Implant Supported Removable Prostheses

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Axial attachments in complete dentures are very effective in stabilizing removable prostheses, but their excessive rigidity makes it difficult for patients to integrate them perfectly. Using Fiber Force reinforced fiber mesh results in considerable resistance to alternating stress.

Axial attachments in large mandibular complete dentures help make removable prostheses more comfortable for the patient. Designed to be fixed on the natural root, their longevity has often been unpredictable in the medium term due to root fractures, support root caps working loose, and the removable prostheses fracturing. The prognosis improved when osteointegrated implants were introduced.[1] The 2002 McGill conference established that the current therapeutic standard for treatment using mandibular complete dentures is the implant supported removable prosthesis with two osteointegrated implants. The removable prosthesis must also respond to the usual factors affecting equilibrium with the support surface, have correctly modeled and adjusted edges, and no unstable or unbalanced guidances.

Mandibular Deformation

Although the literature documents the criteria of adaptability for prostheses, the number of implants required, and the type of attachment quite well, less use is made of other data. The idea that the lateral pterygoidian muscles may, as a result of their obliquity, exercise a compressive action on the mandible was discovered by Grunewald in 1923. It is no longer contested that the mandible deforms elastically or flexes in both free movement and during mastication. The horizontal branches of the mandible move nearer or further away from each other during protrusion, retrusion, and opening.

Movement of 0.0 to 1.5 mm occurs during opening, and of 0.1 to 1.5 mm during protrusion.

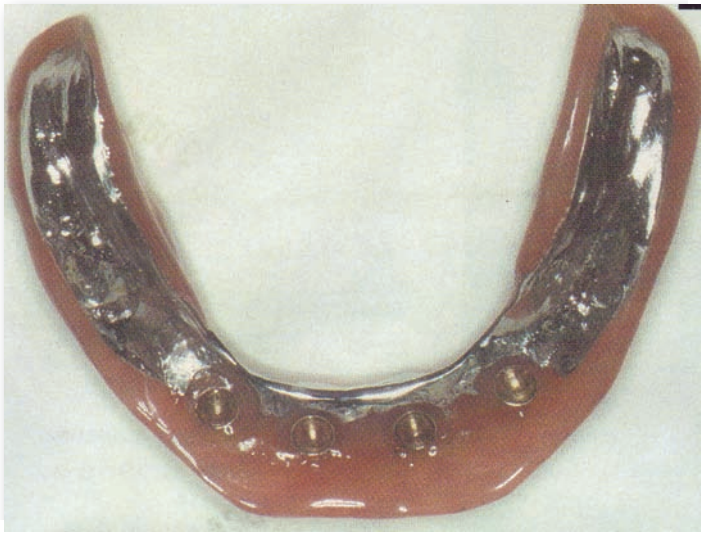

Fig. 1: The solution usually suggested is to make the base plates more rigid by using cast metal frameworks.

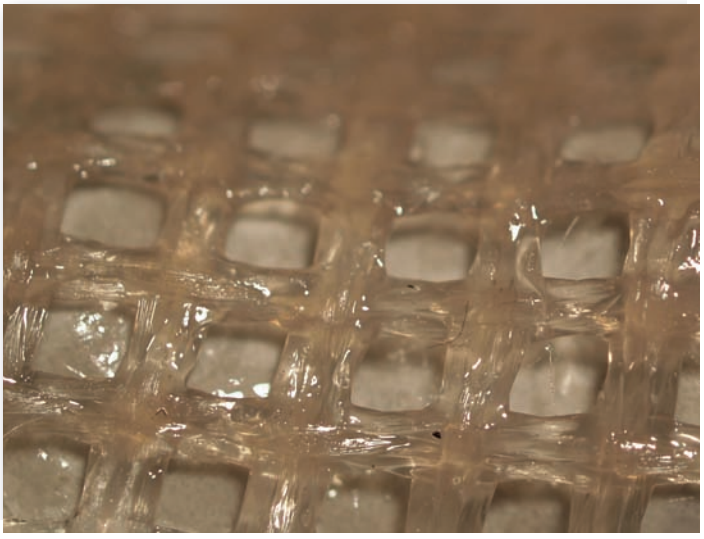

Fig. 2: The Fiber Force mesh has a fracture strength of 280 Mpa for a 15% by volume glass reinforcement.

Fig. 3

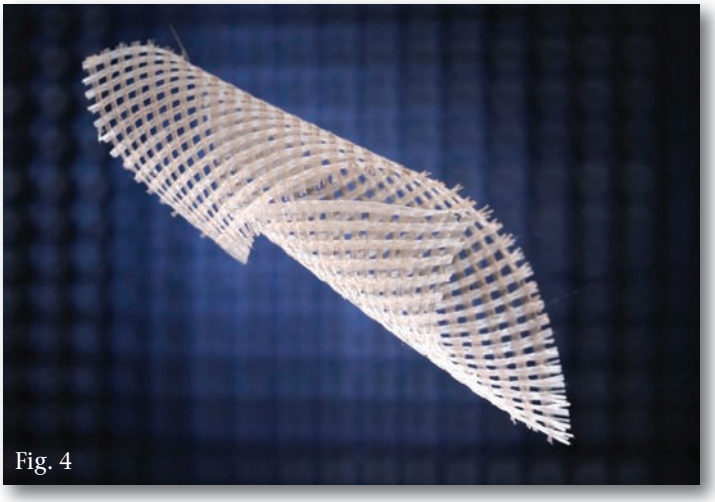
Fig. 4

Figs. 3 and 4: The Fiber Force mesh made of light curable FRC (Fiber reinforced composite).

This incontestable flexing of the mandible is clinically important:

- Can attaching rigid superstructures on implants be justified in major reconstructions?
- Can using rigid metal frameworks to strengthen the implant supported removable prostheses be justified?

Base Plate Fracture

The coexistence of an osteo-mucous support and an implant support also raises the question of the two structures with different physical properties and associated behaviors.[3]

During functioning, the distal prosthetic saddles on the implant supports are subject to the movements described by G. Tabet: the recession of the saddle and its detachment by rotation around the axis are caused by the implant support (two essentially destabilizing movements).

As a result, the material of which the mandibular prosthesis is made (generally PMMA acrylic resin) is subject to significant deformation with strong peaks of pressure affecting the abutments and attachments. Clinically this is where the fracture of the acrylic base plates is found, the fracture being caused by shearing forces and fatigue.

The solution generally implemented is to make the base plates more rigid by using a cast metal framework whose attachments are often laminated (Fig.1).

Fibre Reinforced Composites

The use of a metal framework can be questioned as it runs contrary to the previously described biomechanical evidence, since it must support the mandibular and osteo-mucus deformations rather than restrict them.

Furthermore, prostheses on metal frameworks are heavy as well as expensive, and are badly accepted by patients. Currently the best indicated material is methacrylate resin (PMMA) because of its visco-elastic properties; but its resistance to flex, impact, shearing, and alternating stress is poor. Fiber reinforced composites (FRC) seem to be best suited to the requirements of a removable implant supported mandibular prosthesis[6]:

- Better resistance to flexion[8]
- Better impact resistance[7]
- Significant resistance to shearing[10]
- Significant resistance to fatigue[9]
- Metal free
- Light
- Esthetic
- Simple technique

Fracture Strength

FRC are very strong and resistant materials that are easily obtained and have properties that are much closer to the biomechanical characteristics of the mandibular bone. They are able to support the inevitable deformations of the mandible while remaining solid and esthetic. The visco-elastic properties of these materials (that function as shock absorbers) also seem to be much better suited for reinforcement purposes as the amount of support required can be adjusted by varying the type and quantity of FRC used.

The scientific literature estimates that Young's modulus of cortical bone is 20 Gpa and its fracture strength is 140 Mpa.[9] When a PMMA resin is subject to flexion, it breaks at 80 Mpa while the same PMMA resin reinforced with fiber meshes (Fiber Force mesh) sees its fracture strength increase to about 280 Mpa when using a glass reinforcement of 15% by volume (Fig.2).

Furthermore, the modulus of elasticity of fiber mesh reinforced PMMA resin is 6 to 8 Gpa, but if the mesh (Fiber Force) is reinforced with a high modulus FRC strip (Fiber Force UD), the result is a modulus of 10 to 15 Gpa.[11] Consequently, this material is very appropriate for reinforcing the bases of implant supported prostheses, and this is why the light-cured materials (Fiber Force) are suited perfectly for the application. In fact, they meet all the qualifying criteria in the specifications.

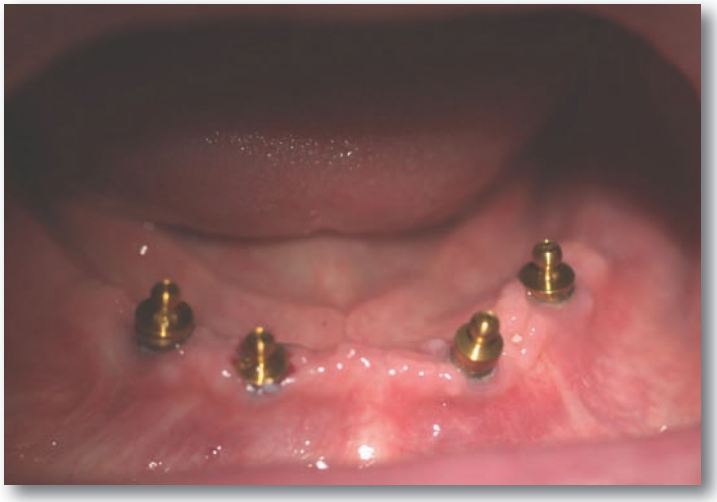

Fig. 5: After five-months osteo-integration of the implants, several ball attachments are screwed on the implants.

Fig. 6: The laboratory team's model of the replica attachments cast in plaster.

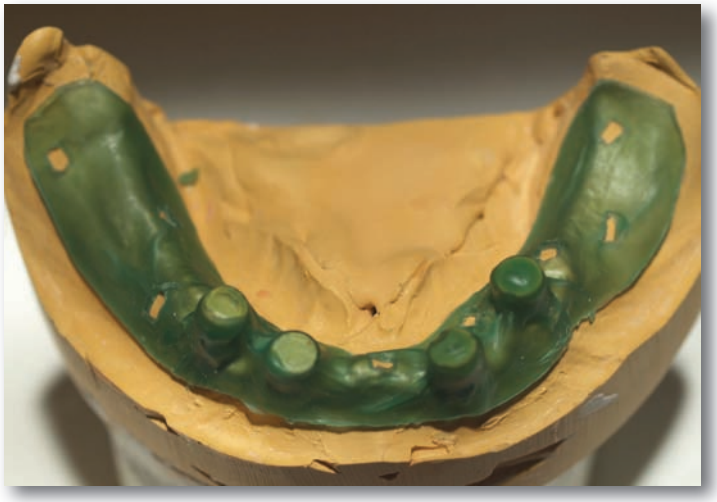

Fig. 7: A space is made so that there is room for the PMMA resin.

Fig. 8:
The spatula goes through the openings in the wax Spacer, while the stops prevent the mesh from coming into contact with the model during the injection or pressing of resin.

Fig. 9:
The openings are filled with light-cured or self-cured PMMA resin to the level of the wax, and polymerized.

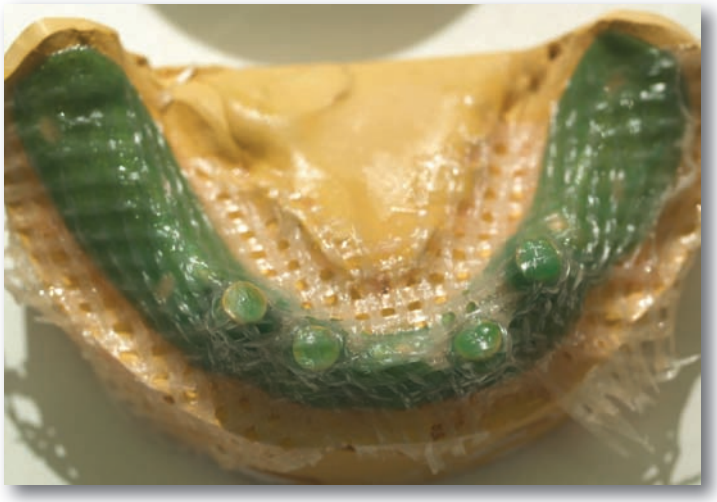

Fig. 10: The mesh is applied on the model, shaped, and light cured using the Ivoclar Vectris VS1 framework former.

Fig. 11: The replica attachments are surrounded by a fiber mesh matrix that forms a solid framework around each element.

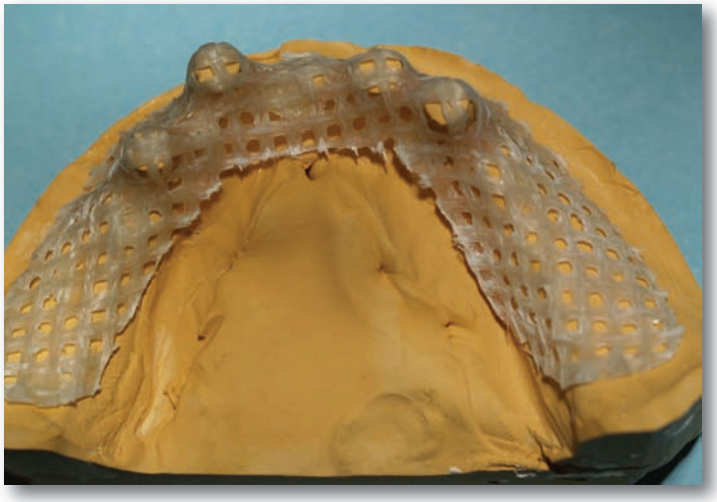

Fig. 12: The wax is removed and the polymerized mesh is returned to the model.

Fig. 13: The spacers are firmly joined to the mesh and prevent contact of the mesh matrix with the model.

Figs. 14 and 15: One or more fibers (Fiber Force UD or Braid) are added lingually below the attachments as a function of the occlusal-functional conditions

Clinical Application

Four implants (Easy Implant) were inserted in the mandible to stabilize the implant supported removable prosthesis. Several ball attachments were screwed into the implants after five months osteo-integration of the implants (Fig. 5). The laboratory team's model of the replica attachments was poured in plaster. A 0.22 mm wax plate (Spacer) was applied on the model to form a spacer.

The mesh must not come into contact with the model nor with the mucosa, and a space must be left for the injection of PMMA resin (Fig. 7). Openings are made in the wax spacer throughout the arches (Fig. 8). These openings are filled with light or self cure PMMA resin and polymerized using a hand-held curing light if necessary, creating spacers that keep the mesh matrix from contacting the model. (Fig. 9).

Integration of a Dense Fiber Network

The mesh is applied to the model, shaped (Ivoclar Vectris VS1 framework former was used), but the method used is irrelevant: vacuum bag, forming device for splints, etc. (Fig. 10). (Editor's Note: The manufacturer currently recommends the use of the Splint Vac vacuum forming unit). It is intimately intertwined with the model and the wax. The replica attachments are surrounded by the fiber mesh forming a solid framework around each element (Fig. 11).

The wax is removed and the cured mesh placed back on the model (Fig. 12). The spacers are firmly joined to the mesh and prevent contact of the mesh matrix with the model (Fig. 13). One or more fibers (Fiber Force UD or Braid) are added lingually below the attachments as a function of the occlusal-functional conditions (Figs. 14 and 15). They are glued and polymerized using a drop of flowable light cure composite. All of the prosthesis is then polymerized in the

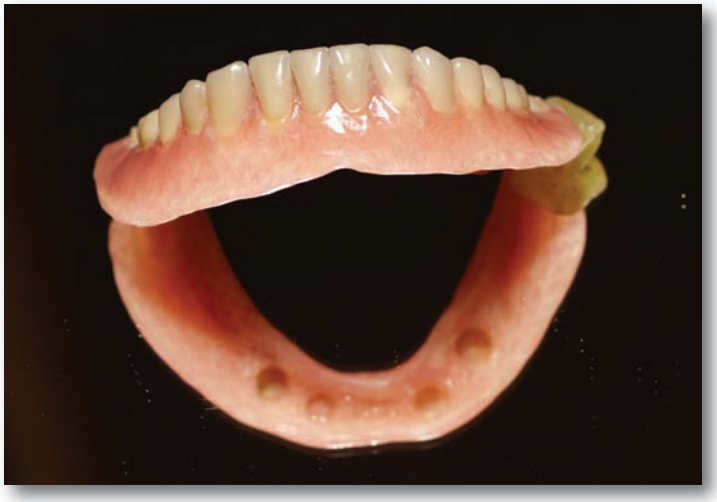

Fig. 16: The denture is finished and polished.

Fig. 17: The trans-illumination in the photograph shows the dense network of fibers integrated in the mass of acrylic resin.

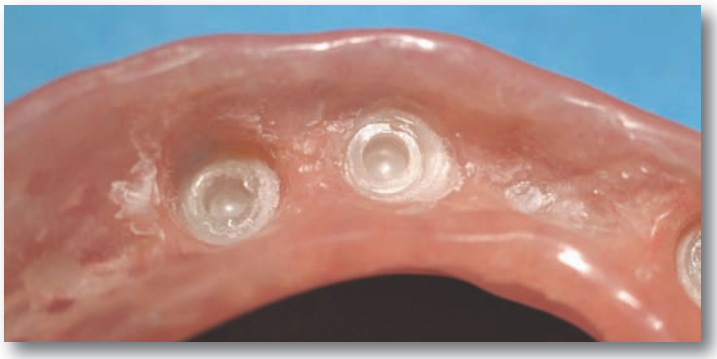

Fig. 18: The flexible (Easy Implant) precision attachments are glued in the mouth.

chamber of a laboratory light curing unit. The resin is pressed or injected or by following the usual protocol, that is, pressing or injection in a muffle furnace. Lastly, the denture is finished and polished (Fig.16).

The trans-illumination in the photograph shows the dense network of fibers integrated in the mass of acrylic resin (Fig. 17).

Although processing can be carried out in the laboratory, the flexible (Easy Implant) precision attachments in this particular clinical case were glued in the mouth (Fig. 18).

Specifications for Use

Fiber reinforced composites are particularly well-suited for manufacturing implant supported removable prostheses as their physical properties can be controlled by adjusting the respective proportions of reinforced fibers to the resin matrix. The visco-elastic properties and the great strength provided by the reinforced composite material's glass fiber are appropriate for this application. Great resistance to alternating stress can be obtained as long as the specifications for using this material are respected.

Impregnation of dry fibers by the technician using bonding resin does not ensure good fatigue resistance as this is a difficult process and the esthetic and mechanical results depend on the operator's skill.

Poor impregnation of the glass fiber makes the fiber/resin interface fragile, leaving a visible white trace under the prosthesis. The mechanical stresses are then not properly transmitted to the fibers that are supposed to provide support. The Fiber Force braids, strands, and meshes are completely pre-impregnated industrially in a methacrylate resin especially formulated for this purpose.

This technique guarantees the desired mechanical properties, and the result is no longer dependent on the technician. To improve fatigue resistance over time, it is better to apply and light cure the meshes under either vacuum or pressure.

Excellent adaptation of the mesh to the plaster model is also obtained and guarantees the final thickness of the prosthesis, which consequently improves comfort in the mouth for the patient.

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