SEMMELWEIS UNIVERSITY
Faculty of Dentistry

Department of Restorative Dentistry and Endodontics
Head:
János Vág Dr. Prof.

Working group name: Digital Forensic Dentistry

1. Team members:

- Group leader: János Vág
- Post-doc: Arvin Shahbazi, Botond Simon
- PhD students: Ákos Mikolicz, Sándor Mikó

2. Research topic: **Proof of concept of digital palatal morphology in human identification**

3. Abstract:

The role of the rugae palatinae in forensic odontology can be reinterpreted as a reliable method of human identification thanks to the development of digital dentistry. In our previous study, we have demonstrated the ability to distinguish monozygotic twins with nearly identical DNA by comparing digital scans of the palate. The aim of our studies is to assess the role of palatal geometry and surface morphology in the similarity between twins. By examining heritability, we will determine the role of genes and environment in the variation between individuals. We would like to determine the extent of palate degradation after death under different environmental conditions and how long the characteristics required for identification can be recognised. We aim to demonstrate the stability of palatal tissue by periodontal plastic surgery post-operative regeneration examination and histological studies. Our expected results suggest that palatal morphology is resistant to degradation for 1-2 weeks and thus could be well suited for use in victim identification. We aim to demonstrate that differences in software and hardware between intraoral scanners used by dentists do not affect the accuracy of identification. This will allow comparisons between antemortem (reference database) and future postmortem scans using intraoral scanners. Based on the results of our tests, a pattern recognition algorithm supported by machine learning can be developed. Our evidence-based results could launch the international exploitation of digital palatal identification.

Address: 1085 Budapest, Üllői út. 26.
P.O Box: 1087 Budapest, Szentkirályi u. 47. 1428 Budapest, Pf. 2.
E-mail: konzervalo.fogaszat@dent.semmelweis-univ.hu
Phone.: 06-317-1598
https://semmelweis.hu/konzervalo-fogaszat/

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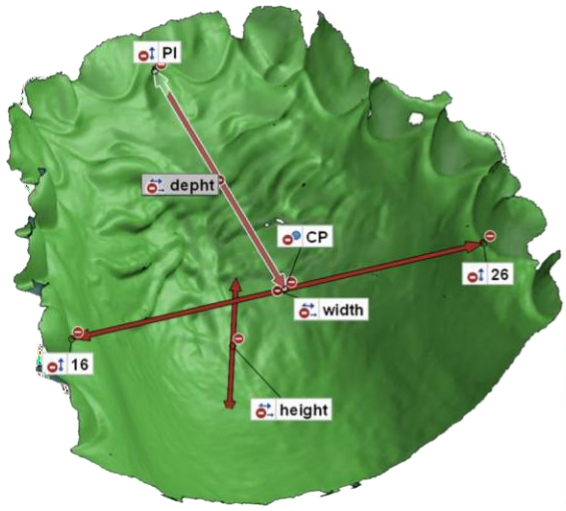

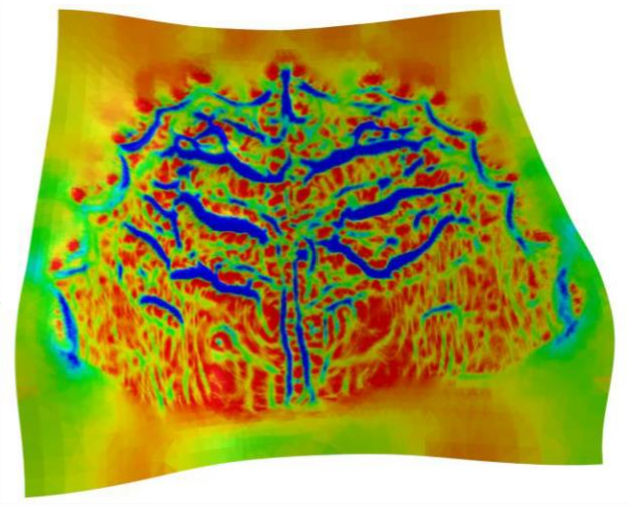

4. Awarded application:
   - American Society of Forensic Odontology, 2019, Application of intraoral scanner to identify monozygotic twins
   - Semmelweis Innovációs Díj, 2019, Szájpadlás felhasználása emberi azonosításra
   - American Society of Forensic Odontology, 2020, The role of the geometry and the palatal rugae in human identification
   - STIA-KFI, 2020, Szájpadlás alapú biometrikus azonosítás fejlesztése mesterséges intelligencia és gépi tanulás felhasználásával
   - OTKA, 2022, A digitális palatinális morfológia koncepciójának igazolása az emberi azonosításban
   - American Society of Forensic Odontology, 2023, Digital analysis of palatal morphology in different ethnicities

5. Congressional participation on the subject
   - Zsolt Nagy, János Vág, Anthony Mennito, Walter Renne. Comparison of distortion of seven intraoral scanners caused by stitching mechanism. Digital Dentistry Society Global Conference, Baden Baden, Germany 2019.
   - János Vág, Evelin Kövér, Ákos Mikolicz, Zsolt Nagy. Assessment of distortion caused by stitching during full arch intraoral scanning. Digital Dentistry Society Global Conference, Baden Baden, Germany 2019.
   - Botond Simon, Ádám D. Tárnoki, Dávid L. Tárnoki, János Vág. Application of intraoral scanner to identify monozygotic twins. Digital Dentistry Society Global Conference, Baden Baden, Germany 2019.
   - Simon Botond, Lipták Laura, Lipták Klaudia, Tárnoki Ádám D., Tárnoki Dávid L., Vág János. Szájszkenner alkalmazása egypetéjű ikrek azonosításához. Adaptív digitális állam, Budapest 2019
   - Vág János: Az intraorális scannerek tudománya és ennek klinikai jelentősége. Pécsi nyári továbbképzés fogorvosoknak 2019
   - Vág János: Accuracy of intraoral scanners (IOS). Accuracy in Digital Dentistry: Where do we Stand? The Third DDS Consensus Conference, Serralunga d'Alba, Italy, October 2nd- 3rd 2020. Meghívott előadó és diszkuszió panel vezetője
   - Vág János: CADCAM A mai intraorális scannerek tudománya és ennek klinikai jelentősége. Digitális lenyomatvétel és odontotechnológia lehetőségei a gyakorlatban és Intraoral Scanner Show - a MERT szervezésében, 2020, Budapest
   - Vág János: A gépek forradalma a fogászatban. Kutatók Éjszakája, online. 2020.

Budapest

- Simon Botond, Vág János. Application of intraoral scanner to identify MZ twin Global Dental Interdisciplinary Summit. 2020
- Simon Botond., Vág János Szájszkenner alkalmazása egypetéjű ikrek azonosítására. XXIII. Tavaszi Szél Konferencia. 2020
- Simon Botond, Vág János. Application of intraoral scanner to identify MZ twin Semmelweis 250 Clinical Conference. 2020
- Botond Simon, Janos Vag. The Application of an Intraoral Scanner to Identify Monozygotic (MZ) Twins. Academy's 73rd Annual Scientific Meeting, 2021 (CST-USA).
- Botond Simon, Ádám Tárnoki, Dávid Tárnoki, Dóra Melicher, Janos Vag. Application of intraoral scanner to identify monozygotic twins. ISTS TWINS Congress, Beijing, China 2021
- Simon Botond, Pellei Dalma, Speer Szilvia, Pál Adrienn, Vág János The role of palatal geometry in gender discrimination and human identification. PhD Tudományos Napok, Semmelweis Egyetem. 2021
- Vág János, Simon Botond. DVI 3D Fogászati Azonosítás bevezetés. Belügyminisztérium 2021.07.08.
- Simon Botond, Vág János. DVI 3D Fogászati Azonosítás, kutatás és innováció. Belügyminisztérium 2021.07.08.
- Simon Botond, Vág János: DVI 3D fogászati azonosítás. Simonffy-szeminárium Tihanyban, 2021.
- Mikolicz Ákos, Simon Botond, Gáspár Orsolya, Vág János: Digital reproducibility of the palate utilizing intraoral scanners and its application in human identification 2023 Dubrovnik
- Mikolicz Ákos, Simon Botond, Gáspár Orsolya, Vág János: Precision of Aoralscan 3 and its application in human identification (poszter prezentáció) 2024 New Orleans IADR konferencia

6. Publications:

- Nagy, Z. A., B. Simon, Z. Toth and J. Vag (2018). "Evaluating the efficiency of the Dental Teacher system as a digital preclinical teaching tool." Eur J Dent Educ 22(3): e619- e623.https://www.ncbi.nlm.nih.gov/pubmed/29797383. DOI: 10.1111/eje.12365.
- Vag, J., Z. Nagy, B. Simon, A. Mikolicz, E. Kover, A. Mennito, Z. Evans and W. Renne (2019). "A novel method for complex three-dimensional evaluation of intraoral scanner accuracy." Int J Comput Dent 22(3): 239-
- 249.https://www.ncbi.nlm.nih.gov/pubmed/31463488.
- Nagy, Z., B. Simon, A. Mennito, Z. Evans, W. Renne and J. Vag (2020). "Comparing the trueness of seven intraoral scanners and a physical impression on dentate human maxilla by a novel method." BMC Oral Health 20(1):
- 97.https://www.ncbi.nlm.nih.gov/pubmed/32264943. DOI: 10.1186/s12903-020-01090-x.
- Simon, B., L. Liptak, K. Liptak, A. D. Tarnoki, D. L. Tarnoki, D. Melicher and J. Vag (2020). "Application of intraoral scanner to identify monozygotic twins." BMC Oral Health 20(1): 268.https://www.ncbi.nlm.nih.gov/pubmed/33008463. DOI: 10.1186/s12903-020-01261-w.
- Vag, J., Z. Nagy, C. Bocklet, T. Kiss, A. Nagy, B. Simon, A. Mikolicz and W. Renne (2020). "Marginal and internal fit of full ceramic crowns milled using CADCAM system
- on cadaver full arch scans." BMC Oral Health 20(1):

- 189.https://www.ncbi.nlm.nih.gov/pubmed/32631333. DOI: 10.1186/s12903-020-01181-9.
- Revell, G., B. Simon, A. Mennito, Z. P. Evans, W. Renne, M. Ludlow and J. Vag (2021). "Evaluation of complete-arch implant scanning with 5 different intraoral scanners in terms of trueness and operator experience." J Prosthet Dent.https://www.ncbi.nlm.nih.gov/pubmed/33832761. DOI: 10.1016/j.prosdent.2021.01.013.
- Simon, B., A. A. Farid, G. Freedman and J. Vag (2021). Digital scans and human identification. Oral Health Journal, Oral Health Group. July 9.
- Simon, B., A. A. Farid and J. Vág (2021). "A preventív és proaktív fogászati azonosítás bevezetése és jelentősége tömegkatasztrófa áldozat azonosításkor." Scientia et Securitas 2(1): 123-134.https://akjournals.com/view/journals/112/2/1/article-p123.xml. DOI: 10.1556/112.2021.00004.
- Vag, J., W. Renne, G. Revell, M. Ludlow, A. Mennito, S. T. Teich and Z. Gutmacher (2021). "The effect of software updates on the trueness and precision of intraoral scanners." Quintessence Int 52(7): 636-644.https://www.ncbi.nlm.nih.gov/pubmed/33749223. DOI: 10.3290/j.qi.b1098315.
- Simon, B., K. Aschheim and J. Vág The discriminative potential of palatal geometric analysis for sex discrimination and human identification. Journal of Forensic Sciences 64(4). https://doi.org/10.1111/1556-4029.15110
- Daniel Borbola, Gabor Berkei, Botond Simon, Laszlo Romanszky, Gyorgy Sersli, Michael DeFee, Walter Renne, Francesco Mangano, Janos Vag In vitro comparison of five desktop scanners and an industrial scanner in the evaluation of an intraoral scanner accuracy, Journal of Dentistry (2022), doi: https://doi.org/10.1016/j.jdent.2022.104391
- Simon, B., Mangano, F.G., Pál, A. et al. Palatal asymmetry assessed by intraoral scans: effects of sex, orthodontic treatment, and twinning. A retrospective cohort study. BMC Oral Health 23, 305 (2023). https://doi.org/10.1186/s12903-023-02993-1
- Mikolicz A, Simon B, Gáspár O, Shahbazi A, Vag J. Reproducibility of the digital palate in forensic investigations: a two-year retrospective cohort study on twins. Journal of Dentistry. 2023;135:104562. https://doi.org/10.1016/j.jdent.2023.104562
- Simon, B., G. Freedman and J. Vag (2023). " Digital Palate Analysis to Verify the Mirror Twin Phenomenon" Oral Health Journal July 1. Oral Health Journal 34-39 https://www.oralhealthgroup.com/features/digital-palate-analysis-to-verify-the-mirror-twin-phenomenon/