm

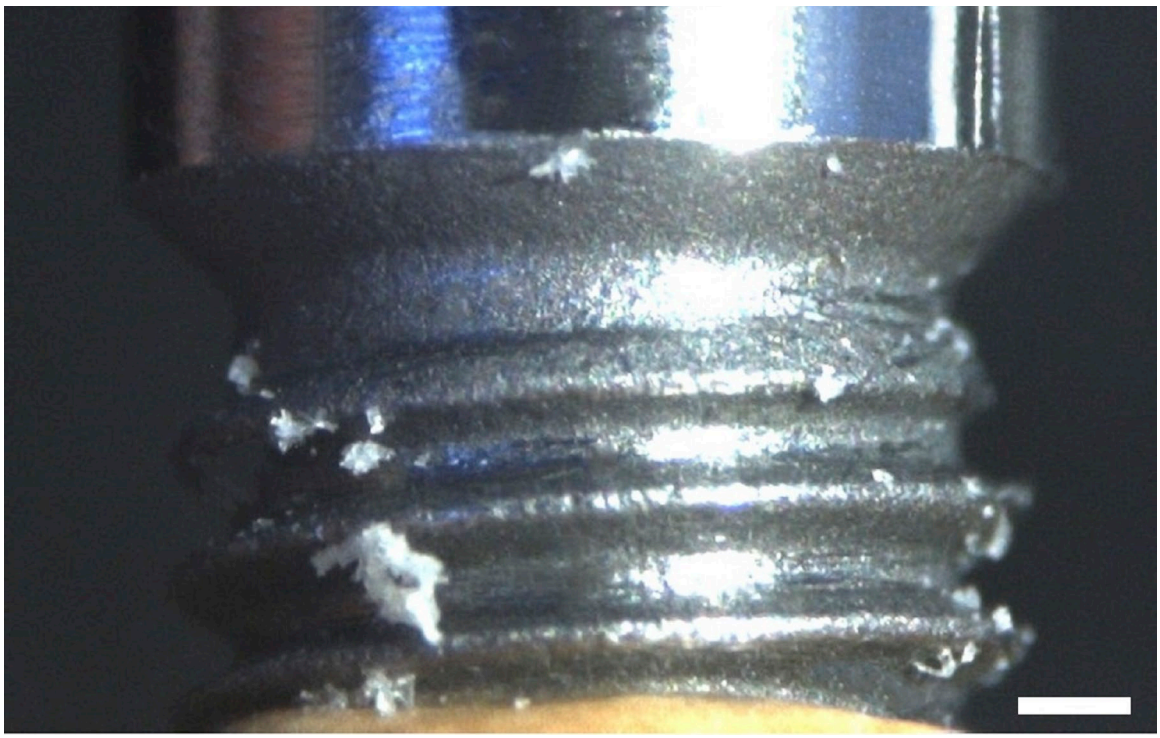

Fig. 3 Microscopic image (10x) showing amorphous particles on the exposed threads. White bar = 400 µm

TABLE:

Table 1. Presence/absence percentage of spongy floss material in the three groups.

| | | | Material | | Total |
|---|---|---|---|---|---|
| | | | Presence | Absence | |
| Group | Control | Count | 0 | 7 | 7 |
| | | % in group | 0.0% | 100.0% | 100.0% |
| | Misfit | Count | 6 | 1 | 7 |
| | | % in group | 85.7% | 14.3% | 100.0% |
| | Threads | Count | 4 | 3 | 7 |
| | | % in group | 57.1% | 42.9% | 100.0% |