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ACCURACY OF PARTIAL REMOUVABLE DENTURE PRODUCED BY ADDITIVE MANUFACTURING TECHNOLOGIES

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SC 09/A3 CoCo AM Additive Manufacturing
ASSOCIAZIONE NAZIONALE DISEGNO E METODI
COMET
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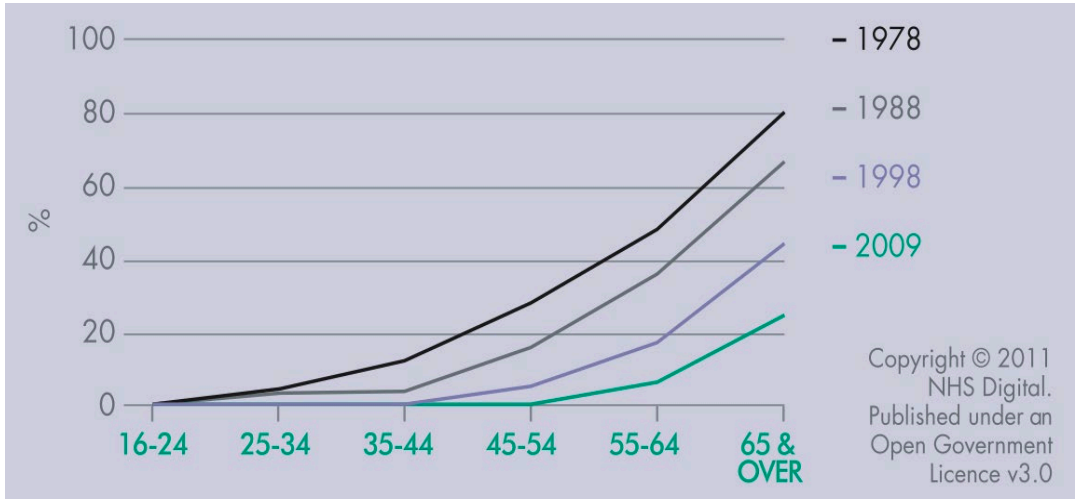
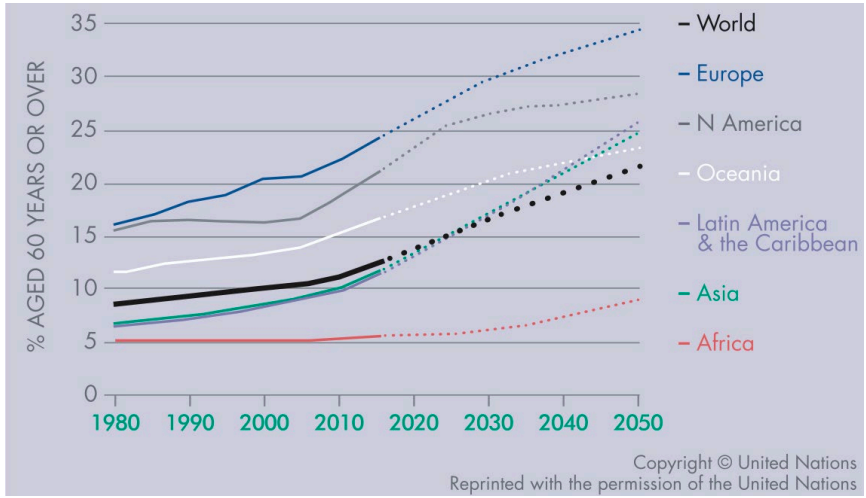
Contents

- Why removable partial dentures;
- The aim of the work;
- Design workflow
- Manufacturing workflow;
- Measurement challenges;
- Reference model;
- Functional alignment;
- Accuracy evaluation;
- Point sampling;
- Statistical analysis;
- Conclusions.

WHY REMOVABLE PARTIAL DENTURES



Trends in percentage edentate



Percentage of the global population aged 60 years and older

Epidemiological studies have demonstrated significant changes in the oral health of older adults in recent years. **As the numbers of edentulous older adults has declined, there has been a significant increase in the number of partially dentate elderly.**

McKenna, G., Tsakos, G., Burke, F., & Brocklehurst, P. (2020). Managing an ageing population: challenging oral epidemiology. Primary Dental Journal, 9(3), 14-17.

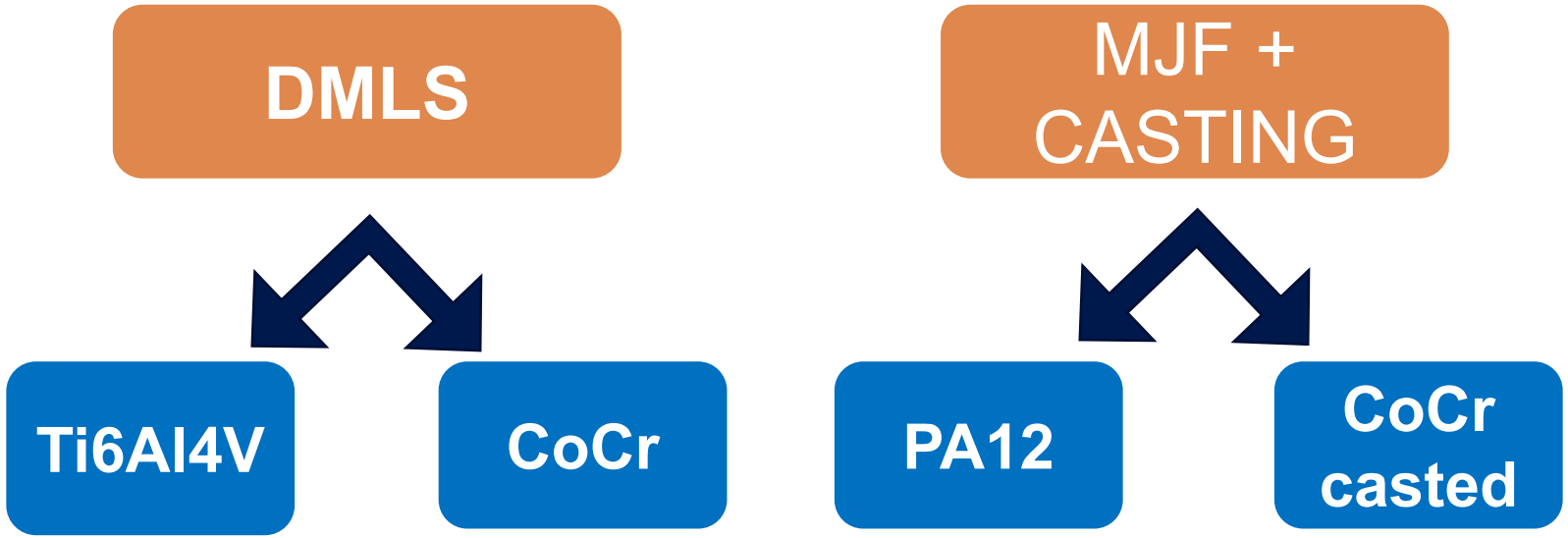
THE AIM OF THE WORK

- **Digital technology:** Valuable alternative to traditional workflows

Xie, W., Zheng, M., Wang, J., & Li, X. (2020)
Torii, M., Nakata, T., Takahashi, K., Kawamura, N., Shimpo, H., & Ohkubo, C. (2018)
Syrek, A., Reich, G., Ranftl, D., Klein, C., Cerny, B., & Brodesser, J. (2010)

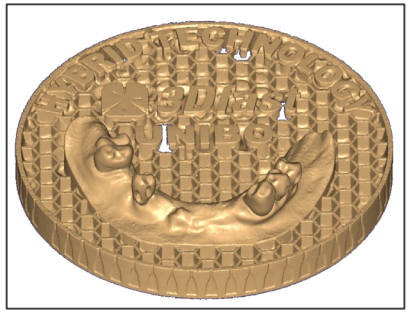
- **Digital technology accuracy:** positive evidences, still to assess the most accurate production workflow

Ye H, Ning J, Li M, Niu L, Yang J, Sun Y, et al. (2017)
Williams RJ, Bibb R, Eggbeer D, Collis J. (2006)
Williams RJ, Bibb R, Rafik T. (2004)



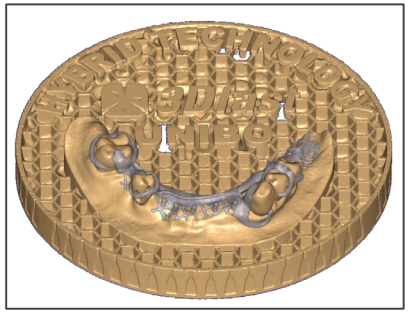
DESIGN WORKFLOWS

Model data



designing

Digital Wax Up



convertin

exocad

MANUFACTURING WORKFLOWS

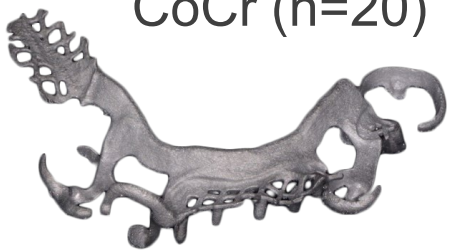
Digital design

DMLS

EOSINT M270

Group I
Ti6Al4V (n=20)

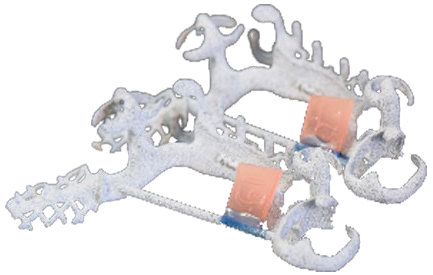
Group II
CoCr (n=20)



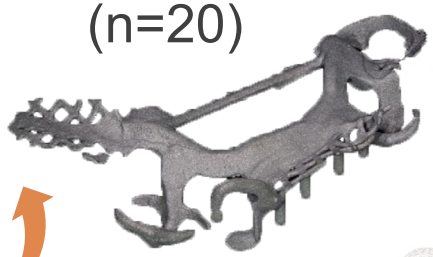
MJF

HP Jet Fusion 4200

Group III
PA12 (n=20)



Group IV
CoCr casted
(n=20)

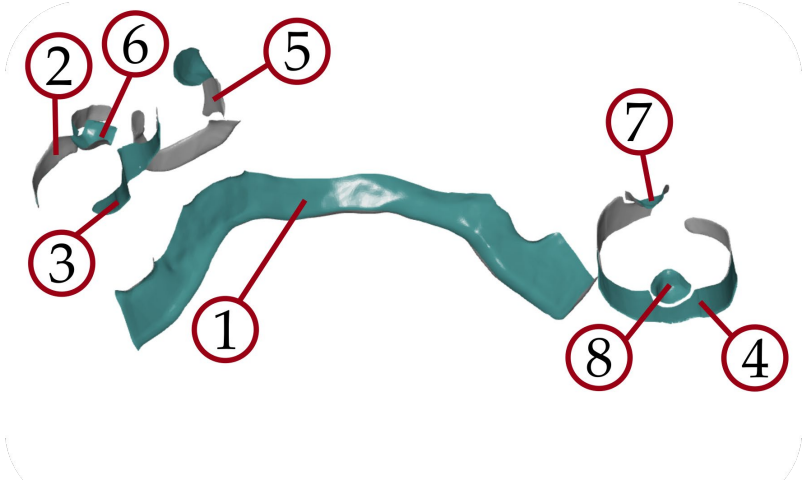


MEASUREMENT CHALLENGES

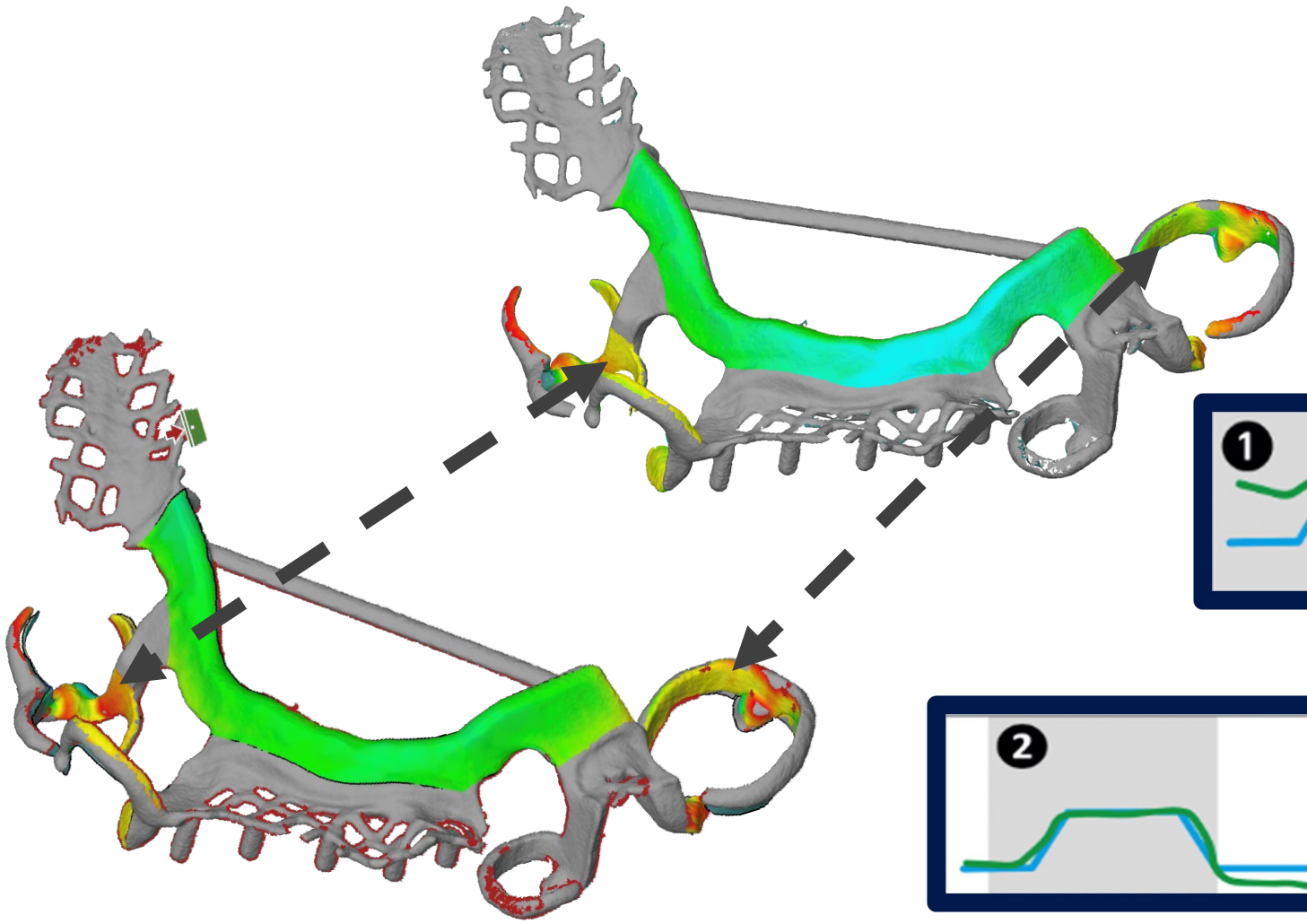
- Functional areas definitions (partition);
- Non-visible surfaces;
- Functional alignment;
- Sampling density.

REFERENCE MODEL

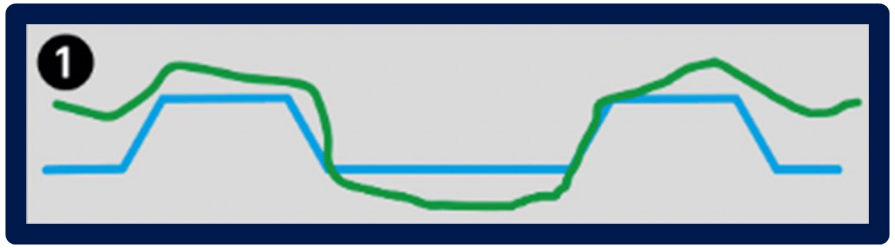
1. Lingual bar
2. Bonwill (external)
3. Bonwill (internal)
4. Circumferential clasp
5. I-bar
6. Bonwill rest
7. Anterior circumferential rest
8. Posterior circumferential rest

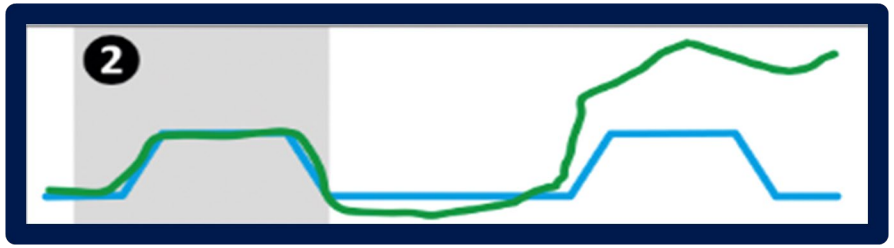


FUNCTIONAL ALIGNMENT



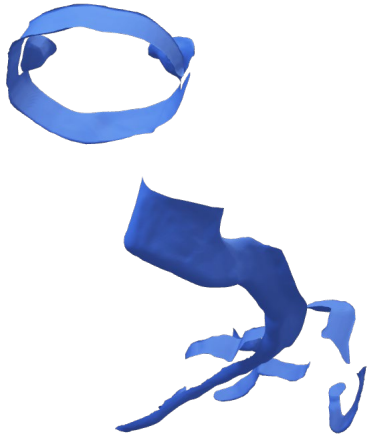
Functional Alignment:
Local Best fit over the lingual bar





ACCURACY EVALUATION

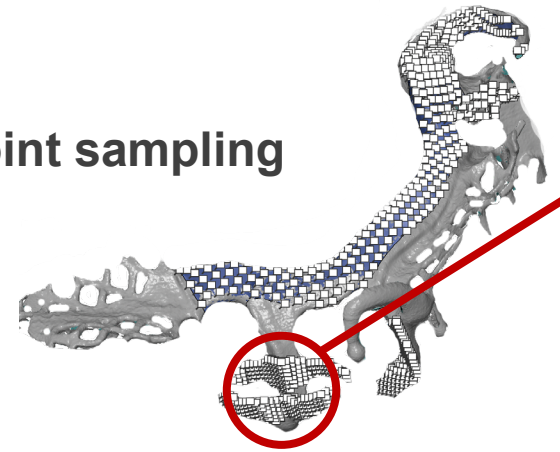
Reference model

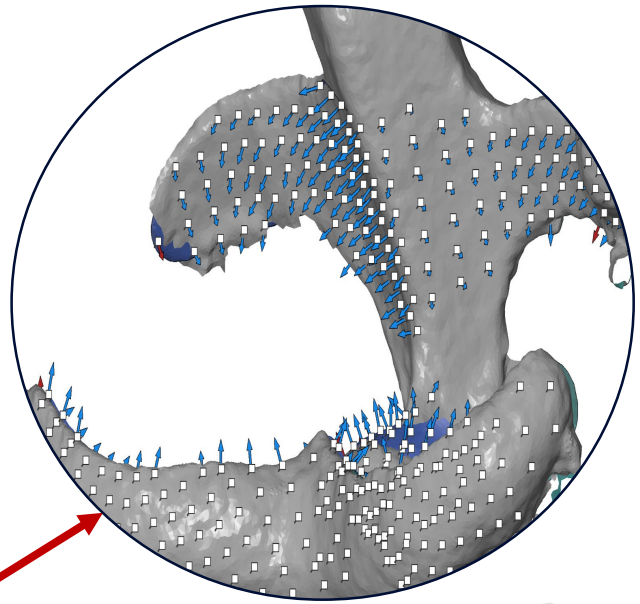


Actual data

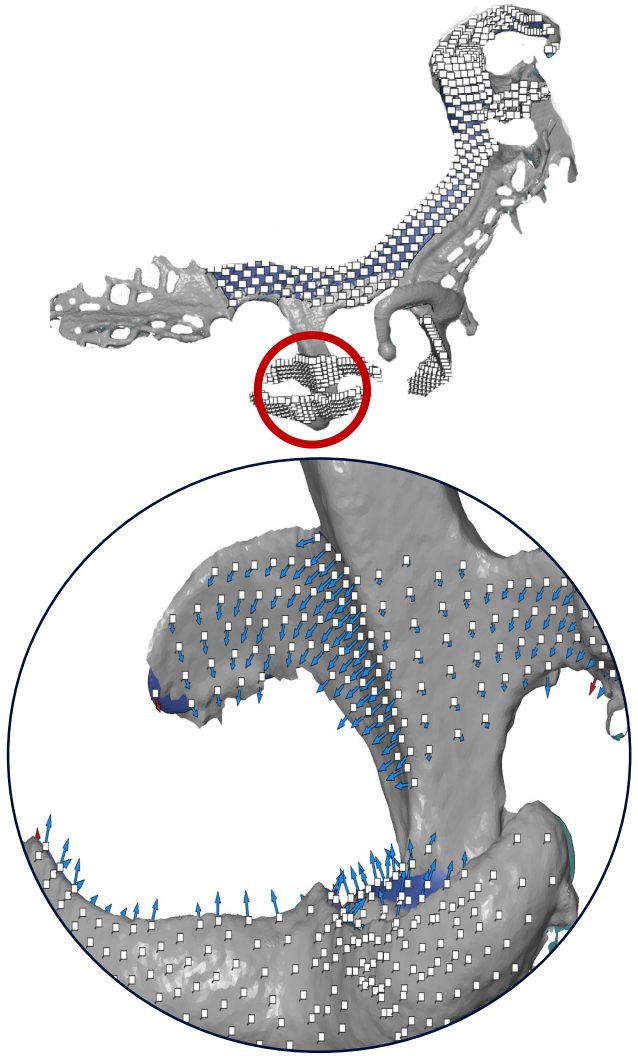
GOM Inspect Suite

Point sampling

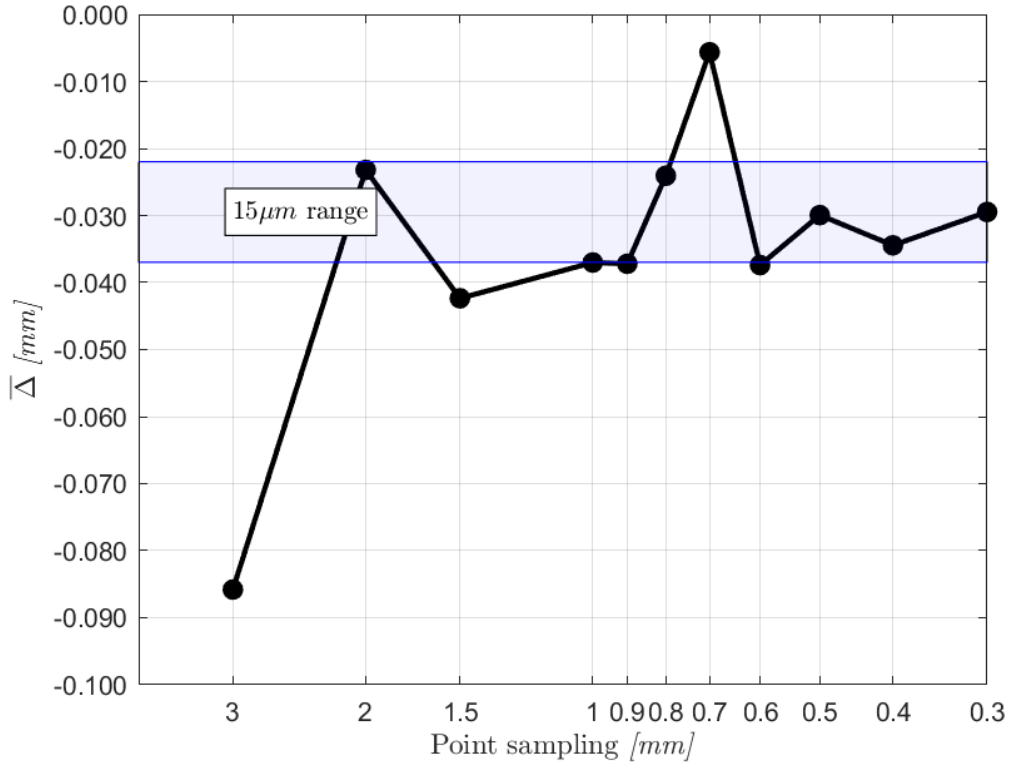




POINT SAMPLING



Sensitivity analysis to determine the optimal point sampling



Final sampling: 0.4 mm
Lingual bar sampling: 0.9 mm

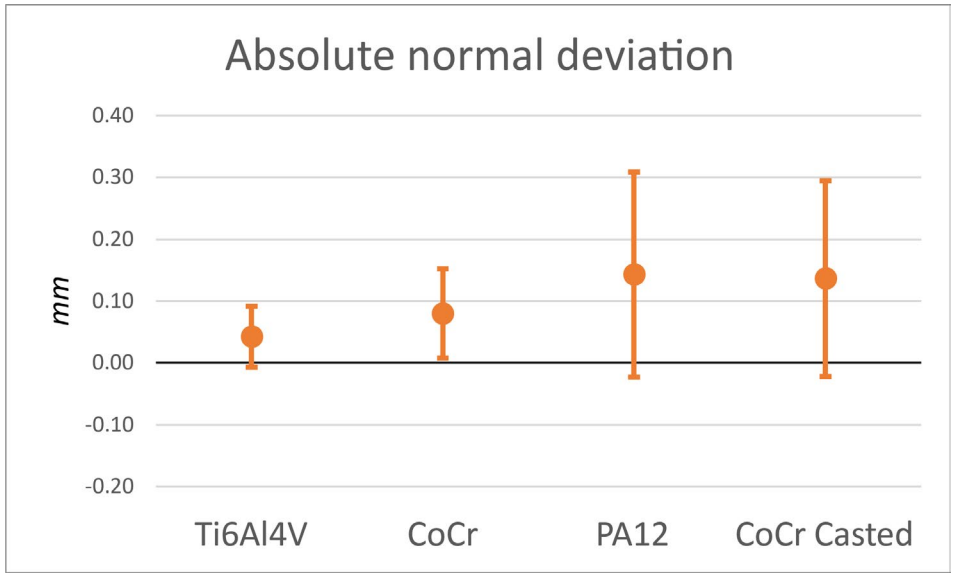
STATISTICAL ANALYSIS

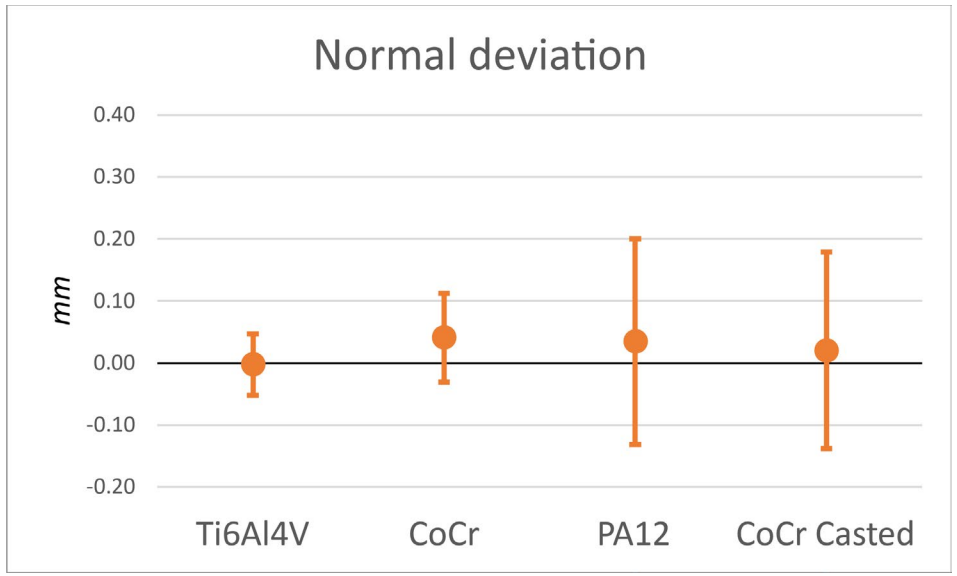
First level ⇒ **Overall comparison among different production techniques**

Second Level ⇒ **Comparison among different production techniques per each area**

Third level ⇒ **Comparison among areas per each group**

STATISTICAL ANALYSIS – FIRST LEVEL





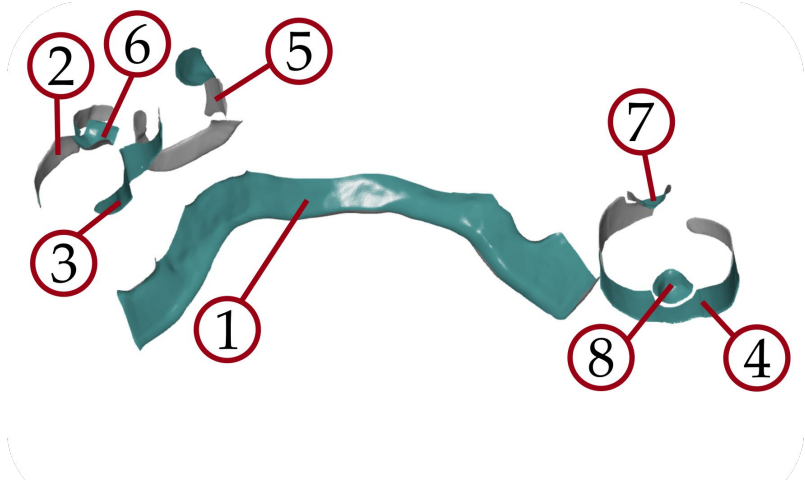
	Average (abs.)	SD (abs.)	Average	SD
Ti6Al4V	0.0423	0.0492	-0.0024	0.0648
CoCr	0.0801	0.0719	0.0409	0.0995
PA12	0.1432	0.1657	0.0344	0.2163
CoCr castes	0.1366	0.1582	0.0205	0.2080

Non-parametric test:

- Kruskal-Wallis → P-value < 0.05

- Dwass, Steel, Critchlow-Fligner

STATISTICAL ANALYSIS – SECOND LEVEL



Non-parametric test:

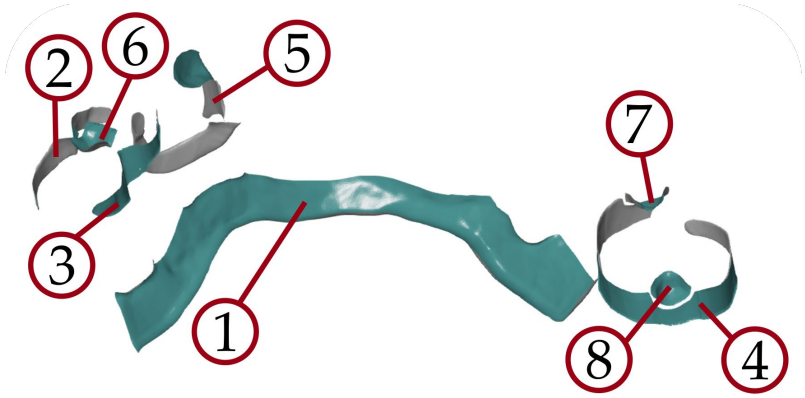
- Friedman → p-value < 0.05

- Wilcoxon, Nemenyi,

McDonald-Thompson

ADDITIVE 4 BIOMEDICAL

STATISTICAL ANALYSIS – THIRD LEVEL



Non-parametric test:

- Kruskal-Wallis → P-value < 0.05

- Dwass, Steel, Critchlow-Fligner

Zona	Ti6Al4V (abs.)	CoCr (abs.)	PA12 (abs.)	CoCr casted (abs.)	Ti6Al4V	CoCr	PA12	CoCr casted
1	0.0279	0.0188	0.0406	0.0628	-0.0029	0.0005	0.0036	0.0226
2	0.0409	0.0987	0.2163	0.1795	-0.0272	-0.0963	-0.1252	-0.0942
3	0.0378	0.1003	0.1990	0.1633	-0.0179	0.1001	0.1113	0.0637
4	0.0418	0.0664	0.2203	0.1759	0.0143	0.0496	0.0625	0.0267
5	0.0622	0.1295	0.1107	0.1380	0.0050	0.0782	0.0155	-0.0096
6	0.0380	0.0902	0.1532	0.1392	-0.0194	0.0523	0.0050	0.0120
7	0.0823	0.1354	0.1970	0.1926	0.0764	0.1210	0.1420	0.1389
8	0.0375	0.1136	0.2835	0.2111	-0.0260	0.0849	0.1517	0.1368

CONCLUSIONS

- The “local **best-fit**” alignment is a valuable approach to evaluate the accuracy of removable partial denture frameworks;
- The titanium (**Ti6Al4V) frameworks** showed the best accuracy results;
- The average deviation for all the tested production protocols are within clinical tolerance therefore the full-digital protocol is confirmed to be reliable.

October 17th–18th, 2022

THANK YOU FOR YOUR ATTENTION

Mattia Maltauro - Accuracy of partial removable denture produced by additive manufacturing technologies

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