PRP INCORPORATION INTO OSSEOUS GRAFT PARTICLES TO IMPROVE OSSEOUS GRAFT HANDLING AND CREATING GUMMY BONE

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INTRODUCTION

Clinically there are situations where osseous grafting needs to be performed. This can vary from socket preservation following extraction, repair of bone loss at the furcation, filling voids between the socket walls and implant when immediate implants are planned, treatment of exposed implant threads to sinus augmentation. These are managed by use of osseous particles which can be allografts, autografts, xenografts or even synthetic materials.

The typical problem with particles is potential for dispersement during the initial healing period. Although they may be rehydrated or wetted with various liquids, such as saline, water or anesthetic these liquids do not hold the particles together and allow them to spread in the area during healing. This will lead to less volume of healed graft at the site desired and may compromise the intended results. Utilization of patient derived autogenous blood concentrates mixed with the particulate graft material improves graft handling during placement as well as maintenance at the intended site eliminating dispersion potential. Autologous blood concentrates are defined as the concentrated portion of the patients blood following centrifuging that contains growth factors, platelets, WBC and fibrin, but does not contain the RBC portion of the blood.

BENEFITS OF USING AUTOGENOUS BLOOD CONCENTRATES WITH OSSEOUS GRAFT MATERIALS

In the 1980's several reports identified the pivotal role oxygen plays in wound healing.[1-5] These studies were the first to recognize that growth factors promote healing related to the macrophage response to oxygen gradients which secreted those wound healing growth factors. Platelet-derived wound healing factor (PDWHF) was first introduced clinically[6] continued on to Platelet-Rich Plasma (PRP) utilized for over two decades to initiate wound healing. Thrombin-released platelets produces angiogenesis and collagen synthesis with fibrin eliciting a cellular exudate, followed by angiogenesis. In the early 1990's Marx and Garg began work on using patient derived blood as a fibrin source for use with osseous grafts to improve product handling. This fibrin adhesive was first published in 1994.[7]

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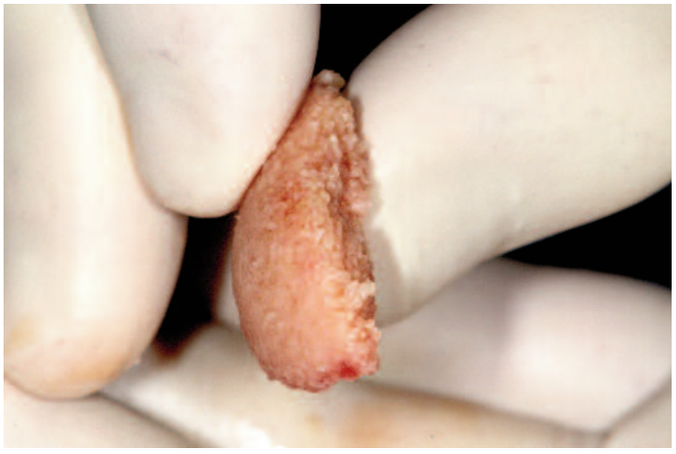

FIG 1: The "gummy bone" has improved handling characteristics for placement in sites being grafted eliminating the potential for particle dispersement during healing.

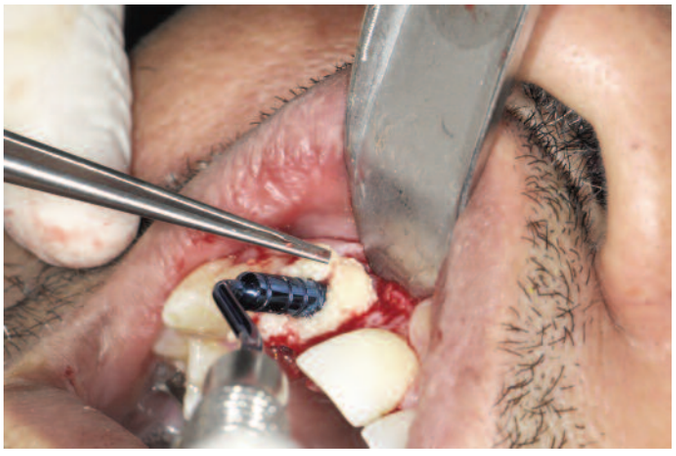

FIG 2: Following extraction, "gummy bone" is placed into the socket for preservation of the site.

Platelets secrete growth factors (PDGFaa, PDGFbb and PDGFab) which stimulate mesenchymal stem cells to replicate, osteoblasts to replicate and produce osteoid, endothelial cells to replicate secreting basal lamina for new blood vessels and fibroblasts

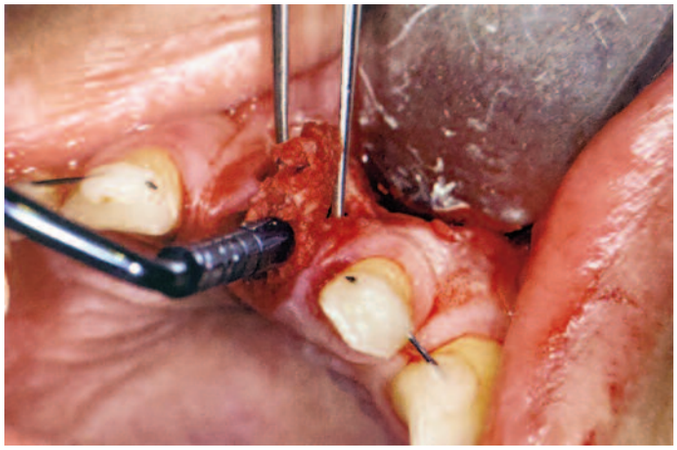

FIG 3: Voids between the implant being placed and the extraction socket walls are filled with "gummy bone" prior to site closure.

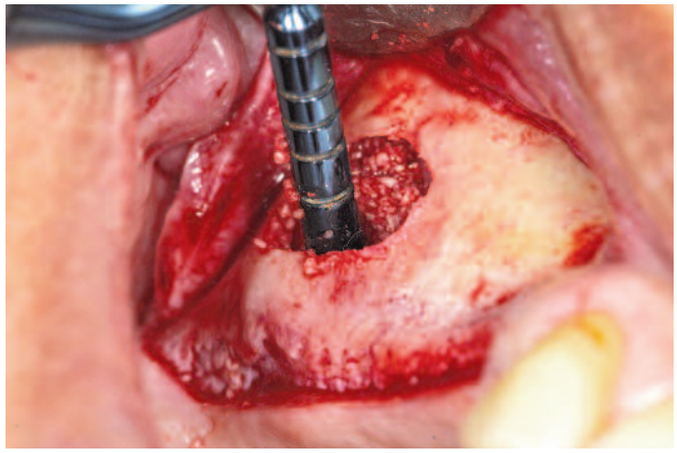

FIG 4: "Gummy bone" being placed into a lateral window sinus augmentation allowing better placement against the medial, distal and mesial walls of the elevated sinus.

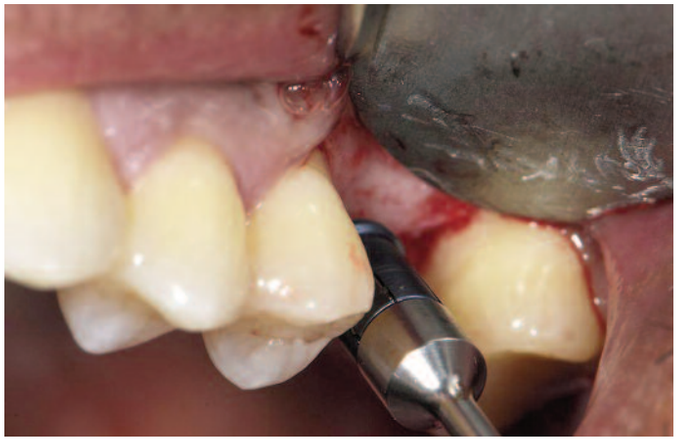

FIG 5: "Gummy bone" being introduced into the osteotomy where a crestal sinus elevation has been performed to increase the crestal height prior to implant insertion.

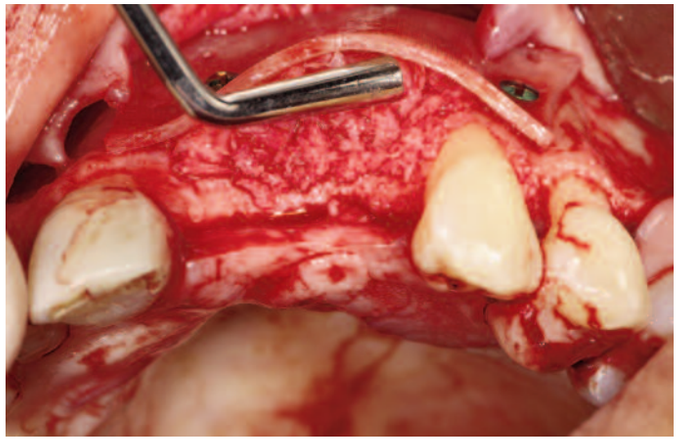

FIG 6: "Gummy bone" being placed between the facial aspect of the ridge and the bone plate placed to widen the ridge to allow implant placement after healing.

to replicate producing collagen. Additionally, transforming growth factors (TGFß1 and TGFß2) and bone morphogenic protein (BMP) are present that stimulate matrix production and guide cell differentiation into bone. Other factors present in the autologous blood concentrates include vascular endothelial growth factor (VEGF) which supports new blood vessel development and epithelial growth factor (EGF) which stimulates migration of the surrounding soft tissue to cover the area and form a basement membrane.

Incorporation of autologous blood concentrates, such as PRP into a particulate graft material provides growth factors to accelerate healing of the graft, stimulating the host cells adjacent to the graft to convert into native bone. More rapid closure of the soft tissue using the patients own factors as that stimulating mechanism can be expected. The additional benefit is a gelatinous mass, termed "gummy bone" that has improved handling without the dispersion issues found with graft particles mixed with saline or even allowed to absorb blood at the site. **(Figure 1)** Gummy bone, has a flexible putty like consistency that can be cut to desired dimensions prior to placement and utilized in a variety of clinical graft situations which include; socket grafting **(Figure 2)**, filling voids around immediate implant placement **(Figure 3)**, lateral sinus augmentation **(Figure 4)**, crestal sinus augmentation **(Figure 5)**, lateral ridge expansion **(Figure 6)**, dehiscence repair at implant placement **(Figure 7)** and furcation repair **(Figure 8)** or grafting fill of defects on the lateral aspect of the ridge **(Figure 9)**.

FABRICATION OF "GUMMY BONE"

At the initiation of the surgical treatment, blood is drawn from the patient into red top tubes. The red top tubes are glass walled and contain no anticoagulant. These are then immediately centrifuged at 3,200 rpm for 3 minutes (about 600 gf) to create separation of the layers of the patients blood. **(Figure 10)** Once centrifuging is complete distinct layers present in the tube. **(Figure 11)** For the purposes of creating "gummy bone", the yellow layer which is the plasma which is high in fibrin and platelets will be used.

The osseous graft particles that will be used are dispensed into a sterile dish. **(Figure 12)** The plasma liquid is withdrawn from the tube with a syringe and needle **(Figure 13)** and then dispensed into the dish containing the osseous graft material **(Figure 14)**. This hydrates the dry graft particles and is allowed to sit for 10-12 min-

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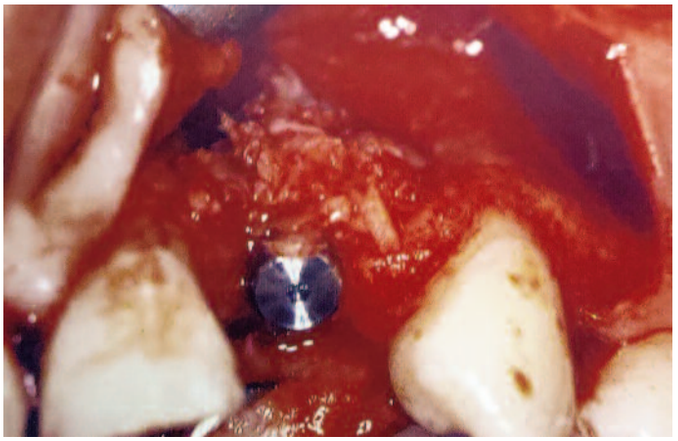

FIG 7: Placement of "gummy bone" over exposed implant threads at implant placement that will allow the osseous graft to remain where needed as the bone heals and prevent dispersement found when particulate graft is used alone.

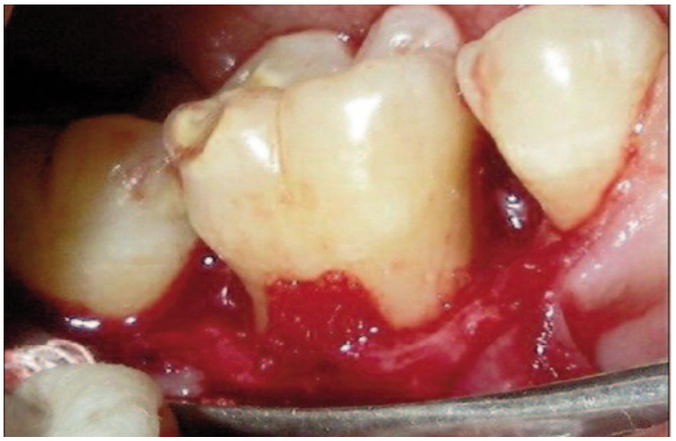

FIG 8: Placement of "gummy bone" into a furcation defect allowing the graft to remain where placed and avoid dispersement potential typically observed with particulates rehydrated with saline.

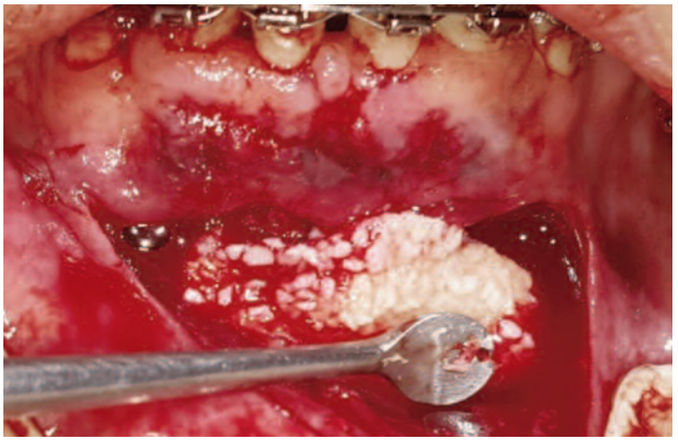

FIG 9: Placement of "gummy bone" to fill a defect in the anterior mandible apical to the existing teeth.

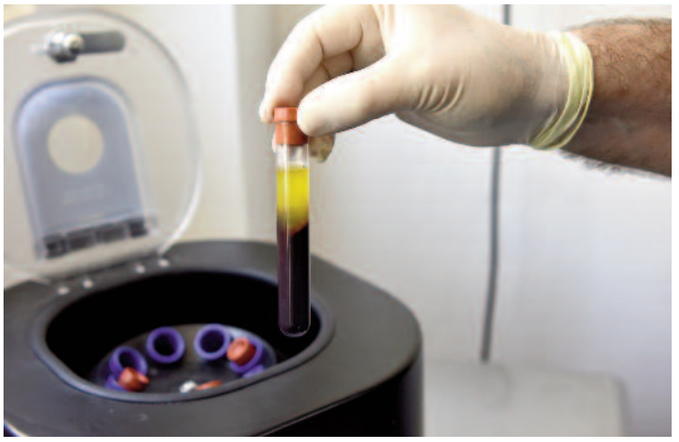

FIG 10: Following phlebotomy the patients blood is centrifuged at 3,200 rpm for 3 minutes (about 600 x gf).

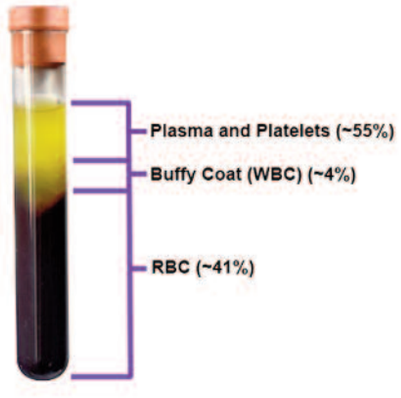

FIG 11: Following centrifugation the blood separates into several layers as outlined in the image above

FIG 12: Allograft (cortical, cancellous or a mixture of the two) are dispensed from the bottle into a sterile dish.

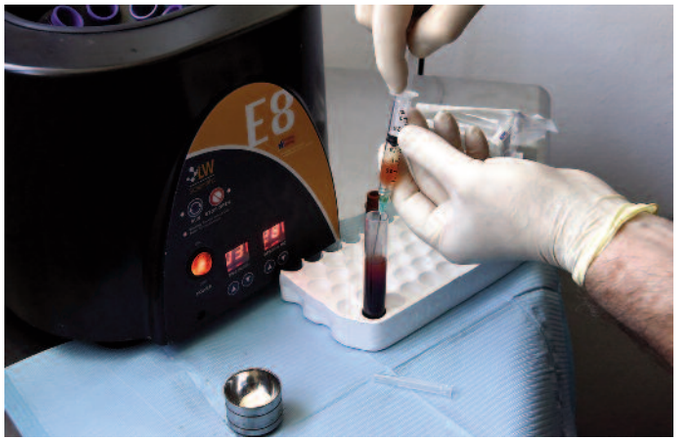

FIG 13: The plasma (yellow liquid) is drawn out of the centrifuged tube with a syringe.

FIG 14: The plasma is placed into the sterile dish containing the allograft particles.

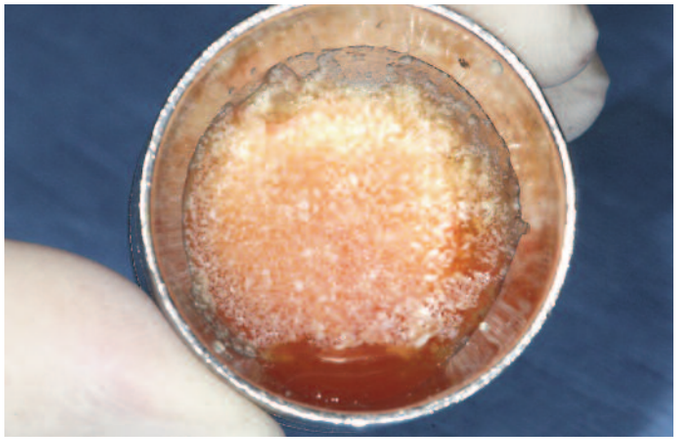

FIG 15: The plasma wets and rehydrates the allograft particles and is allowed to sit for 10-12 minutes before use.

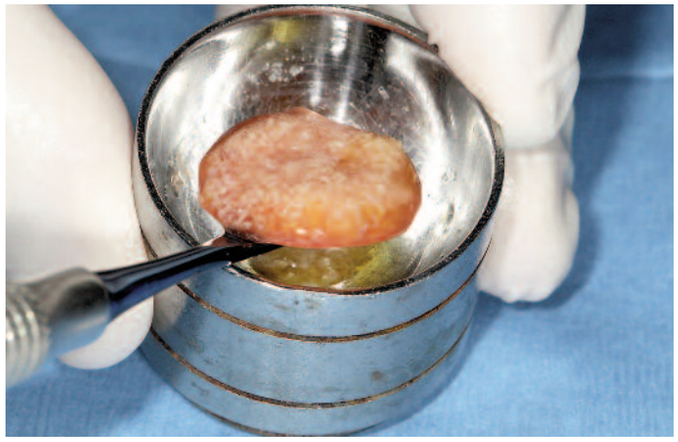

FIG 16: After 10-12 minutes the fibrin within the plasma that had been mixed with the allograft particles forms a gelatinous mass referred to as "gummy bone".

utes to coalesce into a gelatinous mass. **(Figure 15)** Following the coalescence period the "gummy bone" is formed and is ready for use. **(Figure 16)** This does not need to be immediately used during the surgery and can sit in the dish until graft placement in the treatment process is ready. The gummy bone can be used as a single mass **(Figure 17)** when placing in large voids such as sinus augmentation or cut with scissors into smaller pieces **(Figure 18)** that can be incrementally placed into the surgical site. These pieces will adhere to each other when they are placed into contact with each other or the surrounding tissues.

CONCLUSION

As discussed, one of the main challenges to osseous grafting is handling of the graft materials both during placement and during the initial healing period. Particle dispersement is not uncommon with particulate materials as when wetted by non-hematological liquids this limits site blood from infusing into the graft placed initially allowing dispersement to occur. Placing the dry particles into the site to be grafted allowing blood from the surrounding tissues to wet it also limits holding the mass together. There may be limited bleeding from the bones surface and not penetrate through out the graft placed from bleeding at the soft tissue.

Fibrin from the autogenous blood concentrate has more favorable characteristics acting as "tissue glue" to hold the particulate graft into a pliable mass. This pliable material handles better, allowing easier shaping for the defect being treated with potential to increase width when needed that can not be easily accomplished with particulate bone when autogenous blood concentrates are not added. The added benefit of the platelets and associated growth factors stimulate angiogenesis, thus using the patients own systemic factors to aid in graft coalescence, organization and maturation. Those practitioners who are utilizing particulate graft materials in their treatment modalities, should consider incorporating autogenous blood concentrates like PRP to improve graft handling, elimi-

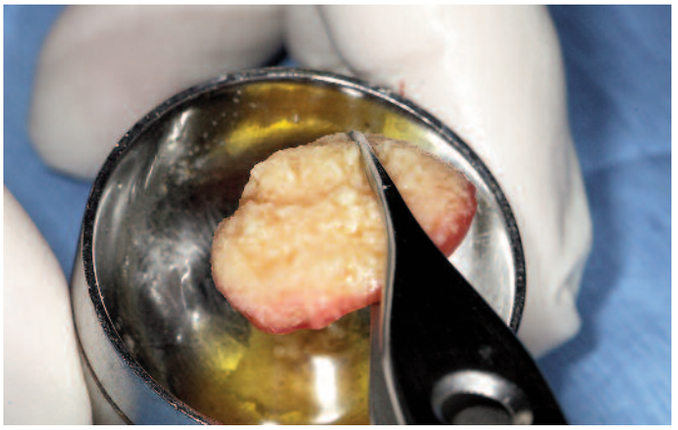

FIG 17: Once the "gummy bone" is created a gelatinous mass is formed that is easily carried to the desired site.

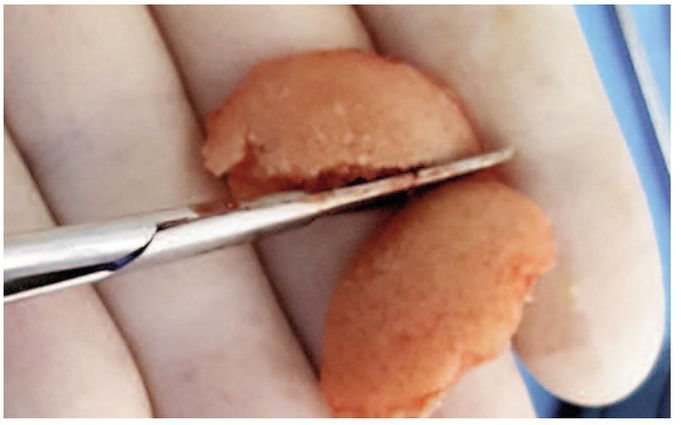

FIG 18: The "gummy bone" can be cut into appropriate sized pieces depending on the clinical need.

nate particle dispersement during healing and stimulate regeneration via the growth factors that are now incorporated within the placed graft material.

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