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Literature Review Article

Instrumentation of dental implants: a literature review

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Abstract

Introduction and Objective: The aim of this study was to review the literature on the systems used to decontaminate the implant's surface. Different instruments have been proposed, but there is no agreement in the literature about which methods would be more efficient with no damage to the implant surface. It was reported the use of plastic, carbon fiber, stainless-steel and titanium curettes and also the use of other systems such as ultrasonic points with different tips, rubber cups and air abrasion. **Literature review:** In most of the studies, the injury caused on the titanium surface at the time of instrumentation was examined. In others, the cell adhesion on the titanium dental implants following instrumentation of the implant surface was observed. Moreover, to enhance cleaning around implants, ultrasonic systems were recently tested. **Conclusion:** Metal instruments can lead to major damage to implant surface, therefore, they are not indicated for decontamination of dental implants surfaces. Furthermore, non-metallic instruments, such as plastic curettes, rubber cups, air abrasion and some ultrasonic systems seem to be better choices to remove calculus and plaque of the sub- and supra-gingival peri-implant area. It is noteworthy that more studies evaluating the effects of these systems are required to establish best practices to be used in the treatment of patients with dental implants.

Introduction

In the last decades the implant installation have become a routinely procedure for the oral rehabilitation of partially or totally edentulous patients because of its high predictability and success rates: 88% in maxilla and 93% in mandible [23]. Notwithstanding, failures related to infectious process may occur in the implant therapy, therefore damaging its osseointegration [15].

The main etiologic factor of periodontal disease is dental biofilm. The bacterias within it account for the inflammatory process in the periodontal tissues [16]. The sequence of bacterial colonization and biofilm formation on dental implants is similar to that occurring on the teeth [34]. Moreover, it is well established that the inflammatory response to the biofilm presence in the peri-implantar tissues follow similar patterns to that of the periodontal tissues in a susceptible host [6, 11, 12].

Mucositis and peri-implantitis are inflammatory process developing in the tissues surrounding the osseointegrated implant and, at advanced stages, may lead to its lost [3]. Considering its common points to gingivitis and periodontitis, it is understandable that the treatment of these infections follows the same guidelines recommended in the periodontal treatment. Therefore, to maintain the periodontal health around implants, a preventive system should be executed following the principles of the Support Periodontal Therapy (SPT), additionally to the adoption of intervention measurements against the pathological alterations already diagnosed [7].

The removal of the plaque and calculus on the implant surface it is necessary to achieve its long-term success [10]. The mechanical procedures to clean the implant should ideally be capable of removing efficiently the bacterial deposits without altering the implant surface, which may negatively affects its biocompatibility [19].

Roughness on the titanium implant surfaces may alter the response of the surrounding soft tissues, directly influencing on the posterior dental biofilm formation and making difficult its proper removal [2, 19]. On the other hand, scaling procedures may also alter the oxide layer on the implant surface, which can result in the corrosion increase [25]. Therefore, one should attempt to maintain the integrity of the implant surface and prosthetic components during the scaling procedures [22].

Different instruments have been proposed for the scaling of the implants. However, there is no consensus in the literature regarding which methods would be more efficient and less damaging. Based on the above discussion, the aim of this study was to report through a literature review, the main systems available for the scaling of dental titanium implants.

Literature review and Discussion

Hand instruments

Instruments for cleaning dental implants should ideally be effective, cause minimum damage to titanium surface and show durability [24].

Several instruments and procedures have been proposed as alternatives to the removal of bacterial deposits of the supra- and subgingival, peri-implant area [7]. The mechanical scaling performed with the aid of hand curettes of different materials is one of these alternatives [20]. Among these instruments, plastic, carbon fiber, stainless-steel and titanium curettes are included. Some studies attempted to evaluate these different materials regarding to their cleaning efficacy and potential of alteration of the implant surface and prosthetic component, which could affect its biocompatibility, biofilm formation and therefore the implant longevity [5, 8].

The use of plastic curettes (acetal plastic) have been largely recommended for this purpose [2, 4, 32]. Fox *et al.* [8] evaluated the effects of scaling on the titanium implant surfaces, demonstrating that the plastic instruments produced the least damage than metallic instruments – stainless steel and titanium alloy –, therefore, they were recommended as instruments of choice during the routinely maintenance procedures. Other authors evaluated, *in vitro*, the effects of implant instrumentation on the adherence and proliferation of fibroblasts and found that the implants scaled with plastic curettes were comparable to the non-treated control implants regarding to the greatest surface compatibility to the stabilization of these cells [5].

Based on these results, the dentists prefer to use these instruments for the hygiene of implant abutments [29]. However McCollum *et al*. [22] verified that the plastic curettes may cause vertical microgrooves on the surface of the prosthetic component, and they were not effective in removing the mature calculus. For this reason, the recommendation of the use of plastic curettes for the scaling of the implants should be carefully analyzed. Although they are the hand instruments that provoke the least alterations on the titanium surface, studies proving their efficacy and efficiency are still required.

Similarly to the plastic curettes, the carbon fiber curettes are also alternative for the scaling of implants [31]. They do not significantly damage the implant surfaces and are capable of reducing the bacterial load surrounding the implants, producing an improvement of the clinical parameters of gingival index (GI), probing depth (PD) and bleeding to probe (BP) [33]. Despite of these benefits, these instruments seem to leave contaminants at the site scaled, even macroscopically visible [26].

The stainless steel is other material that has been used in the curettes for implant scaling. However, researches have demonstrated that the scaling with these instruments result in risks, cuts and bruises that not only can increase the plaque retention on the titanium surface but also making its removal difficult [5, 8, 9].

According to Homiak *et al.* [9], who evaluate the effect of five different prophylaxis procedures for the instrumentation of titanium abutments, found that the stainless steel instruments provided a gouge effect, by creating a rough texture on the surfaces tested and observed by scanning electronic microscopy (SEM).

The instrumentation with these curettes was also tested regarding its effects on the cell adherence [5]. It was found a significant smaller amount of adhered cells on the surfaces scaled with stainless steel curettes, although they were less irregular than those scaled with titanium alloy curettes [8], fact attributed to a possible chemical alteration on these surfaces. It is believed that stainless steel curettes may produce changes in the oxide layer of the surface or even, somehow, alter or contaminate the implant surface, which could result in a higher corrosion rate and affect its biological surface. The contact between two materials of different natures, such as stainless steel and commercially pure titanium, seems to produce even more effect than the contact of two metals of similar compositions, such as the titanium alloy and the commercially pure titanium [5].

Mengel *et al.* [20] examined through SEM, the vestiges left by several cleaning instruments, determining the substance amount that was removed from the implant surface. Among the instruments used for the scaling of the implants, there were titanium alloy, plastic and stainless steel curettes. The results demonstrated that the stainless steel curette left pronounced marks, indicating high substance removal; titanium curette did almost not leave marks, removing little substance; the plastic curette did not modify the implant surface, demonstrating to be adequate for the cleaning of the implant surface.

Unlikely, Mengel *et al.* [21] demonstrated that both the stainless steel and the titanium alloy curettes left pronounced marks on implant abutments and increased the roughness deepness on their surfaces. Souza *et al.* [30] also concluded that the metallic and titanium alloy curettes produced roughness on the surface, therefore being contraindicated for the scaling of the implants.

Other systems

Additionally to the use of hand instruments for implant maintenance, ultrasonic system may contribute to this purpose [13, 29]. Accordingly, the concerns in reducing the surrounding damages to the implants and potentiating the cleaning effect have stimulated the development of *in vitro* studies, which demonstrated that the implant surfaces after the use of ultrasound points, hand instruments and rubber cups, are different among each other [1, 14, 18, 22, 27]. Conventional sonic and ultrasonic devices with metal tips have the advantage of being capable of removing the bacterial plaque and calculus efficiently; however, they may induce considerably modifications on the implant surface [24].

Baek *et al.* [1] assessed through SEM and atomic force microscopy (AFM) four different point types of a conventional ultrasound device regarding its safe and efficacy on the implant surface. The authors used copper (Cetatech, Seoul, Korea), plastic head (EMS, Nyon, Switzerland), plastic (Satelec, Merignac, France) and a conventional stainless steel point (EMS). They concluded that the stainless steel point increased the surface roughness so that it became irregular. On the other hand, the copper point caused minimum damages to the titanium surface, result similar to that obtained by the plastic points, therefore indicating the latter for the maintenance implant therapy. According to these authors, the fact that the copper point is more resistant to fracture and weariness than the other points, would be advantageous. However, further studies are still necessary.

Mann *et al.* [18] compared the effect of the instrumentation with a conventional ultrasound point (TFI-10) with a modified plastic point ('SofTip', Dentsply, PA, USA) on the titanium implant surface and correlated it to the vibration movement of the instruments. The association of the profilometric and mirror laser enabled the 3D visualization of the oscillatory movement during the use of the instruments. The metallic point followed a normal pattern of oscillation. The plastic point showed

lower vibration amplitude of movement, which may indicate its lack of cleaning efficacy. Different weights (100 g e 200 g) were applied onto the point during instrumentation. After their use, the titanium surface was evaluated through profilometric laser and SEM. **The authors concluded that the use of** ultrasonic points on the titanium surface produced higher impact, mainly when a greater weight was used, causing damage to the surface. The plastic insertion on the ultrasonic point caused minimum damages; however, it only provided a polishing action, leaving plastic residues on the implant surface.

Concerning to the use of air abrasion, a study [9] compared its effect on the implant surface with other four prophylaxis approaches – metallic and plastic curettes, rubber cup, and rubber cup associated with tin oxide. After SEM analysis, it can be concluded that when compared with the control group, the metallic curette increased the titanium surface roughness; the other treatments left a more polished surface, decreasing the machine marks on the surface.

McCollum *et al*. [22] **evaluated the surface** of the titanium prosthetic components after the exposure to air abrasion, plastic curette and rubber cups associated with pumice. When compared with the groups without treatment (control), the plastic curette created microgrooves on the surface; air abrasion left small inset bite-like aspect and the rubber cup + pumice left gentle swirl-like circles. In this study, it was also verified *in vivo* the plaque accumulation after the prosthetic components had been submitted to the different treatments. The prosthetic components were functional loaded for a period of seven days and the patients performed their oral hygiene normally. At the ending of that period, the components were removed and analyzed through SEM and a software evaluated the percentage of accumulated plaque. The results demonstrated that there were no statistically significant differences among the groups regarding the plaque formation surrounding the prosthetic components, fact that enabled to conclude that the methods tested did not damage the titanium surface with similar plaque formation after the treatments.

Shibli *et al*. [28] **evaluated** *in vitro* the growth and morphology of the fibroblasts over the surface of the titanium prosthetic components treated with air abrasion with sodium bicarbonate (Prophy-Jet*)*. The prosthetic components were divided into two groups: without treatment (control) and with treatment (air abrasion for 30 seconds). After the treatment, the prosthetic components were incubated with fibroblastic cells for 24 hours. SEM showed that there was a reduction in the proliferation of these cells without altering their cellular morphology, indicating that the air abrasion treatment did not alter the titanium surface biocompatibility.

Therefore, the metallic instruments are more adequate in cases where there would be the need of either removing the implant coverage or making the surface smoother [17]. When the treatment goal is to maintain the implant surface integrity, non-metallic instruments, rubber cups and air abrasion are the treatment of choice (table I).

Table I – Summary of the main studies

Authors	Systems tested	Results
Mann *et al*. [18]	Conventional and plastic-modified ultrasonic point	The metallic ultrasound point caused damages to the titanium surface. The plastic insertion onto the metallic point provided only polishing action, leaving plastic residues on the implant surface
Baek *et al*. [1]	Cooper point, plastic head point and conventional stainless steel point	The stainless steel point increased the surface roughness. The cooper point caused minimum damages to the titanium surface similar to the results obtained by the two types of plastic points
Mengel *et al*. [21]	Titanium, steel, and plastic curettes, rubber cups, metallic ultrasonic point and air abrasion	Steel and titanium curettes and the ultrasonic points led to the removal of the surface coverage and to the increase of the roughness deepness of the implant surfaces. Damages to the surface were not observed after the use of rubber cups, air abrasion and plastic curettes

Table I (continued)

Shibli *et al.* [28]	Air abrasion with sodium bicarbonate	Air abrasion treatment did not alter the titanium surface biocompatibility
Mengel *et al.* [20]	Titanium, stainless steel and plastic curettes; conventional ultrasonic point, air abrasion, conventional and disposable plastic ultrasonic point	The stainless steel curette, conventional ultrasonic point and the plastic ultrasonic point left pronounced marks, indicating high substance removal. Titanium curette and the disposable plastic ultrasonic point left gentle marks on the surfaces. The plastic curette, the rubber cup and the air abrasion did not modify the implant surface
Rühling *et al.* [26]	Sonic and ultrasonic conventional point covered by Teflon and plastic and metal curette	Differently from the metallic curette, no visible damage on the implant surface was caused by either the ultrasonic points covered by Teflon or the plastic curettes
Homiak *et al.* [9]	Metallic and plastic curettes, rubber cup, rubber cup with tin oxide, air abrasion	The metallic curette increased the titanium surface roughness, while the other treatment left a more polished surface, decreasing the previous machine marks
McCollum *et al.* [22]	Air abrasion, plastic curette, rubber cup with pumice	The methods tested did not alter the titanium surface
Fox *et al.* [8]	Plastic, stainless steel and titanium alloy curettes	The surfaces scaled with metallic instruments showed a higher degree of roughness than those not treated and those treated with plastic curettes
Dmytryk *et al.* [5]	Plastic, stainless steel and titanium alloy curettes	After 24 hours, only the surfaces scaled with steel curettes showed a statistically smaller mean of adhered fibroblasts counting than the control group. After 72 hours, the surfaces treated with stainless steel and titanium alloy exhibited a statistically reduction in the number of cells adhered. Morphological alteration in the cells were observed in the group scaled with stainless steel curettes

Conclusion

Aiming to preserve the long-term integrity of implants, it is important to use during the prophylactic approaches, instruments which do not provoke damages to its surface. According to the literature review presented herein, the metallic instruments cause important superficial alterations and, therefore, should not be indicated for the routine scaling of implants. On the other hand, non-metallic instruments, such as plastic curettes, rubber cups, air abrasion and some ultrasonic systems seem to be better choices for removing the biofilm and calculus of the supra- and subgingival peri-implant area. It is noteworthy that further studies evaluating the clinical efficacy of these methods are necessary to define best practices to be used in the treatment of patients with dental implants.

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