The Effect of Surface Roughness and Gold Coating on the Biocompatibility of PEEK Dental Implant Material

Sherine Philip, Dr Nikolaos Poulis, Dr Raya Karaganeva

Queens Dental Sciences Centre, The University of Greater Manchester, United Kingdom

INTRODUCTION & AIM

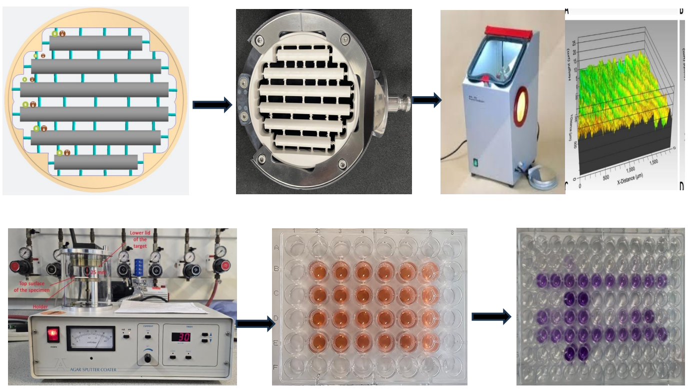
Polyetheretherketone (PEEK) is increasingly favoured in prosthetic dentistry due to its excellent biocompatibility, chemical resistance, mechanical strength, and aesthetic properties. Its modulus of elasticity (3.6 GPa) closely matches that of bone (14 GPa), helping to minimise stress shielding and bone resorption material compared to titanium (Ti) when used as an implant material. However, the hydrophobic nature of pure PEEK limits its interaction with water and recombinant proteins essential for promoting osseointegration, thereby reducing its bioactivity at the implant site (Mishra and Chowdhary, 2018).

To address these limitations, various surface modification strategies have been explored. Mechanical methods such as sandblasting can introduce micro-roughness (Ra 1–2 µm), improving wettability and supporting cell adhesion. Gold (Au) coatings represent another promising modification. Gold is chemically inert, enhances surface roughness, improves hydrophilicity, and promotes protein adsorption factors for osseointegration.

Aim: To evaluate whether modifying the surface roughness of PEEK implant material and application of gold coating can enhance their cell viability.

METHOD

Eighty PEEK discs (8 mm diameter × 2 mm height; PEEK Bio Solution, Merz Dental al GmbH, Germany) were divided into four groups: untreated control (C), sandblasted (SB), gold sputter coated for 30 s (G30), and sputter coated following sandblasting (SBG30). Sandblasting was performed using a Duostar sandblasting unit (BEGO Bremer Gold, Wilh. Germany) with 50 µm alumina particles at 0.25 MPa pressure for 10 s. Gold sputter coating was carried out with an Agar sputter coater (Agar Scientific Ltd., Stansted, UK) at 30 mA for 30 s, producing a coating thickness of approximately 1425 nm. Surface roughness was assessed by optical profilometry (Sa and Ra parameters). Cell viability was evaluated with L929 fibroblasts via the MTT assay at 2 and 7 days.



RESULTS & DISCUSSION

Surface roughness: SBG30 group exhibited the highest mean ± SD for both Sa and Ra (Table 1), whereas the control PEEK group demonstrated the lowest values for these parameters. These results can be attributed to the effect of abrasive particles during sandblasting, which creates microgrooves and irregularities to the surface (Ourahmoune et al., 2014). Such microroughness facilitates micromechanical interlocking and promotes osteoblast activity by enhancing the protein adsorption (Rosentritt et al., 2015).

Table 1. Mean and SD of Sa and Ra and its pixel rate.

Group	Mean ± SD (Sa) (µm)	Mean ± SD (Ra) (µm)	Pixel rate	P - value
C	0.386 ± 0.476	0.180 ± 0.050	90.27	< 0. 01
SB	1.282 ± 0.332	0.493 ± 0.172	21.43	< 0. 01
SBG30	1.398 ± 0.920	0.663 ± 0.185	26.15	< 0. 01
G30	0.478 ± 0.803	0.180 ± 0.044	84.20	< 0. 01

Cell viability (MTT Assay): Across all surface treatments, cell viability was higher at 7 days than at 2 days, with the sandblasted group showing the greatest increase over time (Figure 1).

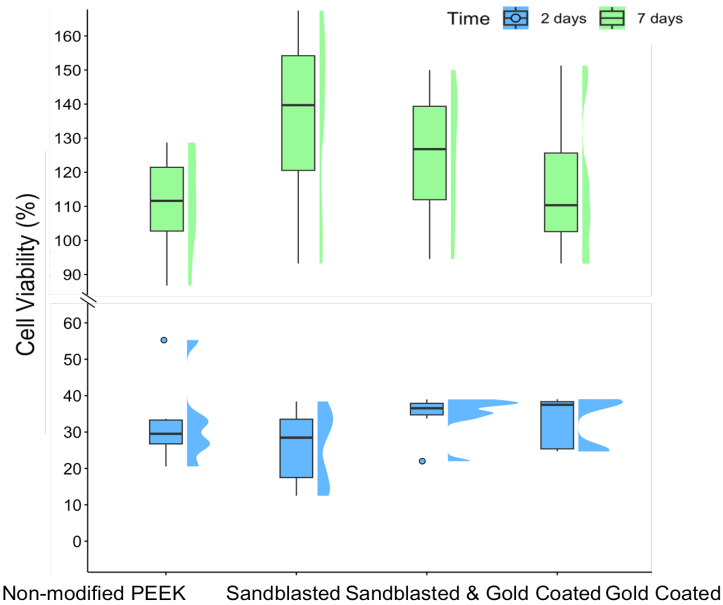


Figure 1. Effect of surface modification and time on cell viability (%).

CONCLUSION

Sandblasting, with or without gold coating, enhanced PEEK's roughness into the optimal Sa (1–2 µm) and Ra (~0.6 µm) ranges associated with improved osseointegration. Gold sputter coating alone did not significantly alter outcomes, whereas sandblasting promoted favourable fibroblast attachment and long-term proliferation. These findings highlight sandblasting as an effective modification strategy to improve the biological performance of PEEK in dental implant applications.

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