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# Impact of Emergence Angles of Individually Prepared Abutments and Bone Implant Interaction to Biological Width: Role of Gingival Thickness in Bone Loss Reduction

**Conflict of interest:** nothing to declare.
**Authors' contribution:** Panahov N. – came up with the concept and did the editing of the article; Huseynli R. – treated patients, took photographs, wrote a text, a table, made a statistical analysis.

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**Abstract**

**Purpose.** To identify how much impact the emergence angle of the individually prepared abutments has on soft tissues and to show in what dimensions this angle is the most effective.
**Materials and methods.** The X-Ray images of bone level dental implants (n=130) with 2 to 5-year functionality. The titanium-zirconium hybrid and premile titanium abutments (CAD/CAM technology).
**Results.** As a result of our research, we can conclude that the most ideal measures that we identified, are up to 30° in the cases where the soft tissue thickness around of implant is 3 mm. In this case, mesio-distal and bucco-linqual sizes up to 6 mm are available for creating emergence profile. In the cases where peri-implant soft tissue thickness equal or more than 4 mm the angle of transgingival part of abutment can be increased up to 40°. Thereby the size of emergence profile can be achieved up to 9 mm in mesio-distal and bucco-linqual measurement.
**Conclusion.** While working especially with fine biotypes, the aesthetic requirements of the prospective prosthetic constructions should be considered in the surgical stage, the implants should be loaded deeply in order to provide soft tissue thickness whenever possible, or soft tissue augmentation has to be planned and implemented.
**Keywords:** prosthodontics, radiology, imaging, bone implant interactions, soft tissue-implant interactions, periodontology

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# Влияние углов выступания индивидуально подготовленных абатментов и взаимодействия костных имплантатов на биологическую ширину: роль толщины десны в уменьшении потери костной массы

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**Резюме**

**Цель.** Определить, какое влияние оказывает угол выступа индивидуально подготовленных абатментов на мягкие ткани, и показать, в каких размерах этот угол наиболее эффективен.
**Материалы и методы.** Рентгеновские снимки дентальных имплантатов на уровне кости (n=130) со сроком службы от 2 до 5 лет. Титан-циркониевые гибридные абатменты и титановые абатменты Premile (технология CAD/CAM).
**Результаты.** В результате наших исследований можно сделать вывод, что идеальные размеры, которые мы определили, составляют до 30° в тех случаях, когда толщина мягких тканей вокруг имплантата составляет 3 мм. В этом случае для создания профиля выступания доступны мезио-дистальный и букко-лингвальный размеры до 6 мм. В случаях, когда толщина мягких тканей вокруг имплантата равна и более 4 мм, угол трансгингивальной части абатмента может быть увеличен до 40°. Благодаря этому размер выступающего профиля может достигать 9 мм при мезио-дистальном и букко-лингвальном измерении.
**Заключение.** При работе, особенно с тонкими биотипами, эстетические требования к будущим протезным конструкциям следует учитывать на хирургическом этапе, имплантаты следует нагружать глубоко, чтобы по возможности обеспечить толщину мягких тканей; необходимо планировать и проводить аугментацию мягких тканей.
**Ключевые слова:** протезирование, радиология, визуализация, взаимодействие костных имплантатов, взаимодействие мягких тканей и имплантатов, пародонтология

## ■ INTRODUCTION

In the modern world, attaching special attention to the aesthetic requirements of implant treatment requires a more careful approach. Nowadays, preparing the emergence profiles, which copy the cervical margins of natural teeth, as well as application of

individual abutments, which provides long-term maintenance of these margins, is widespread (Manicone, Raffaelli, Ghassemian & D'Addona, 2012). At the same time, in order to maintain a long-term conformity to the aesthetic requirements, necessity arises to gather more information on to what extent the individually prepared components will have adequate effect on the tissues (Steigmann, Monje, Chan & Wang, 2014). That said, the susceptibility of both soft and hard tissues should carefully be taken into consideration while preparing the emergence profiles and individual abutments. The perimetric dimensions of the emergence profile, the materials used for making individual abutments, the techniques of taking the measurements while preparing them, the shapes of abutments, as well as the dimensions of the tilting angles of the transgingival part have serious impact on the mentioned tissues (Abichandani, Nadiger & Kavlekar, 2013). In order to make the emergence profiles recast the natural teeth margins, sometimes, the tilting angle of the transgingival part of an abutment is madeconsiderably wide. And this means an obvious intervention in the area where the biological width is expected to develop. The biological width starts to emerge from the day when the integrity of the ectodermal tissue is disrupted, and this is when the abutments or healing caps are fixed. Its complete formation takes about 8 weeks. The biological width, which is combined of sulcular epithelium, junction epithelium and connecting tissues, has the function of protective barrier (Listgarten, Lang, Schroeder & Schroeder, 1991). The biological width, or in other words, supracrestal connecting tissue has certain average dimensions (Hermann et al., 2000; Judgar et al., 2014). These dimensions are observed to be 2.5 mm or more on dental implants. Just because of this fact, there's need for mucosal thickness that would provide these dimensions of the biological width in implant surgeries or prosthetic operations (Vervaeke, Dierens, Besseler & De Bruyn, 2014). That said, in soft tissues that do not have this thickness, the dimensions should be obtained by loading the implants deeper and fixing the healing caps. Alternatively, soft tissue augmentations should be carried out during an implant surgery or in the second phase of operation (Puisys, & Linkevicius, 2015; Pellicer-Chover et al., 2015). Otherwise, the biological width will supply its dimensional area by means of bone resorption. And this means bone loss in the dental implant cervix and consequently, disadvantage of far less osteointegration.

Sometimes, when the transgingival part of the individual abutments is made with substantially wide angle, it makes intervention inevitable in the area which belongs to the biological width.In these cases, even the dimensions of the mucosal thickness that were initially acceptable, undergo diminishment and eventually, the tissue is forced to recover this thickness by means of bone loss (Berglundh & Lindhe, 1996). As a result, the biological width is formed not on the transgingival surface of the abutment, instead, it develops fully or partially on the implant cervix having migrated towards apical. Consequently, this leads to serious aesthetic problems associated with bone loss. The objective of our research is to identify how much impact the emergence angle of the individually prepared abutments have on soft tissues and to show in what dimensions this angle is the most effective.

## ■ METHODS

The X-Ray images of dental implants with 2 to 5-year functionality and which were loaded in different years, were studied meta analytically for the research purpose. The abutments of the researched implants were prepared individually. These are titanium-zirconium hybrid and premile titanium abutments. All abutments were made with CAD/

CAM technology. The X-Ray images were taken when the healing caps or temporary abutments were replaced with permanent abutments, and the images were compared with the ones of the 5-year results. For this purpose, in total of 130 bone level dental implant images were comparatively studied. All measurements were done in Keynote program. The ruler used for the measurements, was calibrated each time on the X-Ray image. The calibration was made according to the length of the implant and after the operation, the dimensions of each studied implant are recorded in the patient file. This information is always easily accessible. The level of the alveolar bonein the X-Ray images that were taken after the healing caps and abutments were placed, and the level that was in the X-Ray images taken again after a few years when the implants already had full functionality (the X-Ray images of all the researched implants cover 2–5-year functionality period), the opening angle of the transgingival areas of the individually prepared permanent abutments and healing caps (the ones that were fixed both immediately after extraction and during late implant surgeries) were recorded and measured by means of the options that are provided in the control panel of the Keynote program.

## ■ RESULTS

The table was prepared to describe the averaged results of the retrospective analysis. Bone resorption around the implant neck was described at different emergence angles of the abutments and different thickness of the peri-implant mucosa. At 2.5 mm thickness of the mucosa at 30 degrees of emergence angles of the abutment 0–0.5 mm, bone resorption was observed.

| Thickness of mucosa (mm) | Trans gingival part's angle° | Resorption of crestal bone (mm) | Recommended mes/dist dimention (mm) |
|---|---|---|---|
| 2.5 | 30° | 0–0.5 | |
| 4.2 | 45° | 0 | |
| 4.2 | 63° | 0.5–1 | |
| 3 | 30° | 0 | <6 |
| 3 | 64° | 2 | |
| 1.5 | 21° | 1.5 | |
| 2 | 61° | 1.5 | |
| 4 | 30° | 0 | <9 |
| 2.5 | 60° | 1.8–2 | |
| 2.5 | 45° | 1.2 | |
| 3 | 60° | 1–1.2 | |
| 3 | 45° | 0.5 | |

Accordingly, 1.2 mm of bone resorption was observed at 45 degrees and 1.8–2 mm at 60 degrees for the same mucosal thickness. No resorption was observed at a thickness of the mucous of 3 mm at 30 degrees of emergence angles of abutments. However, 0.5 mm of bone resorption was observed in 45 degree and 1–1.2 mm was observed in 60 degree in the same mucosal thickness. The bigger result of crestal bone losing was observed in 64 degree of emergence angles of abutment in 3mm mucosal thickness. The dimension of bone resorption was 2 mm. No resorption was observed at a thickness of the mucous of 4 mm at 30 degrees of emergence angles of abutments. Although bone resorption was

not observed at 4.2 mm of mucosal thickness at 45 degrees, 0.5–1 mm of bone loosing was observed at 63 degrees with the same thickness of mucous. 1.5 mm of crestal bone resorption was observed in 1.5 mm mucosal thickness even with 21 degree of emergence angle of abutment. 0.7–1.2 mm resorption was observed at 30 degrees and 1.5–2 mm at 61 degrees with a mucous thickness of 2 mm.

## ■ DISCUSSION

As a result of the research, it's been noticed that, the emergence angle of the individually prepared abutments has a considerable impact on peri-implant soft and hard tissues (Abichandani, Nadiger & Kavlekar, 2013). That said, depending on the degree of the emergence angle, changes take place in the mucosal layer. In order to provide the dimensions of the biological width, there's more intervention in the needed area, in cases of abutments with more acute angles. As a result, the peri-implant soft tissue has to move apically towards the implant cervix, in order to restore these dimensions. And this, in its turn, disrupts the bone integrity of the implant cervix. The epithelium and connecting tissue attachment migrates from the transgingival surface of the abutment towards the implant cervix (Hermann, Cochran, Nummikoski & Buser, 1997). As per the results of the measurements, no considerable bone resorption is observed when the opening range of the angles of the transgingival parts of the abutments that are individually prepared for the tissues with about 3–3.5 mm of mucosal thickness on the implant, is up to 30–35°. As the opening range of the above-mentioned angle increases, migration in the bone tissue occurs towards apical. The most acute opening angle has been identified to be 64° during the research. In this case, the mucosal thickness was above 2.5 mm and the individual healing caps that were made from standard abutments, were fixed immediately after the operation. The dental implants at bone level, were loaded as per the surgical protocol. 11 months after the operation, the temporary abutments were replaced with permanent hybrid titanium-zirconium abutments. An X-Ray image was taken again upon the completion of the 2nd year of the functional period. The image revealed 2 mm resorption in the alveolar bone. The total thickness of soft tissue had reached 4.5 mm. However, in the adjacent tooth, the emergence angle degree is 24°. While the bone loss was recorded about 0.7 mm on the proximal surface between this implant and the adjacent implant that underwent resorption for a functional period of 2 years, no considerable bone loss was observed on the other proximal surface at all (fig. 1–4).

**a** **b**

**Fig. 1. The state of peri-implant tissues: a) immediately after prosthodontics treatment; b) after 2 years of functionality**

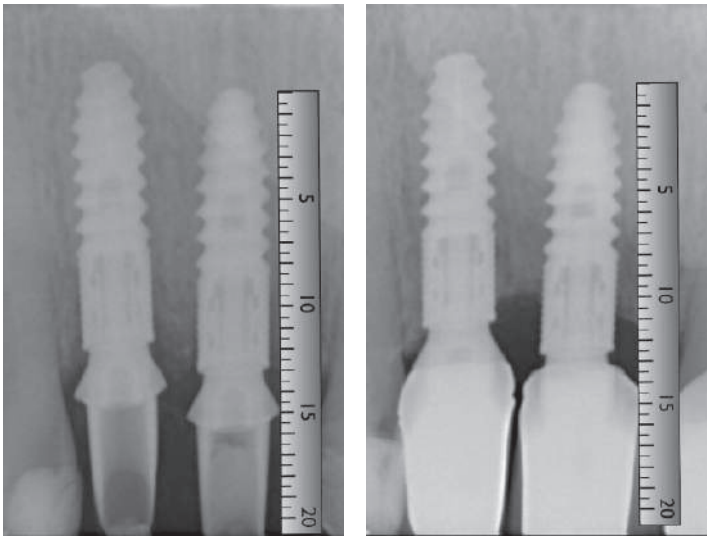
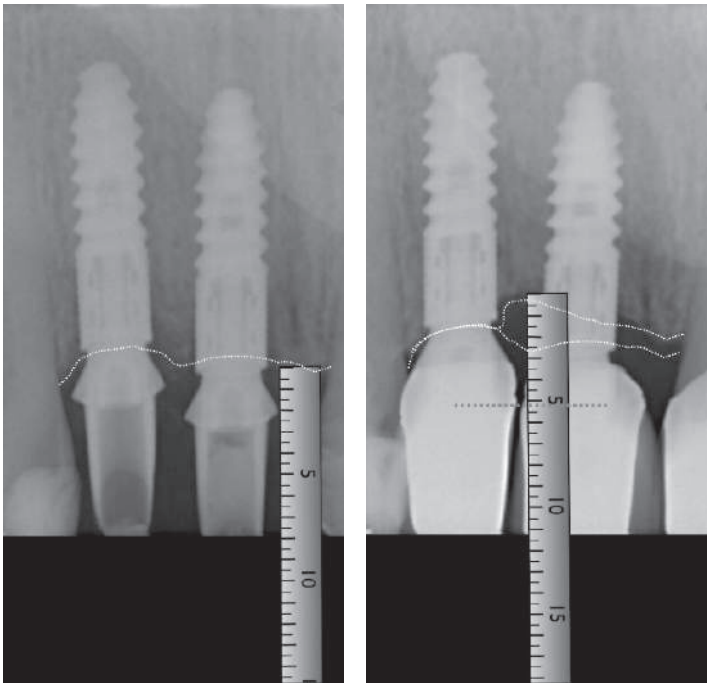
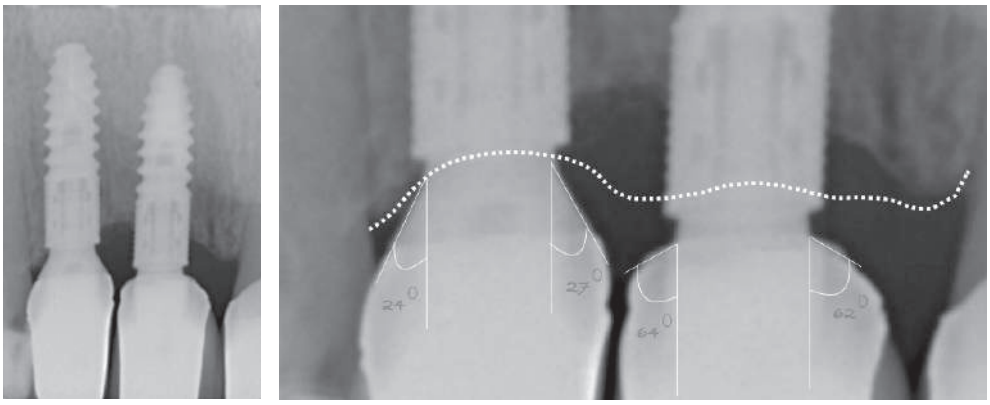



**Fig. 2. The calibration of ruler on the x-ray images**




**a** **b**

**Fig. 3. The state of crestal bone: a) temporary used abutments after 1 year of functionality; b) measurement of crestal bone resorption in Keynote program using a ruler**

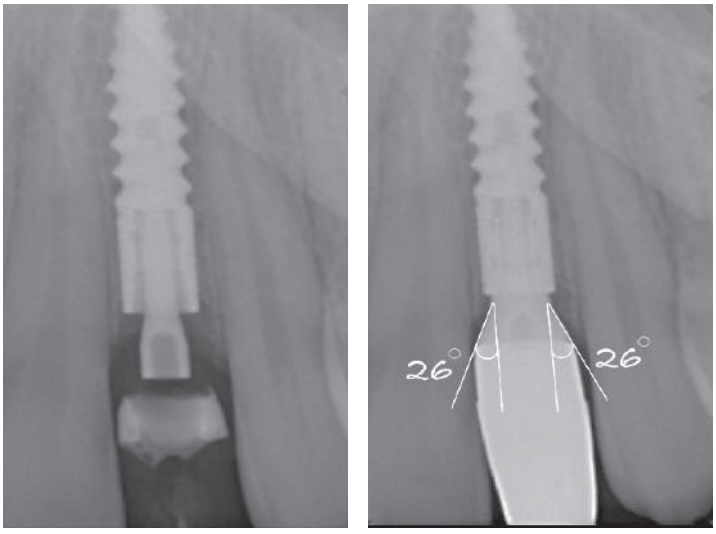



**a** **b**

**Fig. 4. Individual prepared abutments: a) after 2 years of functionality; b) the emergence angle degrees of permanent abutments**

As a result of the study, in the 3 mm soft tissue thickness the abutments with opening angles of up to 35° were referred as satisfactory for the peri-implant tissues around the implants. No considerable bone loss was observed at all, in angles up to 30°. In this cases recommended size of emergence profile is up to 6 mm in mesio-distal and bucco-linqual measurement (fig. 5, 6).

In the cases where peri-implant soft tissue thickness equal or more than 4 mm, the angle of transgingival part of abutment can be increased up to 40°. Thereby the size




**a** **b**

**Fig. 5. X-ray image: a) 16 weeks after surgery with temporary plastic abutment; b) after 5 years of functionality. The emergence angles of permanent abutment are 24 degree**

**Fig. 6. The state of peri-implant soft tissue after 5 years**

of emergence profile can be achieved up to 9 mm in mesio-distal and bucco-linqual measurement, which are enough for creating emergence profile for molar teeth. However even 30° is enough for creating emergence profile with 9 mm mesio-distal and bucco-linqual measurement if the mucosal thickness 4 mm.

Recently, preparation of emergence profiles and application of individual abutments for the purpose of meeting the aesthetic requirements in particular, proves the actuality of the research carried out by us. In most cases, the emergence profiles created by the temporarily fixed healing caps, for some reasons, are not fully copied in the preparation of the individual abutments that would be used permanently. Sometimes, the correction of the ready emergence profile is done on a practical model by a dentist or dental technician. In these cases, the opening angle of the transgingival part of the individually prepared abutment may be ignored. Nevertheless, the importance of these parameters should always be taken into account. The angle degree should always be carefully studied especially while working on biotypes. It might not result in bone loss in the thick biotypes when the angle range is more than 35°. In one of the clinical cases that we researched, for example, although the opening angle was 63°, no serious bone loss has been observed during the last 3-year functional period. The mucosal thickness is 4.5 mm during the period of temporary abutment replacement. The emergence angles of the transgingival parts of the temporarily fixed healing caps for 2 implants were measured to be 31° and 38°, respectively. However, for permanent individual abutments these angles were arranged to be at 63° and 45°, respectively. Nevertheless, the area with the most considerable bone loss was measured to be 0.3 mm. The reason for this fact was that there is soft tissue connection of more than 4 mm on the implant, and about 4.5–5 mm on the papilla (fig. 7–9).

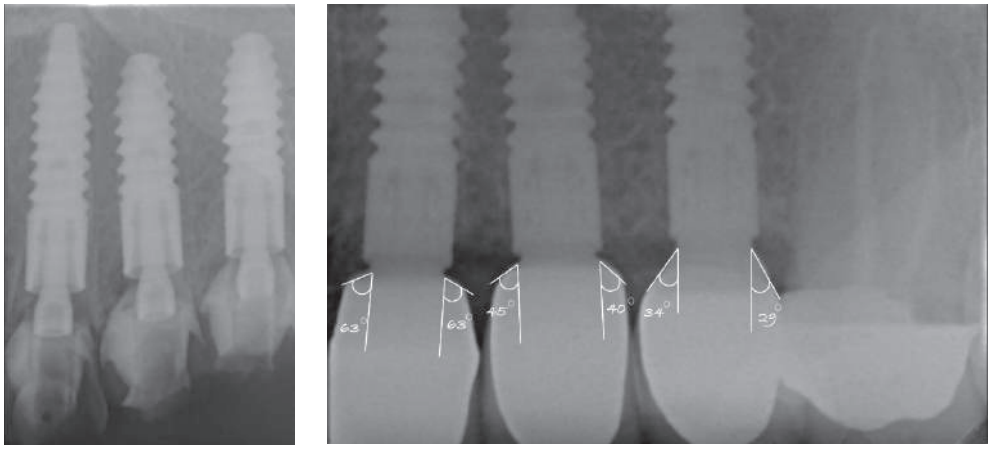
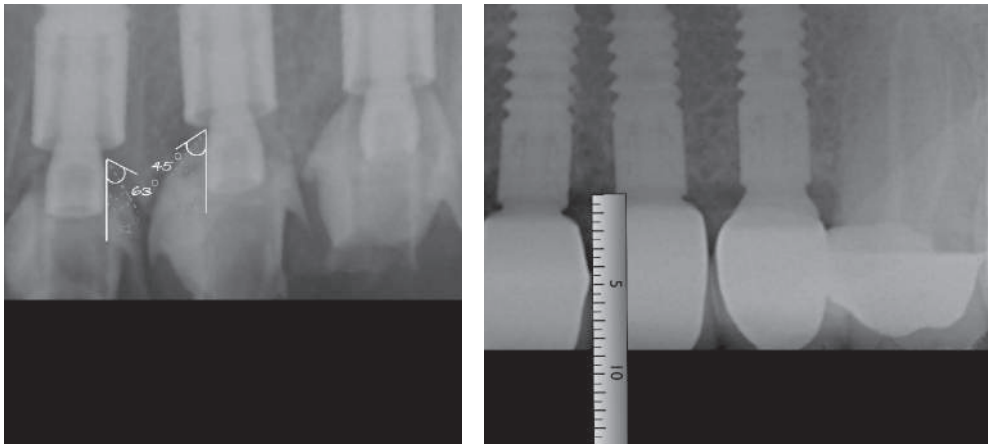



**Fig. 7. The degrees of emergence angles of permanent abutments**




**a** **b**

**Fig. 8. The differentiation of temporary and permanent abutments angles: a) the temporary abutments placed after surgery; b) the permanent individually prepared abutments after 3 years of functionality**

**a** **b**

**Fig. 9. The state of peri-implant tissues: a) after prosthodontics treatment; b) after 3 years of functionality**

As a result of our research, we can conclude that even for thick biotypes, we should adopt a very sensitive approach to the emergence angles of the individual abutments. The emergence angle should provide the dimensions to the biological width and the intervention to the area within these measures should be minimized. The most ideal measures that we identified, are up to 30° in the cases where the soft tissue thickness around of implant is 3 mm. In this case, sizes up to 6 mm are available for creating emergence profile. In the cases where peri-implant soft tissue thickness equal or more than 4 mm the angle of transgingival part of abutment can be increased up to 40°.Thereby the size of emergence profile can be achieved up to 9 mm in mesio-distal and bucco-linqual measurement.

## ■ CONCLUSION

While working especially with fine biotypes, the aesthetic requirements of the prospective prosthetic constructions should be considered in the surgical stage, the implants should be loaded deeply in order to provide soft tissue thickness whenever possible, or soft tissue augmentation has to be planned and implemented.

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