Molecular assessment of osseointegration (angiogenesis-osteogenesis coupling) using three different bone graft materials (autogenic, xenogenic and synthetic) around dental implants; in vivo study

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Objective

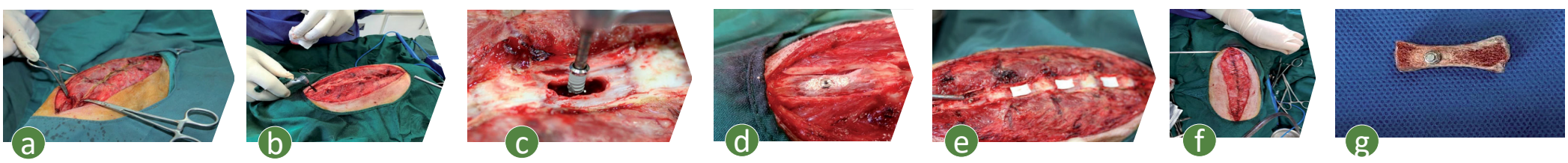
To evaluate osteogenesis and angiogenesis coupling in different bone materials (Autograft, xenograft and synthetic) used around dental implants, we design this study to compare osteogenesis and angiogenesis coupling in 3 types of bone graft for dental implants. Implant restorations are an important every day treatment to replace missing teeth in the general dental practice. An understanding of implant design and placement for optimum clinical results is common knowledge for dental practitioners.

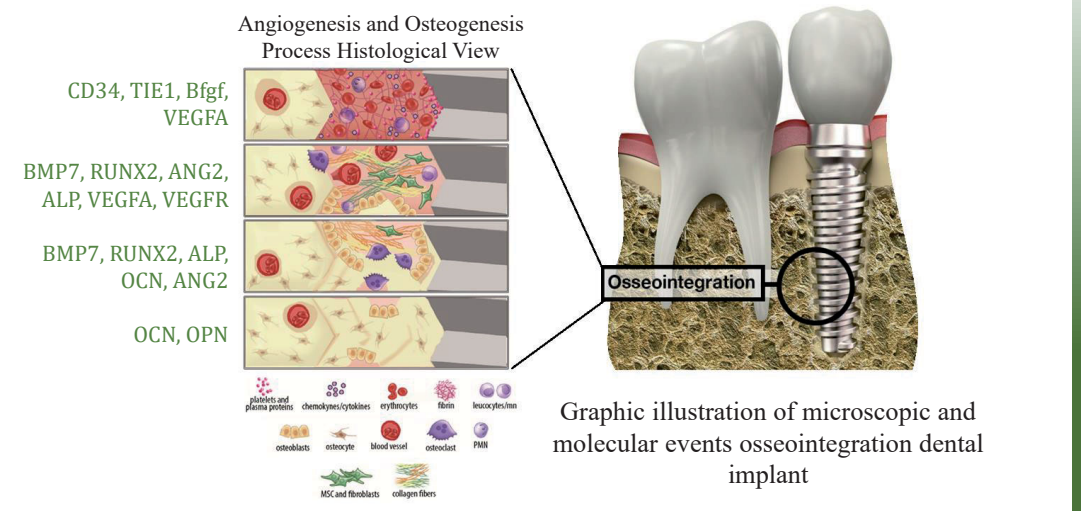
Materials & Methods

Twelve healthy adult male dogs are randomly assigned into three Groups. Under general anesthesia the area corresponding to the 2nd to 6th sternebra is exposed. A 6 mm depth hole in the each sternebra was created, using a 10 mm diameter trephine drill. After performing 2 mm further drilling at the end of the hole using ICX surgical kit, a 3.45 mm * 6.5 mm ICX dental implant (Medentis Medical GmbH) is inserted within each hole. The gap around the implants is filled with synthetic bone material (OSTEON™, South Korea) in Group I, xenogenic bone material (cerabone, GmbH, Germany) in Group II and autogenous bone particles in Group III.

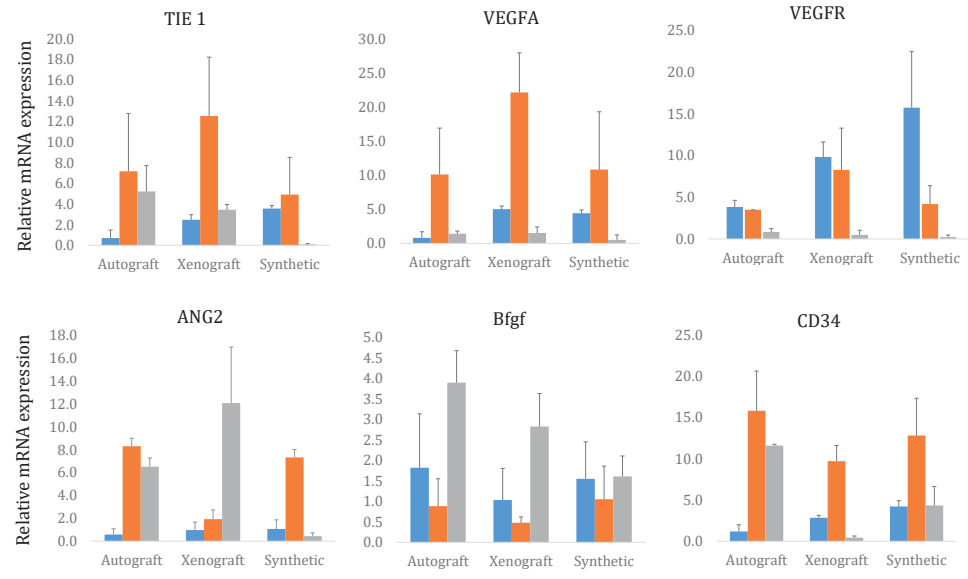
To evaluate the effect of time on the bone healing and implant osseointegration every 2 months 4 dogs will be sacrificed (at 2, 4 and 6 months). We evaluated osseointegration process surrounding dental implant by osteogenesis and angiogenesis. As osseointegration composes of angiogenesis and osteogenesis processes, osteogenesis and angiogenesis expresses genes such as ALP, BMP7, RUNX, OCN and TIE1, Bfgf, ANG2, VEGFA, VEGFR, CD34 respectively, which these genes express in around of dental implant in 12 implants (4 implants from each group; divided into 2, 4, and 6 months). This evaluation of gene expression and proteins have performed by Real time PCR and ELISA test, respectively

Intra-operative views. **a** Exposure of 2nd-6th, **b** 6 mm depth hole by trephine drill, **c** implant placement, **d** Filling gap with 3 types of bone materials, **e** Each defect area was covered with a collagen barrier membrane, **f** Suture opening area, **g** dental implant with bone material

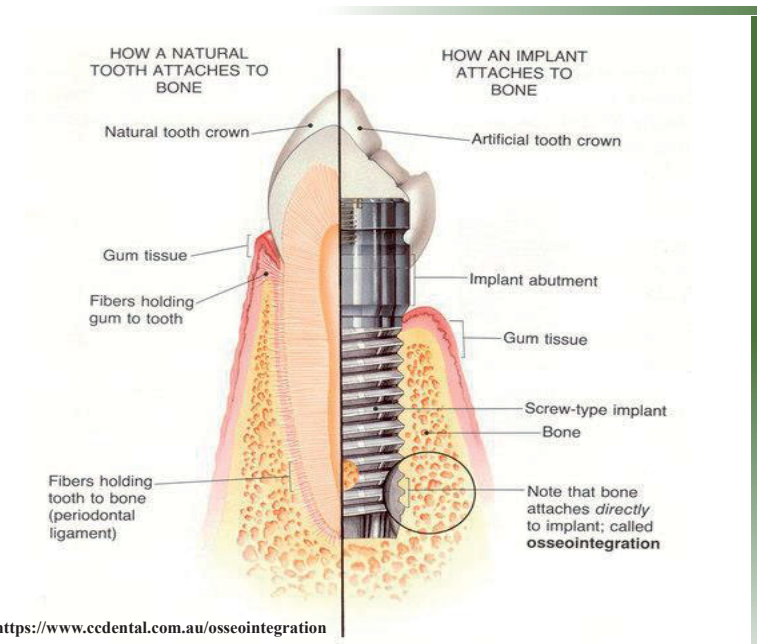




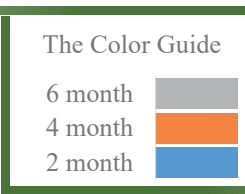
Graphic illustration of microscopic and molecular events osseointegration dental implant

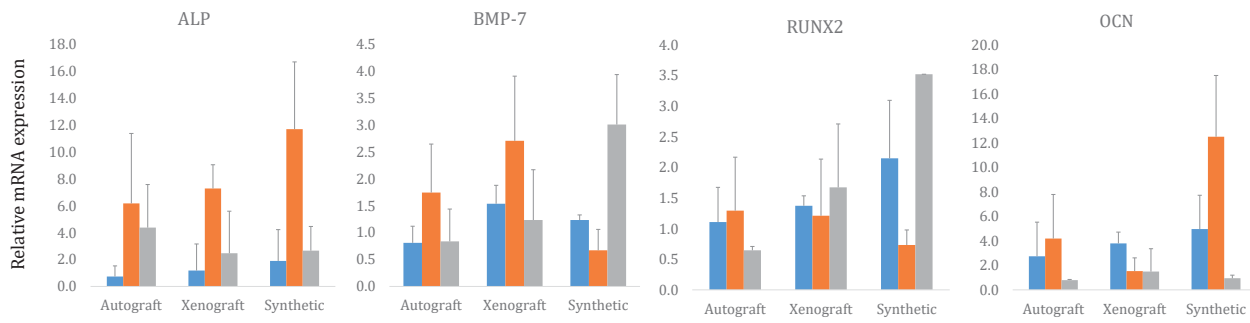


Relative mRNA levels of TIE1, VEGFA,VEGFR, ANG2, Bfgf and CD34 for 1) Autograft (2) Xenograft (3) Synthetic at 2, 4 and 6 months. Data shown is the average value from three independent experiments (three replicates per experiment).



Ref: https://www.ccdental.com.au/osseointegration





Relative mRNA levels of ALP, BMP-7, RUNX2 and OCN for 1) Autograft (2) Xenograft (3) Synthetic at 2, 4 and 6 months. Data shown is the average value from three independent experiments (three replicates per experiment).

Results

Osteon as synthetic bone material revealed osteogenesis process by high gene expression ALP, RUNX2 and OCN during 2 months. While, cerabone as xenogen bone material showed these genes expression after 4 months. BMP-7 as a osteogenic gene has same level of expression by both of bone materials after 2 months.

In angiogenesis process, two genes of ANG2 and VEGFA have expression by osteon in 4 months while these genes start expressing by cerabone after 6 months. Osteon can start TIE1 gene expression after 2 months and continue until 4 months while this gene has expression by cerabone after 6 months. CD34 and Bfgf genes have same levels of expression by both of bone materials in 2,4 and 6 months. All of data are based on real time gene expression analysis and for RUNX2 as osteogenic gene and ANG2 as angiogenic gene also immunoassay.

Conclusion

Based on these preliminary in vivo results which related to osteogenesis and angiogenesis coupling, we can conclude that osteon as synthetic bone material which is osteoconductive quickly provoke osseointegration in implant place in compare with cerabone as xenogenic bone material. This bone material can produce appropriate osseointegration around dental implant.

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Acknowledgements

This study was supported by a Research council of Medical University of Mashhad.This study was supported by a Research council of Medical University of Mashhad. We thank ICX dental implant.