On peri-implant bone level measures: To see or not to see, that is the question

As long as there have been dental implants, clinicians and scientists have been using diagnostic means to follow up their integration in the jaw bone and the peri-implant marginal bone levels[1,2]. In thousands of clinical follow-up and comparative studies on implant placement, two-dimensional intraoral radiographs have been used to describe the success rate of the implants[3]. Throughout the years, literature moved from periodontal marginal bone levels to peri-implant bone level measures, but the principle has not been changed nor questioned over 50 years of implant-related research[4,5]. Peri-implant bone measures during the follow-up phase are still considered as a clinical standard of reference to express the dental implant status and osseointegration success[6,7]. Practically, to all of us and in the vast majority of studies, this clinical standard is an expression of linear vertical distances, denoted as marginal bone levels at the mesial and distal implant sites taken with a strict paralleling technique, given that the horizontal and vertical angulation is perpendicular to the axis of the implant[8].

Fifty years of implant research has brought us into a different century, where the traditional 2-stage pure titanium screw-type implant has transformed into a tropical forest of materials, designs, techniques and grafting procedures. Developments are constantly on the move, in such a way that it becomes hard to follow up.

In contrast to these fast changes and remarkably, throughout five decades of research, at no point or no consensus conference, have any of us questioned the so-called strategic peri-implant bone level measures. During nearly every consensus report, we have continued to repeat the statement that we consider the intraoral radiograph as being the ultimate diagnostic follow-up tool. It is probably by far the least discussed point during the processing and updating of consensus and guideline reports[3,9,10].

We therefore think that after half a century of implant research, it is time to reflect and go back to the original paper of Sewerin[8], in which he clearly pointed out how important it was to – even with standard design implants and their most traditional placement – care for the strict horizontal and vertical angulation. Due to the vertical angulation differences, speculation arises regarding how many bone level gains have been reported throughout this half century because of a slightly horizontally angulated radiography. This cannot be visually perceived, unless we are able to depict either the full three-dimensional crater morphology or the bone in the vicinity of the craters, potentially superimposed on the implant, considering the slight horizontal angular deviations[11]. The only way to fully exclude this problem is to have a three-dimensional view of the peri-implant tissues. Indeed, as has been stated before, times have changed and currently we are more focused on vestibular bone in the aesthetic zone; bone grafting for defect fill-up and sinus augmentation; severe peri-implant bone loss and crater development, often coined as peri-implantitis[12]; angulated abutments; and alternative implant designs. All of this should question the traditional two-dimensional diagnostics as they are imposing the bone with three-dimensional healing and changes thus to evaluate their effect; and also what we can express when merely looking to the superimposed approximal bone adjacent to the implants. In research, we can even question the histology, as long as it remains two-dimensional and as long as the evaluation is limited to a selective number of slices. We realise that this statement sounds shocking for many, yet one should admit that most often we report on only a few micrometres of observation along the course of an implant contour between 10 to 20 mm. On top of that, when evaluating the histological slices, we usually compare these with several radiographic observations, but seldom do we fully register the exact same cutting angle and position. Again, as we observe three-dimensional structural changes, one should move towards attempting to observe and report this via some three-dimensional histology.

This brings us back to the potential clinical means for three-dimensional evaluation[13,14]. In the nineties and for the purpose of clinical research, the surgical re-entry procedures as the ultimate clinical standard for evaluation of healing or changes were considered. Yet again, much research applied the simple two-dimensional measures (x and y axes) while dealing with a three-dimensional change (expression in x, y and z coordinates). Linear measures should thus be considered as an angled and thus biased view, often not really revealing what we are looking for and definitely not counting as a clear prognostic marker[13,15].

One may then jump towards all the research using cone beam computed tomography (CBCT) for postoperative evaluations. When thinking along the lines of all previous reasoning, you may see that many researchers are obtaining ethical approvals for CBCT follow-up while not maximally using the information in these images. This is definitely a shame. Indeed, there is actually only one appropriate approach: when following up bone healing, grafting and peri-implant bone tissue changes using 3D imaging, it is important to properly register the preoperative and postoperative images to assess volumetric changes and not report on millimetres of gain[15]. Although the latter is easily understood by all we continue to report on linear bone level. Yet, one may wonder what we really assess when measuring linear distances and if this has any prognostic value.

For sure one may also question whether CBCT is ready for this. The CBCT market has been growing tremendously over the last decade. Although more than eighty different CBCTs are available, it seems that few have paid attention to the problem of metal artefacts[16]. Artefacts are worse with denser materials and thus more with zirconium than with titanium, but in general they cause blooming of the implant, with enlargements easily reaching a quarter of the implant diameter, not forgetting the black bands and streak artefacts. It is evident that this hampers three-dimensional peri-implant diagnostics, especially in places where it is critical to observe bone, such as in the vestibular region. Only a few machines and protocols seem to allow a reliable depiction, but still include only some jaw bone and patient-specificity.

In conclusion, after half a century of research, we are still lacking reliable diagnostic and prognostic measures and if we wish to improve, one should strive for a three-dimensional evaluation. For now, we are forced to remain with peri-implant bi-dimensional bone level measures on correctly taken periapical radiographs, where we can state: to see or not to see, that is the question.

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