Augmenting the Bioactivity of Polyetheretherketone

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Background

Polyetheretherketone (PEEK) may be advantageous as an alternative material to metal alloys in some orthopaedic applications. However, it is bioinert and does not osteointegrate[1]. A novel accelerated neutral atom beam technique (ANAB) has been developed to improve the bioactivity of PEEK where the surface is modified to a depth of 5 nm without affecting the integrity of the underlying PEEK structure[2].

Aim

The aim of this study was to investigate the growth of human Mesenchymal Stem Cells (hMSCs), adult human Osteoblasts (hOB) and skin Fibroblasts (BR3G) on PEEK and ANAB treated PEEK surfaces.

Materials and Methods

The surface properties of PEEK and ANAB PEEK were characterized by measuring surface roughness and contact angle. Cells were seeded at a density of 10,000/cm^2 on PEEK, ANAB PEEK and a Thermonox control. Cell proliferation, attachment, and alkaline phosphatase (ALP) activity on these surfaces was quantified at 7 and 14 days (n = 2). Cell attachment was measured by staining adhesion plaques with anti-vinculin. Attachment was quantified by measuring the number of plaques per cell on day 3. A Mann Whitney-U test was used to compare groups where p values < 0.05 were considered significant.

Results

ANAB treatment increased the hydrophilicity of the PEEK surface (91.74 ± 4.80º (PEEK) vs 74.82 ± 2.70º (ANAB PEEK), $P<0.001$) (Fig 1) with no changes in surface roughness. Cell proliferation for all cell types significantly increased on ANAB PEEK surfaces when compared to PEEK at both day 7 and 14 (Fig 2). Results showed no significant differences when the proliferation of BR3G and hMSC on ANAB PEEK was compared with Thermonox at 7 and 14 days, whereas hOB proliferation significantly reduced at these time points on ANAB PEEK compared with Thermonox. Increased cell attachment with all cell types was measured on ANAB PEEK when compared with PEEK at day 3. MSCs seeded on ANAB PEEK in the presence of osteogenic media, expressed significantly increased levels of ALP compared to normal PEEK ($p<0.05$).

Conclusion

ANAB increased the bioactivity of PEEK by significantly increasing the osteogenic differentiation of MSCs and by significantly enhancing the proliferation of osteoblasts This method may improve the osteointegration of PEEK implants.

References

[1] Kurtz SM, Biomaterials.2007 Nov; 28(32).

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Acknowledgements

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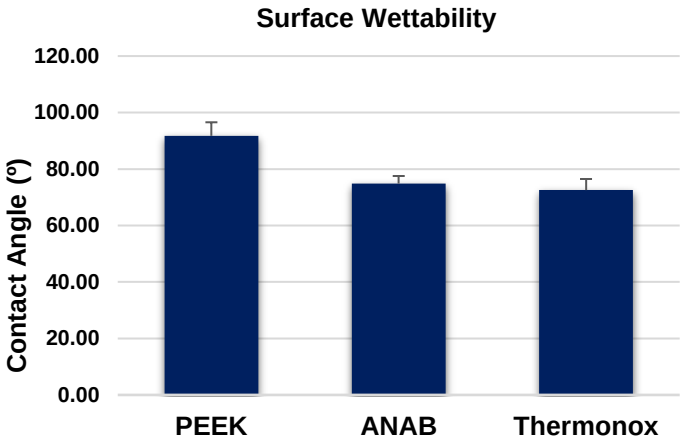

Figure 1.Surface wettability of (A) PEEK, (B) ANAB PEEK and (C) Thermonox

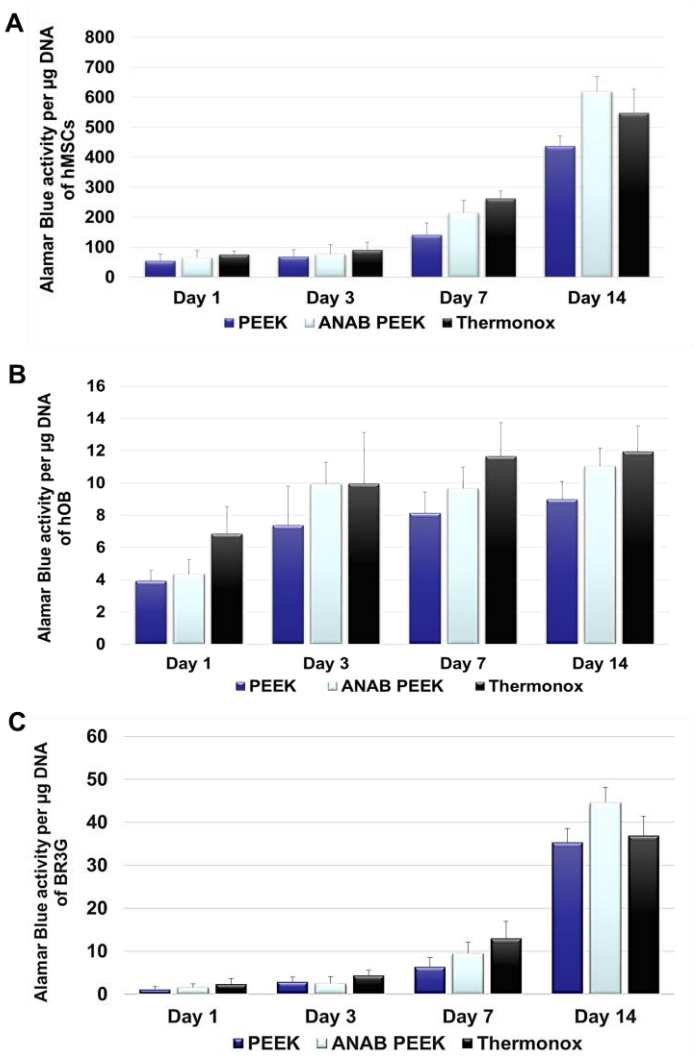

Figure 2. Cell proliferation in (A) hMSCs , (B) hOB and (C)BR3G at all time-points.