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Dental Science

INDUCTIGRAFT: A FUTURE GRAFT IN PERIODONTICS

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ABSTRACT Bone grafts are used to regenerate the lost architecture and structure of the periodontium. A plethora of materials have been tried and tested in search of the ideal material. Various researches have led to the development of a new graft material Inductigraft™. It is a novel graft material which has osteogenic and osteoinductive properties similar to that of autogenous bone grafts. There have been many researches and studies carried out using Inductigraft™ in Orthopaedic- spinal fusion surgeries, wherein its bone forming capacity has been demonstrated. The excellent bioactivity of this graft and its ability to accelerate bone formation in as little as four weeks as compared to that of eight to 12 weeks is of advantage and hence further research in the field of Periodontology is required for the use of Inductigraft™, to avail its benefits.

KEYWORDS : bone grafts; Silica substituted Calcium Phosphate; guided tissue regeneration; osteoinductive, osteoconductive

INTRODUCTION:

Periodontitis is an inflammatory disease of the periodontium and tooth supporting tissues which leads to loss of alveolar bone. This loss of bone leads to tooth loss which is detrimental to stability of the dentition. The ultimate goal of therapy using regenerative techniques is to form new structure, thereby restoring the function of the periodontium.[1]

Various treatment modalities help restore the periodontal status, which include non-surgical therapy, surgical therapy, regenerative and resective therapy. Bone grafting is a dynamic process which utilizes the concepts of osteogenesis, osteoinduction, osteoconduction and osteointegration.[2] Current literature suggests that Guided Tissue Regeneration and bone augmentation procedures show evidence of periodontal regeneration.[3] A wide range of graft materials have been utilised and evaluated for the regeneration which include autografts, allografts, xenografts, alloplasts, bone substitutes for the treatment of osseous defects;[4,5] all of which have shown to have certain limitations. Bone substitutes are synthetic, organic or inorganic substances which can used as a replacement to either autogenous or allogenous bone grafts.[4] Modern day periodontics aims at regenerating maximum amount of the lost tissue with maximum benefits. The goal of this article is to evaluate the benefits of a synthetic, newer bone graft material, with excellent bone forming capacity: **Inductigraft™**, which could help overcome the barriers of regeneration and be a revolutionary graft material.

CLASSIFICATION:

There are various systems of classifying bone grafts, this classification states the properties and disadvantages of bone grafts.[6]

Table 1

		Osteoconductive	Osteoinductive		Disadvantages
Autologous Bone grafts	Autologous cancellous	+++	+++	+++	Limited availability, donor site morbidity
	Autologous cortical	+	+	+	Same as above
Allogenic Bone grafts	Allogenic cancellous	+	+	-	Risk of disease transmission ,immune reaction
	Allogenic cortical	+	-	-	Same as above
	De - mineralised bone matrix	+	++	-	Variable osteo inductivity associated with donors, processing methods
Synthetic Bone substitutes	Calcium sulfate	+	-	-	Rapid resorption, osteo conductive only
	Hydroxy apaptite	+	-	-	Slow resorption, osteoconductive only
	Calcium phosphate ceramic	+	-	-	Osteo conductive only
	Calcium phosphate cement	+	-	-	Osteo conductive only
	Bioactive glass	+	-	-	Bioactive osteo conductive only
	Polymethyl meth-acrylate	-	-	-	Inert, exothermic, monomer-mediate toxic

NEED FOR A NEWER GRAFTING MATERIAL:

According to Schallhorn (1977), certain factors need to be considered in the selection of the graft material, they are: biologic acceptability, predictability, clinical feasibility, minimal operative hazards, minimal postoperative sequelae and patient acceptance.[7]

Despite the plethora of materials available for grafting, autogenous bone grafts are considered to be the gold standard graft materials.[8] Autografts have a greater osteogenic capacity than any of the other graft materials available.[9] However, a number of disadvantages are associated with their use which include donor site morbidity associated with 20% of cases, the requirement of a second surgical site, difficulty in harvesting the bone graft, quantity of material obtained and complications like chronic pain with a range of 2.5% to 8%, dysesthesia (6%) and infection (2%).[10,11]

There are many alternatives to autogenous grafts, which include allografts and xenografts all associated with various disadvantages. Allografts comparatively have a lower osteogenic potential and can cause immunologic reactions. Xenografts have the risk of immunogenicity and disease transmission. Xenograft disease transmission is associated with prions causing Creutzfeldt-Jakob disease and bovine spongiform encephalopathy (BSE).[12]

Various synthetic substitutes have also been researched, but none possess the qualities of an ideal graft material. In an effort to find an able substitute for the autografts clinicians and investigators have sought alternative synthetic graft materials, which could substitute or enhance the use autografts. Continuous research to incorporate all the ideal properties and osteogenic capabilities, has led to the development of a new synthetic graft material, Inductigraft™.

INDUCTIGRAFT™:

Inductigraft™ [Silica substituted Calcium Phosphate, enhanced porosity bone graft (SiCaP EP)] is a novel bone graft which has demonstrated efficacy in various clinical trials. It is osteogenic and osteoinductive and is comparable to autografts with respect to its properties. It contains microgranules, sized 1–2 mm with 80-85% macro porosity, 31-47% micro porosity and 0.8% silica.[13]

The properties of Inductigraft™ that make it special are its increased strut porosity, increased neovascularization, 0.8% silica, physiologic bone formation, osteoinductive, osteoconductive and bioresorbable nature. Inductigraft™ has an added Silica 0.8%, which is similar to the natural levels in bone,[14] in the basic hydroxyapatite matrix, causing a negative charge on the surface leading to increased protein adsorption, increased neovascularisation and subsequent osteoblastic cell attachment and proliferation compared with that seen on stoichiometric hydroxyapatite.[15-17]

Inductigraft™ has enhanced strut porosity. Strut porosity is micro porosity wherein the pore size is less than 50 micrometers. Strut pores or microporosity are basically formed by interconnected spaces between particles.[18] Studies comparing porosity of 23% to that of 46% SiCaP reported formation of larger hydroxyapatite crystals with that of higher porosity.[19] This interconnected and porous structure resembles that of human cancellous bone facilitating osteogenic bone formation.

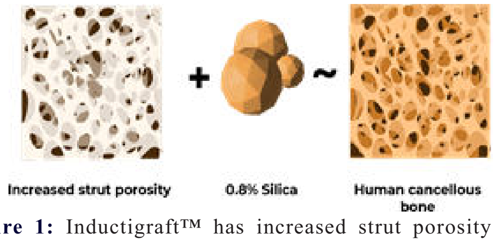

Figure 1: Inductigraft™ has increased strut porosity with interconnected open porous structures and 0.8% added silica which makes it similar to human cancellous bone

This enhanced porosity, increases bone formation, by mimicking a network of microporous osteocyte lacunae similar to that of normal bone as well as increases the surface area which affects the protein binding and promotes osteogenic protein adsorption and cell anchorage, leading to faster bone apposition.[20] Studies done invitro, comparing Inductigraft™ (SiCaP EP), SiCaP and Bioglass bone graft, shows greater cell proliferation and earlier osteoblastic differentiation using SiCaP Ep[21].

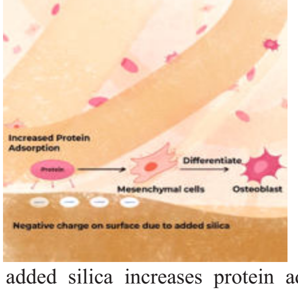

Figure 2a: The added silica increases protein adsorption which stimulates the mesenchymal cells to differentiate into osteoblasts

Figure 2b: Osteoblasts then attach and proliferate forming an osteoinductive matrix

It has a 3-D microcellular structure, creating a micro-environment similar to that of bone, causing mesenchymal bone cells to be stimulated, which then differentiate to osteoblasts. It also increases the permeability, thereby increasing the accessibility of nutrients into the graft.[20]

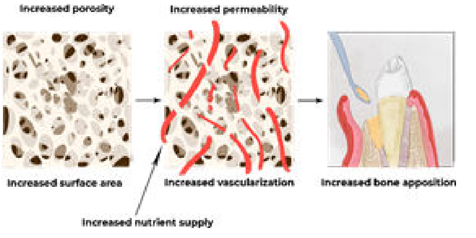

Figure 3: Shows the process of faster apposition of bone graft in Inductigraft™

Studies have also proven that the high microporosity of Inductigraft™, allows for bone implant contact, thereby increasing the growth of natural bone.[20] An in vitro study carried out on rat model by Fredericks et al[22] compared Inductigraft™ with an iliac crest autograft and showed greater posterolateral bone fusion rates clinically and radiographically using Inductigraft™ compared to that of an autograft. Studies by Campion et al[23] concluded that increased strut porosity, using Inductigraft™, causes increased neovascularisation, leading to faster bone growth at 8 weeks.

Hence, demonstrating the benefits of using Inductigraft™, which shows faster neovascularisation and faster bone apposition at 8 weeks compared to other grafts. Another invitro study by Smucker JD et al[24] in a rat model, demonstrated SiCaEP having a higher fusion rate compared with that of autograft, SiCaP and βTCP-bioglass.

Various surgeries have been carried out using Inductigraft™ in the orthopaedic field, showing promising results. Studies by Mokawem et al[25] showed excellent bone fusion results using Inductigraft™ in spinal fusion surgeries. A study by Bolger et al[20], showed fusion rate of 86.3% at 12 months with SiCaP EP, compared to 52–80% observed with traditional autologous iliac crest and allograft material.

LIMITATIONS:

Inductigraft™ cannot withstand forces of torsion, compression, shear or bending forces and hence should be avoided in areas where such forces are exerted.[13]

PROSPECTS IN PERIODONTOLOGY:

Inductigraft™ can be used as bone graft substitute instead of autografts, corticocancellous and cancellous allografts in periodontology. Due to its faster bone apposition, osteoinductivity, bioresorbable characteristics along with other essential properties like neovascularisation, which help it simulate natural bone, it can be used as a graft material in various regenerative procedures, intrabony defects and hard tissue augmentation in implant cases.

CONCLUSION:

Various studies have focused on the formation of materials that will closely mimic the structure and chemical composition of natural bone. Inductigraft™ is one such material, which possess characteristics which could possibly cater to bone regeneration procedures in the field of Periodontology. Despite certain limitations that the graft holds, Inductigraft™, is a novel bone graft, and hence its applications in Periodontology should be tested.

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