UV photoactivation of 7-dehydrocholesterol on titanium implants enhances osteoblast differentiation and decreases Rankl gene expression

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INTRODUCTION: Vitamin D plays a central role in bone regeneration and its insufficiency negatively affects bone regeneration, including implant osseointegration [1]. Ti is the material most commonly used for bone implants because of its physical and biological properties [2]. Current dental implant research aims to produce innovative surfaces promoting a favorable biological response and a rapid osseointegration. UV-activated provitamin D3 coating on Ti surfaces is here suggested to have a stimulatory effect on bone cells and accelerate bone regeneration as result of active vitamin D synthesis.

METHODS: Titanium disks were coated with 7-dehydrocholesterol dilution and then allowed to air-dry until UV-irradiation. A 302 nm UV lamp was used for the photoactivation process during different UV time exposures. FTIR analysis and HPLC were used to characterize and quantify the conversion of 7-DHC to previtamin D3. Cytotoxicity, alkaline phosphatase (ALP) activity, calcium (Ca) content, 25-hydroxyvitamin D3 (25-D3) production, gene expression of bone markers and enzymes involved in vitamin D3 synthesis were analyzed using MC3T3-E1 cells as an in vitro model.

RESULTS: FTIR results showed changes in the ring structure resulted from the 7-DHC conversion into previtamin D3. HPLC analysis determined a 16.5±0.9% conversion of 7-DHC to previtamin D3 after 15 min of UV exposure, and a 34.2±4.8% of the previtamin D3 produced was converted to 25-D3 by the osteoblastic cells. No cytotoxic effect was found for Ti implants treated with 7-DHC and UV-irradiated. Moreover, Ti implants treated with 7-DHC and UV-irradiated for 15 min showed increased 25-D3 production, together with increased ALP activity and calcium content (Figure 1). Interestingly, Rankl gene expression was significantly reduced in osteoblasts cultured on 7-DHC coated Ti surfaces when UV-irradiated for 15 and 30 minutes to 33.56±15.28 % and 28.21±4.40 % respectively when compared to control.

DISCUSSION & CONCLUSIONS: Our results show for the first time the use of UV-activated 7-DHC to locally produce cholecalciferol at the surface of the titanium implant which increases in vitro osteoblast differentiation as result of the endogenous synthesis of active vitamin D [3].


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Fig. 1: Effect of 7-DHC and UV exposure of Ti implants on ALP activity and mineralization. ALP activity measured at 21 days and Ca content measured at 28 days of MC3T3-E1 culture. Mann–Whitney test (p < 0.05): “UV-treated vs. UV-untreated for 7-DHC and ethanol, respectively; ”7-DHC treatment vs. the corresponding ethanol control.