Original Research Paper

Volume : 5 | Issue : 8 | August 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Differences in Subgingival Shoulder Position In Digital Design and Intraorally on Cad/ Cam Custom Made Abutments. A Prospective Case Series

Medical Science

KEYWORDS : CAD/CAM implant abutments

Jan Pietruski	Dental Practice, ul. Waszyngtona 1/34, 15-269 Białystok, Poland
Anna Skurska	Dental Practice, ul. Waszyngtona 1/34, 15-269 Białystok, Poland, 2Department of Periodontal and Oral Mucosa Diseases Medical University of Białystok, ul. Waszyngtona 13, 15-269 Białystok, Poland
Anna Bernaczyk	Dental Practice, ul. Waszyngtona 1/34, 15-269 Białystok, Poland
Robert Milewski	Department of Statistics and Medical Informatics Medical University of Białystok, ul. Szpitalna 37, 15-295 Białystok, Poland
Maria Julia Pietruska	Student Association of Periodontology and Implantology at the Department of Periodontal and Oral Mucosa Diseases Medical University of Białystok, ul. Waszyngtona 13, 15-269 Białystok, Poland
Małgorzata Pietruska	Dental Practice, ul. Waszyngtona 1/34, 15-269 Białystok, Poland, Department of Periodontal and Oral Mucosa Diseases Medical University of Białystok, ul. Waszyngtona 13, 15-269 Białystok, Poland

ABSTRACT

Aim: *The aim of the clinical study was to compare the abutment shoulder position in relation to the free gingival margin on a customized CAD/CAM abutment in a digital design with a real intraoral situation following abment delivery.* ***Material and Method:*** *305 dental implants were evaluated in the study.* ***Results:*** *A statistical analysis revealed positive correlation between the virtually designed shoulder and its actual position. A decrease in the vertical dimension of the tissue occurred in 21.7 % of cases while an increase in this dimension was achieved in 34.4 % of cases.* ***Conclusion:*** *Within the limitations of this study it can be assumed that virtual designing of the abutment shoulder position gives intraorally average predictable results. As there was a reduction in tissue height in one sixth of the implants placed in the aesthetic region special care is needed in cases involving particular aesthetic demands*

Introduction

Many types of abutments are used in implant dentistry. Every implant system offers numerous stock abutments but irrespective of the wide variety, there are still many technical imperfections which makes the abutment the main restrictive barrier to achieving an optimal therapeutic and esthetic outcome. That is why clinicians have tried to overcome this problem by customizing abutments. A custom made abutment provides a biological and esthetic option that combines an ideal abutment shape, angulation, retention and soft tissue contouring with an optimal subgingival emergence profile.1, 2 Furthermore placement of the preparation margin just below the level of the tissue crest can help prevent cement induced peri-implantitis. 3, 4, 5 In the 1990s and early 2000s the idea first emerged of utilizing digital technology to design and manufacture all parts of an abutment. 6, 7, 8 Atlantis Components, Inc. (Cambridge, MA) developed a patented integrated computer-aided design/computer-assisted manufacturing process to fabricate patient-specific, precision-milled abutments from single blocks of titanium. Besides milling machines another important part of the system is the software, which allows to control and modify digital the 3D design. One aspect of the future abutment which can be precisely planned is its shoulder position in relation to the free gingival margin. However during the digital design process the free gingival margin visible on the computer screen is based on the tissue shape scanned from the model which can differ from reality. Later, the subgingival part of the abutment during the delivery process compresses the soft tissue and this can also trigger changes in the free gingival margin position. As there is a possibility that the intraoral position of free gingival margin will differ from the position in the digital image and there is no available data on this issue, the aim of this clinical study was to compare the shoulder position with respect to the free gingival margin in a customized CAD/CAM abutment in a digital design with a real intraoral situation after abutment delivery.

Material and methods

The study was designed as a single-center retrospective case series. A total of 305 dental implants (170 in the maxilla, 135 in the mandible) with diameters of 3.5, 4.0, 4.5 and 5.0 (Osseospeed TXTM, Dentsply Dental Implants, Mölndal, Sweden) were evaluated in the study. The implants were inserted in 63 generally healthy individuals aged 24-85 years (45 females, 18 males) who were treated in Dental Practice in Bialystok between 2012-2015. The study was carried out in accordance with the Helsinki Declaration of 1975, as revised in 2008. All the patients gave their written informed consent for implant therapy and the clinical examinations.

A two-stage surgical procedure was performed by the same operator on all patients. Implant level impressions using the open tray technique were taken not earlier than 4 weeks after the second stage of the surgery. The master stone models with silicone gingiva replicas together with removable wax-ups were sent to the Atlantis Center in Mölndal (Sweden). At the Atlantisweborder file subgingival position of the abutment shoulders were always planned in the same pattern in four aspects (buccal, palatal/lingual, mesial and distal): in the esthetic region - buccal 2.0, palatal/lingual 0.5, mesial 1.5, distal 0.75; in the premolar and molar region: buccal 1.5, palatal/lingual 0.5, mesial 1.0 and distal 0.5. The selected emergence profile was concave and featured a chamfer-margin design. After being scanned the CAD/CAM abutments were digitally designed using At-

lantis™ 3D Editor software (Dentsply Implants, Mölndal, Sweden) and milled out of titanium.

Figure 1 about here.

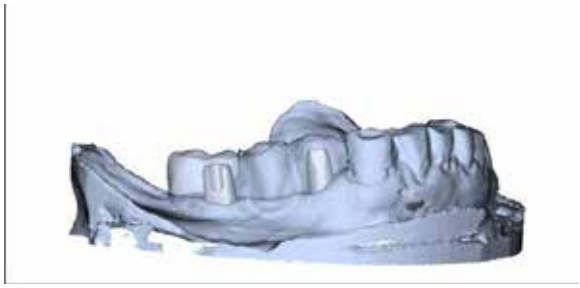

Fig. 1. Virtual design of CAD/CAM abutments in position 44 and 46.

The next step in the prosthetic procedure involved screwing the abutments into the implants, cementing temporary crowns made of composite material (Luxatemp, DMG, Hamburg, Germany) and later cementing the definitive crowns, made out of monolithic zirconia (Prettau®, ZirkonZahn, Brunico, Italy).

Clinical examinations were performed on two occasions, the first examination was done right after CAD/CAM abutment delivery, while the second took place during the following appointment before cementation of the definitive crown. The purpose of the examination was to evaluate the abutments' shoulder position relative to the gingival margin (in mm) in four aspects: buccal, palatal/lingual, mesial and distal. For the purpose of the examination a periodontal probe PCP UNC 15 (Hu-Friedy, Chicago, IL, USA) was used.

Figure 2 about here.

Fig. 2. Intraoral examination of abutment margin position in relation to the free gingival margin

The Chi-square Test of Independence and Fisher's exact test were used to assess the relationship between qualitative variables. Normal distribution was verified by the Kolmogorov-Smirnov test combined with the Lillefors amendment and the Shapiro-Wilk test. No normal distribution of quantitative variables analyzed was found. When comparing quantitative variables without normal distribution involving two dependent variables the nonparametric Wilcoxon matched pairs test was used. The Spearman's rank order correlation coefficient was also determined. The results were considered statistically significant at $p < 0.05$. Statistica 12.0 StatSoft (StatSoft. Tulsa, OK, USA) was used as the statistical software.

Results

The statistical analysis revealed a positive correlation in terms of the average distance between the virtually designed shoulder and its actual position relative to the gingival margin specified in the first and the second clinical examination (R=0.38 and R=0.36 respectively) for all implants and implants positioned both in the maxilla (R=0.41 and R=0.36 respectively) and mandible (R=0.32 and R=0.37 respectively). A strong positive correlation between the virtually designed shoulder position and its actual position relative to the gingival margin determined during the first clinical examination for all implants placed in the esthetic zone (incisors, canines) (R=0.54). The positive correlation between the virtual shoulder and the position of the gingival margin assessed during the second clinical examination for all implants placed in the aesthetic zone and implants placed in the aesthetic zone in maxilla was average (R=0.46 and R=0.45 respectively).

In the largest number of cases - 43.9 % - the distance between the gingival margin and the abutment shoulder did not change. A decrease in the vertical dimension of the tissues was noted in 21.7 % of all cases while an increase occurred in 34.4 % of cases. In the esthetic region in the largest number of case - 45.7% - the position of the gingiva was shown to be stable. In 15.7% of cases the vertical dimension of gingiva was reduced, whereas in 38.6% it increased.

An analysis of the dependency between the virtual and actual position of the abutment shoulder showed an average positive correlation regardless of the implant diameter in relation to the whole group

An analysis of the correlation between the virtual and actual position of the abutment shoulder depending on the position and diameter of the implant revealed a strong positive correlation between the real and virtual shoulder in the first examination (R=0.53) for the 3.5mm diameter implants positioned in the aesthetic region. A strong positive correlation between the virtual and real shoulder was also shown for 4.0mm diameter implants placed in this area in both clinical examinations (R= 0.79 and R=0.83 respectively).

Discussion

The problem of predictability of subgingival position of abutment shoulder is particularly important in the esthetic region as a shift in the shoulder position in a supragingival can lead to titanium exposure and an unacceptable esthetic outcome.

The positive aspect of our research results demonstrated that a correlation exists between the virtually planned and clinically measured position of abutment shoulder. However, as this is only the average correlation, absolute perfect matching of virtual and real shoulder position can't be expected. A strong positive correlation was observed in all implants in the aesthetic region (canines and incisors) during the first clinical examination. During the second clinical examination an average positive correlation was observed for all implants placed in aesthetic region as well as in the aesthetic region of the maxilla (R=0.46 and 0.45). This result is of particular importance. The following changes over time can result from differences in the microanatomy of tissues surrounding implants as compared to those surrounding teeth, which may result not only from differences at the cellular level, but also from a proper blood supply. 9, 10 The response of the periimplant mucosa is not clearly understood. On the one hand, gingival recession has been reported in up to 16% of anterior single implants restorations, while on the other spontaneous rebound of the receded gingiva has been shown to occur after a few years of use. 11, 12, 13, 14 In systematic review published by Jung

Volume : 5 | Issue : 8 | August 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

et al. the issue of peri-implant gingival recession is mentioned both in terms of biological and aesthetic outcomes. What is interesting to note is that soft tissues complications including dehiscences are reported in 7.1% of cases after 5 years. 15 In earlier studies this rate was 9.7% after 5 years. 16 In our studies we found a reduction in tissue height in 21.7% of cases, an increase in 34.4% and no change in 43.9%. This is consistent with earlier studies and may indicate that the problem of soft tissues instability does not arise from the technology used for prosthetic reconstruction but rather from the properites of the peri-implant tissues. Regardless of whether we are dealing with an increase or a reduction of soft tissues height it indicates the unpredictability of a virtually planned abutment margin position. The possibility of a reduction in soft tissues in over 21% of cases is a worrying problem and suggests that it would be advisable to plan the position of the shoulder a little deeper subgingivaly than would result from virtual image. The above data from our study pertain to all cases but an analysis of soft tissues stability in the aesthetic region leads to slightly different findings. In this region a decrease in soft tissues was observed in 15.7% of cases and increase in other 38.6%, which are better outcomes than for cases as a whole. The explanation of better soft tissues stability in the aesthetic region may result from soft tissues augmentation procedures, which are employed more often nowadays. This would also explain why in subsequent reviews published by Jung et al. over a period of four years the percentage of dehiscences occurring in front region decreased. 15, 16 According to data published by Basetti et al. and based on a review of the literature, soft tissues conditions should always be optimized before or during implant placement through various grafting procedures in order to achieve easier and more predictable prosthetic treatment. 17 Therefore regardless of type of abutment used soft tissue augmentation should always be taken into account.

Conclusions

Within the limitations of this study it can be concluded that virtual designing of the abutment shoulder position gives intraorally average predictable results. As there was a reduction of tissue height in one sixth of implants placed in aesthetic region special care is needed in cases involving particular aesthetic demands. However, further studies on larger research groups would appear advisable.

References

1. Priest, G. Virtual-designed and computer-milled implant abutments. Journal of Oral and Maxillofacial Surgery 2005; 63(9 Suppl 2): 22-32.
2. Papazian, S., Morgano, S. M. A laboratory procedure to facilitate development of an emergence profile with custom implant abutment. Journal of Prosthetic Dentistry 1998; 79: 232-234.
3. Gapski, R., Neugeboren, N., Pemeraz, A. Z., Reissner, M. W. Endosseous implant failure influenced by crown cementation: a clinical case report. International Journal of Oral and Maxillofacial Implants 2008; 23: 943-6.
4. Pauletto, N., Lahiffe, B. J., Walton, J., N. Complications associated with excess cement around crowns on osseointegrated implant: a clinical report. International Journal of Oral and Maxillofacial Implants 1999; 14: 865-8.
5. Linkevicius, T., Vindasiute, E., Puisys, A., Linkeviciene, L., Maslova, N. & Puriene, A. The influence of the cementation margin position on the amount of undetected cement. A prospective clinical study. Clinical Oral Implants Research 2013; 24: 71-76.
6. Ganz, S. D. Computer-Milled Patient-Specific Abutments: Inredible Quality With Unprecedented Simplicity. Practical Procedures and Aesthetic Dentistry 2000; 15 (8 Suppl): 37-44.
7. Osorio, J. Use of the Atlantis Abutment in restorative practice speeds time to function and aesthetics. Dental Implantology Update 2000; 11: 57-62.
8. Adams, M. W. Computer-Designed and Milled Patient-Specific Implant Abutments. Dentistry Today 2005; 24: 1-4.
9. Makigusa K. Histologic comparison of biologic width around teeth versus implants: The effect of bone preservation. Journal of Implant and Reconstructive Dentistry 2009; 1: 21-24.
10. Kan, J. Y. K., Rungcharassaeng, K., Umezu, K., Kois, J. C. Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. Journal of Periodontology 2003; 73: 557-562.
11. Goodacre, C.J., Kan, J. Y. K., Rungcharassaeng, K. Clinical complications of osseointegrated implants. Journal of Prosthetic Dentistry 1999; 81: 537-552.
12. Jemt, T. Regeneration of gingival papillae after single-implant treatment. International Journal of Periodontics and Restorative Dentistry 1997; 17: 327-333.
13. Jemt, T. Restoring the gingival contour by means of provisional resin crowns after single-implant treatment. International Journal of Periodontics and Restorative Dentistry 1999; 19: 21-29.
14. Cooper, L., Felton, A. D., Kugelberg, C. F., Ellner, S., Chaffee, N., Molina A. L., Moriarty J. D., Paquette, D., Palmquist, U. A multicenter 12-months evaluation of single-tooth implants restored 3 weeks after 1-stage surgery. International Journal of Oral and Maxillofacial Implants 2001; 16: 182-192.
15. Jung, R. E., Zembic, A., Pjetursson B. E., Zwahlen, M. & Thoma, D. S. Systematic review of the survival rate and the incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. Clinical Oral Implants Research 2012; 23 (Suppl. 6): 2-21.
16. Jung, R. E., Pjetursson B. E., Glauser, R., Zembic, A., Zwahlen, M. & Lang N. P. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. Clinical Oral Implants Research 2008; 19: 119-130.
17. Bassetti, M., Kaufmann, R., Salvi, G. E., Sculean, A., Bassetti, R. Soft tissue grafting to improve the attached mucosa at dental implants: A review of the literature and proposal of a decision tree. Quintessence International 2015; 46: 499-510.