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Letter to Editor

Novel Dental Graft Materials Manufactured From Dental Sources

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Nowadays dental graft materials are very popular which are made from synthetic sources. But those materials production methods are real time consuming (i.e. wet production method: here the formation of the hydroxyapatite (HA) phase and rinsing of the unnecessary anions takes time) [1]. Beside synthetic sources obtaining HA graft material from natural sources is also very significant. Since 70's most required dental - orthopedic HA grafts are produced from healthy bovine (xenografts) and from other human from bones (allografts). The cleaned HA graft source material were first diluted with HCL for demineralization, very neatly cleaned from chemicals and possible artifacts and then freeze dried. They are called on the market as freeze-dried bones (DFDB). With this method some undestroyed prions can survive from that non-calcination (calcination = high temperature sintering application) process. Prions are mysterious protein particles and when misfolded can be very dangerous and deadly. They can cause bovine spongiform encephalopathy (BSE or mad cow disease), Creutzfeldt–Jakob disease (CJD) and other deadly prion diseases [2].

Autografts (from human itself) can be a very reliable way for the human itself, but there is always the possibility that the bone amount in the body of the individual can be insufficient. Autografts also lead a secondary operation on the patient itself.

Xenografts can be another solution but it can be dangerous for example having bone grafts from a baboon to a human. An unknown disease from the deep of Africa can kill the operation victim and can lead anytime to a giant pandemic. Both human immunodeficiency viruses (HIVs) are the result of multiple cross-species transmissions of simian immunodeficiency viruses (SIVs) naturally infecting African primates. Sharp and Hahn had reported that the transmission of human immunodeficiency viruses (HIV) is the result of multiple cross-species transmissions of simian immunodeficiency viruses (SIVs) naturally infecting African primates [3]. Under these circumstances an unexplored disease can knock the door of humankind anytime.

So, far it was detected for allografts from other humans; those grafts seem dangerous with improper and insufficient manufacturing methods. Autografts from the patient itself can be limited but it is still regarded as golden standard. Xenografts from animals with insufficient manufacturing techniques sound also dangerous from contamination of possible known (i.e. mad cow disease) and other unknown diseases.

High temperature calcination can be a very reliable and proper method obtaining HA graft material from natural sources. Oktar., *et al*. had mostly first totally characterized the calcinated extracted human tooth structures such as enamel and dentine. According to atomic absorption tests, Oktar., *et al.* had found the total heavy metal amount for enamel HA (EHA) as 40.073ppm (Arsenic: 0.043ppm + Cadmium:0.06ppm + Mercury: 39.97ppm = total 40.073ppm) and for dentine HA (DHA) as 21.399ppm (Arsenic: 0.049ppm + Cadmium:0.06ppm + Mercury: 21.29ppm = total 21.399ppm). According to US ASTM standards (ASTM Designation: F 1185-88.514-515,

1988) the total required heavy metal amount should be maximum 50ppm [4]. From food we are consuming much more Hg and other heavy metals. Normally much lower heavy metal amounts can be observed, particularly if teeth will collected which are extracted for space preparing for orthodontic applications, but normally it is hard to obtain those tooth structures without amalgam or composite fillings. Only orthodontic treatments allow extraction of tooth without fillings (most of them are healthy teeth) getting free space for the orthodontic treatment. In other words it is easy to collect extracted teeth from general dentistry clinics – but some them can have fillings. Orthodontic treatment in private clinics in Turkey is really expensive and when compared to average patients. Those patients have low price deduction from Turkish Social Security System and it is also hard to get appointments for orthodontics at social security hospitals. Less orthodontic treatment visits will lead less extraction.

Oktar had calcinated (at 850˚C) EHA from enamel parts (human originated) [5] and Goller and Oktar [6] had calcinated (at 850˚C) DHA from dentin parts of extracted teeth, which were collected from various dental clinics. Those were ball milled and sieved to powder and pressed to pellets, sintered (at 1000-1100-1200˚C and 1300˚C) and subjected for microhardness, compression, density, x-ray diffraction tests and scanning electron microscopy (SEM) images were taken. The main ideas of these experiments were to gain HA blocks with more possible high load resistible characteristics. It is known that for the body after a traffic accidents high load resistible HA materials required. For dental operations such high loads are not much expected. The best compression test results for EHA was 61.27MPa (1300˚C) for DHA was 56.77MPa (1300˚C). The best HV for EHA was 286.6HV (1300˚C) and for DHA was 251.9HV (1300˚C) [5]. The result for EHA can be attributed to slighter higher F content of EHA when compared with DHA [5]. Oktar and Goller had completed another study adding some biologic glasses about 5 and 10% {Two oxide glasses = (45.5 wt.% P_2O_5, 54.5 wt.% CaO)and three-oxide glasses = (45 wt.% P2O5, 28 wt.% CaO, 27 wt.% Na_2O) glasses}. The best compression test results for DHA-two-oxide glasses (10% addition) were 67MPa (1200˚C) and for three-oxide (5% addition) glasses 55MPa (1300˚C). The best microhardness value were 285HV (1300˚C) for DHA two oxide glasses (10% addition) and 358HV (1300°C) for DHA three oxide glasses [7]. The Hench's 45S5 bioglass is known as a very good surface-active bioceramic. Goller., *et al*. had added 45S5 bioglass 5 and 10% to DHA. The best compression test result for DHA-bioglasses (5% addition) was 68.81MPa (1300˚C).The best microhardness value were 383HV (1300°C) for DHA-bioglasses (10% addition) [8]. At another work Goller., *et al*. conducted a study adding Ti (metallic titanium) powder to DHA (5 - 10%). The best compression test result was 32.1MPa (1300˚C sintering by 10% addition) [9]. Erkmen., *et al*. had conducted a study by adding 5 - 10% yttria partially stabilized zirconia to EHA. The best compression result was nearly 104MPa EHA-5% yttria partially stabilized zirconia. The best microhardness result was obtained as~370HV for EHA-%5 yttria partially stabilized zirconia [10]. When we compared all those results with synthetic HA, it is easily seen that compression (39.47MPa – 1100°C) and microhardness (336HV – 1200˚C) test values are comparable to tooth originated HA materials (EHA – DHA) [11]. Also bovine derived HA (BHA) values (best compression 67MPa – 1200˚C, best microhardness 145HV – 1300˚C) are [12] also comparable with EHA, DHA and synthetic HA properties.

Some cell culture studies were conducted by Valerio., *et al*. for DHA, EHA, BHA (bovine HA), synthetic HA and DHA-Ti composites [13,14]. The cell viability for DHA, EHA and synthetic HA are (commercial HA) almost same with the control group. The BHA group seems better. For alkaline phosphatase production DHA and EHA groups are higher than others. For collagen production BHA is higher than all other groups [13]. Another cell culture study of DHA-Ti5% (sintered at 1300˚C) shows very interesting results. Especially for collagen production for this 5% Ti added DHA (sintered at 1300˚C) is 3 times better than when compared with the control group (Figure 1), and 5%Ti (sintered at 1200˚C) and two times better than 10% Ti added (sintered at 1200˚C) and 10% Ti added (sintered at 1300˚C) [14]. Natural obtained HA production for dentistry will be much more simple and effective.

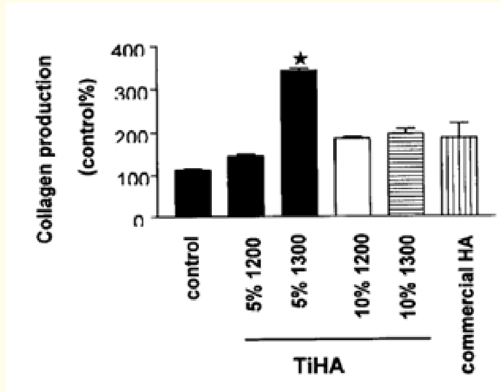

Figure 1: *Collagen production at DHA-Ti composites and synthetic HA [14].*

Beside human enamel and dentine, some other dental biomaterials were obtained from animals like sheep and bovine teeth. Akyurt., *et al*. had obtained 145.98MPa (sintered at 1300˚C) as compression strength and 125.2HV (sintered at 1300˚C) as microhardness from sheep dentine HA. Especially 145.98 MPa is a very high value [15]. Akyurt., *et al*. had completed another study with sheep enamel and got 100.17 MPa for compression test and 366.36HV at 1300˚C sintering. Still 100.17MPa is a very high value [16]. Demirkol., *et al*. had worked with sheep enamel. The highest compression test value was 37.25MPa at 1100˚C sintering. The highest microhardness value was 132.5HV at 1200°C [17]. Here at that among animal enamel and dentine studies especially sheep dentine HA seems very promising.

Under the guidance of getting novel dental graft materials from extracted tooth structures seems very promising. Those structures can be obtained from human and animal teeth. Those teeth can be collected from dental clinics and slaughterhouse. Otherwise all those remains will be dropped in trash. We can describe our production method as nature friendly recycling. The production techniques for those natural HA materials are very simple when compared to other time consuming methods. They are also very safe. The whole process can be described as: collecting extracted teeth→ NaOH treatment →cleaning all possible chemicals with distilled water → drying → calcination (800 - 850°C) →ball milling → sieving → pellet preparation → sintering at 1000-1100-1200 and 1300˚C → characterization studies. After all these the *in vitro* cell culture tests and *in vivo* animal tests must be completed.

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