Assessment of Artificial Teeth Setup Device: A Three-Dimensional Model Analysis

Noppavan Nagaviroj, DDS, MSc[a]/Michael Figl, MSc, PhD[b]/Rudolf Seemann, DDS, MD, PhD[c]/Toni Dobsak, BSc[d]/Kurt Alexander Schicho, MD, PhD[c]

This study assessed the use of the commercial artificial teeth setup device Staub Cranial System (Neu-Ulm) in Asian subjects. Fourteen completely dentate Thai volunteers were randomly recruited. Study casts (control group) and duplicated casts (experimental group) of all subjects were prepared. Artificial teeth were replaced on duplicated casts according to the manual. Computed tomography scans of all casts were performed. Intercanine width, intermolar width, incisocervical length, and occlusal plane were investigated. The length of the natural mandibular left central incisor was smaller than the reconstructed one. The reconstructed occlusal plane was more parallel to the hamular-incisive papilla plane than that of the control group. *Int J Prosthodont 2015;28:383–385. doi: 10.11607/ijp.4116*

Determination of the correct anterior and posterior tooth position is an important consideration in fabricating dental prostheses. Many methods are used to determine the position of artificial teeth and the plane of occlusion. A new approach, the Staub Cranial System (Neu-Ulm), is a commercial artificial teeth set-up device based on defined anatomical landmarks. It applies a mathematical calculation to reconstruct tooth position and occlusal plane.[1] The purpose of this study was to evaluate the outcome of using the commercial artificial teeth setup system in Asian populations by comparing the original tooth position and the reconstructed tooth position.

[a]*Center for Medical Physics and Biomedical Engineering, and Department for Cranio-Maxillofacial and Oral Surgery, Medical University of Vienna, Austria; and Department of Prosthodontics, Faculty of Dentistry, Mahidol University, Thailand*
[b]*Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Austria.*
[c]*Department for Cranio-Maxillofacial and Oral Surgery, Medical University of Vienna, Austria.*
[d]*Bernhard Gottlieb University Clinic of Dentistry, Medical University of Vienna, Austria.*

Correspondence to: *Michael Figl, Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Waehringer Guertel 18-20, 4L, A-1090 Vienna, Austria. Fax: +431404003988. Email: michael.figl@meduniwien.ac.at*

A preliminary version of this study was presented at 18th Jahreskongress der Österreichischen Gesellschaft für Mund-, Kiefer- und Gesichtschirurgie in Mayrhofen, Austria on January 29, 2014.

Materials and Methods

A convenience sample of 14 fully dentate Thai volunteers (11 females, 3 males; mean age: 27.86 ± 4.80 years) with skeletal Class I occlusion, good alignment of teeth, and no history of orthodontic treatment was randomly recruited from Thai students studying in Austria and from dental students and staff at Mahidol University, Thailand.

Maxillary and mandibular impressions were taken with irreversible hydrocolloid, and the study casts were made (control group). The duplicated casts were then fabricated (experimental group). All plaster teeth in the experimental group were replaced by the acrylic teeth (Vitapan, Vita), selected and arranged by the experienced dental technician according to the system instructions.

After computed tomography (CT) scans of all casts were performed, three-dimensional (3D) models were analyzed with Amira version 5.4.5 (FEI). Measurements were taken at two separate times by one investigator. The intercanine width, intermolar width, and incisocervical length of central incisors were measured (Fig 1). With this system, the maxillomandibular relationship record is still mandatory. In this study, mandibular posterior teeth were arranged according to each subject's original bite, so the mandibular intermolar width of both groups was neither measured nor compared. The angular relationship between the hamular-incisive papilla (HIP) plane and the occlusal plane (OP) was also observed (Fig 2). The definitions of HIP and OP are described in Table 1. A Wilcoxon signed-rank test was performed to compare the measurements between the groups.

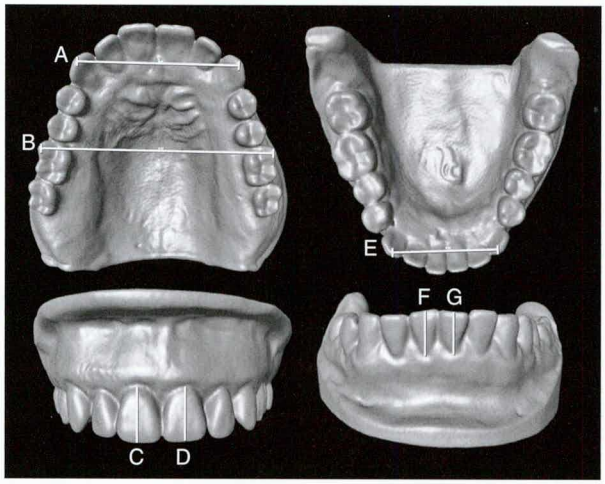

Fig 1 *(left)* Measured distances on maxillary and mandibular 3D models: A = maxillary intercanine width, B = maxillary intermolar width, C = length of the maxillary right central incisor, D = length of the maxillary left central incisor, E = mandibular intercanine width, F = length of the mandibular right central incisor, and G = length of the mandibular left central incisor.

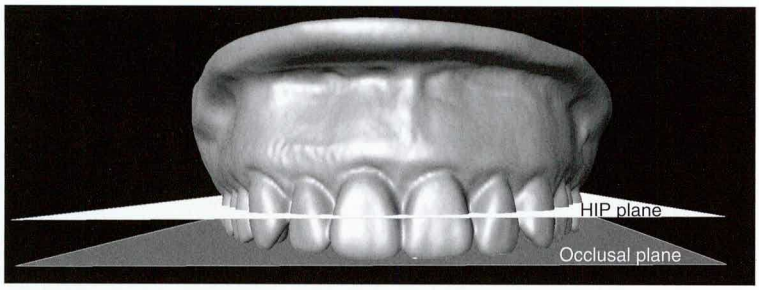

Fig 2 *(below)* HIP plane and occlusal plane analysis on 3D models.

Table 1 The Definition of the HIP Plane and Occlusal Plane Used in This Study

Plane	Anterior reference point	Posterior reference points
HIP plane	The center of the incisive papilla	The lowest points of bilateral hamular notches
Occlusal plane	Mesiolabial incisal edge of the maxillary left central incisor	Mesiopalatal cusp tips of maxillary first molars

Table 2 Descriptive Statistics and Statistical Analysis of All Measurements*

	LICW	LRIL	LLIL	UICW	UIMW	URIL	ULIL	HIP-OP (deg)
Original	26.43	7.83	7.66	34.57	52.51	9.49	9.38	2.45
StraubTM	26.18	810	8.02	34.90	52.53	9.61	9.53	1.27
P value	.0706	.096	.039	.221	.730	.615	.074	.011

*Wilcoxon signed-rank test was used for the comparison
LICW = mandibular intercanine width, LRIL = mandibular right central incisor length, LLIL = mandibular left central incisor length, UICW = maxillary intercanine width, UIMW = maxillary intermolar width, URIL = maxillary right central incisor length, HIP = hamular-incisive papilla plane, OP = occlusal plane.

Results

Statistically significant differences between the original and reconstructed groups were found in HIP-OP angle (P = .011) and incisocervical length of the mandibular left central incisor (P = .039). The mean HIP-OP angle of the original dentition (2.45 ± 1.33 degrees) was higher than that of the reconstructed group (1.27 ± 0.73 degrees). The mean length of the mandibular left central incisor of the original dentition (7.66 ± 0.42 mm) was smaller than that of the artificial teeth setup group (8.02 ± 0.36 mm) (Table 2).

Discussion

In the present study, it was found that the length of the original mandibular left central incisor was statistically less than that of artificial teeth (mean difference = 0.36 mm). The esthetics in this region may not be compromised since the labial surface of mandibular anterior teeth and gingiva slightly displayed at rest and during smiling.[2] In addition, the mean difference between the two groups is very small.

In both groups, the HIP-OP angles of all subjects were in the range found in other studies.[3,4] The Staub

reconstructed occlusal plane is statistically more parallel to the HIP plane than is the original occlusal plane. The parallelism of the HIP plane and the prosthetic occlusal plane was also found in other studies measured with the cephalometric tracing method.[3–5]

This study showed that the size and position of the artificial teeth selected and determined by this commercial teeth setup system is comparable to those of the original group and is applicable to Asian subjects. The commercial artificial teeth setup system could help dentists and dental technicians determine artificial teeth size and position from the existing anatomy. However, the application of this teeth setup system could be limited when patients have lost the key anatomical references from trauma or surgery or have been affected by craniofacial anomalies.

Conclusions

Within the limitations of this study, the following conclusions were drawn:

- The position and the length of the artificial teeth determined by the investigated teeth setup system were comparable to the original dentition.
- The reconstructed occlusal plane is statistically more parallel to the HIP plane than is the natural occlusal plane.
- Further clinical studies should be performed in edentulous patients to evaluate the patients' satisfaction regarding esthetics, phonetics, and function and to compare the Staub reconstructed occlusal plane with the Camper's plane, which is one of the routinely used arbitrary reference planes.

Acknowledgments

The authors reported no conflicts of interest related to this study.

References

1. StaubCranial. Healthy Dentures: Theoretical summary. http://www.staub-cranial.de/download.html. Accessed 7 July 2015.
2. Al-Habahbeh R, Al-Shammout R, Al-Jabrah O, Al-Omari F. The effect of gender on tooth and gingival display in the anterior region at rest and during smiling. Eur J Esthet Dent 2009; 4:382–395.
3. Karkazis HC, Polyzois GL. Cephalometrically predicted occlusal plane: Implications in removable prosthodontics. J Prosthet Dent 1991;65:258–264.
4. Čelebić A, Brkić H, Kaić Z, Valentić-Peruzović M, Vojvodić D. Evaluation of some lateral cephalometric methods for determination of occlusal plane inclination. Acta Stomtol Croat 1994; 28:11–18.
5. Rich H. Evaluation and registration of the HIP plane of occlusion. Aus Dent J 1982;27:162–168.

Literature Abstract

Effectiveness of implant therapy analyzed in a Swedish population: Early and late implant loss

Early implant loss (before prosthesis completion) was studied in a total of 2765 clinical files from 800 clinics (11,311 implants). Late implant loss (after definitive prosthesis completion) was studied in a group of 596 individuals (2367 implants) from the aforementioned population who had attended a clinical examination up to 8.9 years post-treatment. On average, 5.4 (SD2.2) years of longitudinal data was collected. The results showed that early implant loss was 1.4% and late implant loss was 2%. Various other factors were studied, among them age, sex, loading protocol, medical condition, specialist or generalist clinician, anatomical locations, prosthesis type, and time of implant loss. The results revealed that 4 factors significantly impact the odds ratio (OR) that affected implant loss: (1) a history of periodontal disease, OR = 3.3; (2) smoking, OR = 2.3; (3) implants below 10mm, OR = 3.8; (4) 4 groups of implant brands: with Straumann group implants used as reference (OR = 1.0), odds ratios for Nobel Biocare group implants and Astra Tech group implants were 6.1 and 5.2, respectively. For other implants (OR = 58.2), a significantly higher odds ratio was observed. It is important to note that implant brand does have an effect in early and late implant loss. However, the percentage range from 0.5 to 3.8 percent was noted as insignificant.

Derks T, Håkansson J, Wennström JL, Tomasi C, Larsson M, Bergundh T. *J Dent Res* 2015; 94(suppl 3):44S–51S. **References:** 15. **Reprints:** Department of Periodontology, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden. Email: jan.derks@odontologi.gu.se—*Ansgar C. Cheng, Singapore*