METHODS OF REINFORCEMENT - IMPLICATIONS IN THE OPTIMIZATION OF COMPLETE DENTURE IN ACCORDANCE WITH CLINICAL PARTICULARITIES

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Abstract: The clinical reality of the total edentation from the point of view of the impact on the general condition of the patient, with extremely serious disturbances on the body pattern, correlated with the variety of clinical situations, always impregnated by the current social aspects, are only a few elements that advocate optimizing the total prosthesis structure by different reinforcement methods. The aim of the study is the practical materialization of the possibilities of optimization of the parameters of totally removable prostheses by associating the types of acrylate with the method of reinforcement with polyethylene fibers and metal nets. Material and method :A total of 12 specimens were made in the form of thin rectangular plates with a longitudinal dimension of 40 mm, a width of about 20 mm, having a thickness ranging from 1.8 to 2.5.Biomechanical tests were done on a HEKERT 50 machine (on a 10 kN scale) and on a Textenser test machine (500N maximum force).The test specimens have combined the different types of acrylate used in dental practice by associating it with various forms of reinforcement, represented by metal nets, respectively polyethylene fibers. Results and discussions: After the examination of the traction patterns of the traction specimens, the following aspects were noted: Unarmed materials showed cross-sectional sections, slightly corrugated with respect to the direction of force. The armed (asymmetric) materials yielded to areas without reinforcement (cracks usually starting from the hole made at the gripping ends). The cracks produced in the reinforcing areas had the following directions: transverse to the reinforcing fibers: I (acrylate and randomly arranged polyethylene fibers), II (acrylate, longitudinally disposed polyethylene fibers), III (acrylate, metal mesh). Conclusions: In the optimization of the therapeutic solutions excellent results are obtained in case of reinforcement with polyethylene fibers longitudinally disposed. It is known that the clinical particularity dictates the final design of the total prosthesis, so in the case of patients with muscular hypertonia, the optimal therapeutic solution remains the reinforcement with polyethylene fibers due to the very good adherence of the polyethylene fibers to the acrylate followed by the metal mesh reinforcement.

Keywords: *complete denture; polyethylene fibers; acrylate; reinforcement; oral rehabilitation*.

INTRODUCTION

The treatment of the total edentation, this complex clinical entity, proceeds according to well-defined stages, bearing the specific fingerprint for each clinical situation, a determinant factor in the particularization of the clinical-technological algorithm[1,2]. The principles governing the elaboration of the treatment plan play an essential role in choosing the optimal therapeutic solution in full compliance with the clinical and biological indices that characterize the total edentrial prosthetic field, without circumventing the parameters of the general state and the biomechanical equilibrium elements[3,4]. The variety of clinical cases requires the prevalence of a principle, reducing the weight of another in order to choose a correct treatment solution that has the goal of restoring the harmony of the stomatognomed system, a profoundly affected aspect, impacting on the psychosomatic balance of the patient[5,6]. From the category of materials used in the development of fully removable prostheses, the acrylic resins are clearly and indisputably detached as the most used, notable results being achieved by finding ways to optimize their structure according to the fracture risk they pose during exercising the functions of the dental system[7]. In common practice, total prostheses with social addressability are made of conventional acrylic resins, the thickness of which must reach 2 mm in order to withstand mechanical stresses.

The *aim* of the study is the practical materialization of the possibilities of optimization of the parameters of totally removable prostheses by associating the types of acrylate with the method of reinforcement with polyethylene fibers and metal nets.

MATERIAL AND METHOD

A total of 12 specimens were made in the form of thin rectangular plates with a longitudinal dimension of 40 mm, a width of about 20 mm, having a thickness ranging from 1.8 to 2.5. Biomechanical tests were done on a HEKERT 50 machine (on a 10 kN scale) and on a Textenser test machine (500N maximum force). The test specimens have combined the different types of acrylate used in dental practice by associating it with various forms of reinforcement, represented by metal nets, respectively polyethylene fibers(Figure no. 1).

Figure no. 1. Various forms of reinforcement

A number of 2 test samples were made of acrylate, super-opposable to the working protocol in the current practice, namely by combining the liquid (14 ml), represented by the monomer, materialized in the polymerizable methyl methacrylate with the powder of methyl polymethacrylate (35 mg), a number of 5 test samples made of acrylate were reinforced with polyethylene fibers arranged in various patterns, 5 test samples reinforced with metallic net, the most frequently met reinforcement technique. The forces applied on the test sample were below the breaking point and the loading speed (the increase of the speed was below 3N/sec) ensured the compensation of the flow and allowed an accurate command of the equipment (the equipment stopped to read the deformation). The following parameters were calculated for all the test samples under analysis:F_{max}=the maximum force when the breaking of the test sample occurred; σ_{max}= maximum (normal) tension ($\sigma_{max}=F_{max}/S_0$), where $S_0=b\cdot g$ is the section where the breaking can occur (or the initial section of the study area in the test sample);$(\sigma_{max})_{real}$= the real maximum normal tension, calculated in the section where the breaking actually occurred, the traction force being eccentric due to the asymmetrical structure and the load distribution by the structure.

Depending on these parameters we quantified the superiority of the reinforcement compared to acrylic test samples. A non-reinforced test sample was selected of all results obtained, together with a test sample reinforced with polyethylene fibers and a test sample reinforced with metallic net. One can notice the certain superiority of polyethylene fiber reinforcement compared to non-reinforced or metallic net reinforced samples.

RESULTS AND DISCUSSIONS

After the examination of the traction patterns of the traction specimens, the following aspects are noted:fragile tearing (lack of plastic deformations preceding tearing) of all specimens;the unarmed materials exhibited cross sections, slightly corrugated with respect to the direction of force;armed (asymmetric) materials have yielded to areas without reinforcement (cracks typically starting from the hole made at the gripping ends).

The cracks produced in the reinforced areas had the following directions:parallel with the fibers: the specimen reinforced with polyethylene fiber; transverse on the armed fibers: (acrylate and polyethylene fibers arranged at random), II (acrylate, longitudinally disposed polyethylene fibers), III (acrylate, metal mesh/net).

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Table I. Parameters of broken test samples subjected to traction again

Test sample	Glued surface	Breaking force	τ_{max} (conventional)
	mm^2	N	MPa
VI	$20 \cdot 20-(\pi/4) \cdot (3,5)^2=390,378$	800	2,049
VIII	$18,8 \cdot 17-(\pi/4) \cdot (3,5)^2=309,378$	1750	5,656
IX	$15 \cdot 18,4-(\pi/4) \cdot (3,5)^2=266,378$	1650	6,194

The removal of the base material was followed by the loading of the reinforcement by the reinforcement: the small (elastic) deformations of the acrylate were not simultaneous with the deformations of the reinforcement materials. The polyethylene fibers are made of twisted yarns, exhibiting a much lower modulus of elasticity than that of the acrylic resin, especially due to the yarn curls(Figure no.2).

For the reinforced metal mesh (IX), the cracking of the resin perpendicular to the direction of force was observed, the metal reinforcement suffering an insignificant deformation. The metal mesh (III) test piece broke in the grip zone by releasing the adhesive with which the tabs were glued(Figure no.3).

Figure no. 2. Aspects of the traction specimens using reinforcement with polyethylene fiber

Figure no. 3. Aspects of the traction specimens using reinforcement with metal reinforcement

Within the practical possibilities of optimizing the resistance of the total denture bases, reinforcement with polyethylene fibers is included in the sphere of the avant-garde means, the superiority of the resistance to the traction forces being already demonstrated in a previous stage, superposed on the literature data[8].

Achieving optimal parameters of mechanical strength, corroborated with the augmentation of the comfort that the totally removable prosthetic constructions must fully comply with the prosthetic field particularities, is a desirable achievement[9].

Technological processes are intended to reduce this thickness, resulting in increased patient comfort without impairing its strength. In day-to-day practice, extrinsic reinforcement is commonly used to increase fracture resistance and reduce the thickness of the primary connector. The problem raised by this method of increasing the resistance is the fact that the action of metal nets is an interface between the acrylic layers leading finally to the detachment of the reinforcement element(Figure no.4).

Figure no. 4. Practical aspects of complete denture reinforcement with metal

The reinforcement of acrylic resins, materialized by the introduction of metal nets with physical properties superior to the base material, improves the final mechanical characteristics of different types of stresses. It can be concluded that the reinforcement of the total prosthesis with metal mesh results in a composite body with increased resistance properties which is recommended as a prophylactic solution against fractures(Figure no.5).

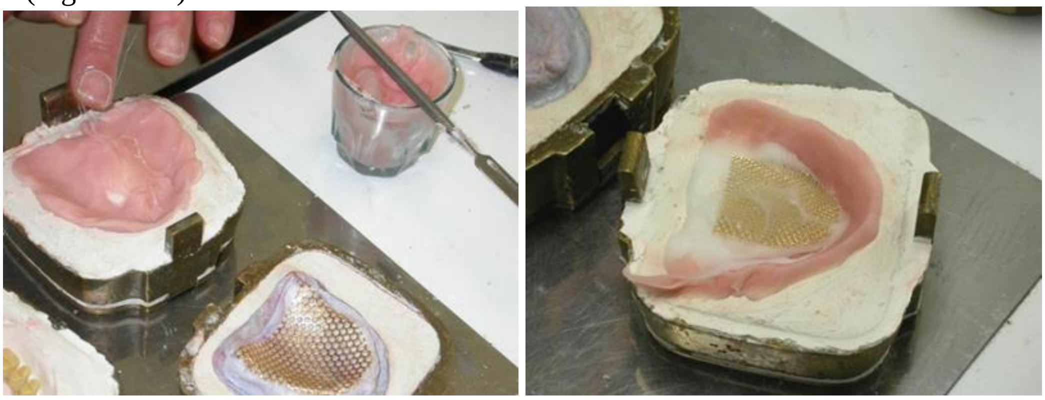

Figure no. 5. Technological aspects of metal mesh reinforcement

Other reinforcement alternatives have been tested using non-metallic materials. Since 1957, reinforcement attempts have been made using glass fibers, since carbon fibers have been used since 1971. Both types of fiber raise elements of difficulty in use because the full coverage of their sharp ends has become an extremely important aspect[10].

The study suggested by Neşet Ertaş aimed to determine the dimensional changes in water absorption in the case of unidirectionally arranged glass fiber reinforced bases and nylon fibers having different weights arranged at random throughout the prosthesis mass. Following the evaluation of the obtained results, important features in terms of biomechanical aspects have been noted in the use of glass fibers, which recommends them in dental practice as superiority to those of nylon[11].

At the same time with the increased number of glass fibers, it was found that the dimensional changes and the degree of water absorption in the structure of the complete removable prostheses were considerably reduced. Remaining in the field of studies that address the resistance of totally removable prosthetic structures improved by the reinforcement method with different fibers, conclusive results provide us the studies of the researchers Daryll. The proposed study examines the interface area of the polymethylmethacrylate backed with polycarbonate fibers and polyamide fibers. Fragments of the acrylic resin were examined using an electron microscope. The results lead to the conclusion that in both cases reinforcement an important role in the final strength is the very dense fiber disposition.

Research by Ladizesky brings to the attention of practitioners the use of linear polyethylene fibers inserted into the acrylic mass of total prostheses. Worthy to note is the superiority of adhesion of polyethylene fibers immersed in a solution of polymethylmethacrylate, compared to other reinforcement methods. Optimal results were obtained by Chow, which found that the presence of polyethylene fibers reduces water absorption, which reduces the dimensional changes observed in prostheses kept in water. The layout of polyethylene fibers in both Ladzesky's and Chow's research had a longitudinal trajectory, resulting in a ten-fold impact strength of these prosthetic pieces, 10 times higher than conventional resins[12-19].

If polyethylene fibers are subjected to plasma treatment and will be disposed through the acrylic resin interlayer, a higher net result is obtained, reducing the risk of fracture.

Another possibility of increasing the resistance is represented by the intrinsic reinforcement, which consists in obtaining a correct polymerization associated with an effective final heat treatment, aiming at the consumption of the residual monomer. The fitting of the teeth with restoring correct occlusal reports, taking into account the changes in the mandibular dynamics of the total edentulous patient, has a specific role in the biomechanical balance. In order to achieve an individualized final aspect that equals the balance between aesthetics and functional, with particular attention to the biomechanical principle through the different types of reinforcement; it is necessary to customize the aspects of choosing and mounting the teeth.

The clinical-technological algorithm for total prosthesis has been enrolled in the classical manner, except for the step of introducing acrylate in the printing press when the reinforcement of polyethylene fibers was made(Figure no.6).

Figure no. 6. The clinical-technological algorithm for total prosthesis using the reinforcement of polyethylene

We used polyethylene fibers from Kerr Company, CONSTRUCT Tire, three types of rollers, having 1.2 mm and 3 mm polyethylene fibers respectively(Figure no 7).

In this clinical situation, we used randomly arranged polyethylene fibers with a diameter of 3 mm.

Figure no. 7. Trust Construct from KERR

Polyethylene fibers were sized proportionally to the dimensions of the prosthetic field, being arranged both transversally and longitudinally. In the first instance, a layer of acrylate is introduced, the polyethylene fibers are disposed, another layer is introduced afterwards(Figure no.8).

Figure no. 8. Practical aspects of reinforcement with polyethylene fibers

One problem that has raised concerns was the discreet "run" of polyethylene fibers, a situation that has been encountered in the literature in Vallitu's studies, a situation that has improved in the following clinical cases. By increasing acrylate consistency.

Not only the maxillary prosthesis has a rectangular and mandibular structure, the lingual slope having a height corresponding to the application of a 2 mm diameter polyethylene fiber.

The AD patient, 54 years old diagnosed with subtotal edentation, 5th grade Kennedy maxillary and 6th Kennedy mandibular, was presented in our Clinic with two mixed prostheses, inappropriate from the point of view of technological achievement, as well as from the point of view of the stability and the ability to restore the functions of the stomatognomate system.

The outstanding units that were kept on the arcade were 1.3.1.5 and 1.6. The correct endodontic treatment was performed, the specific coronal portions were prepared, following the preparation of the root vessels for the anchoring of the caps(Figure no.9).

Figure no. 9. Aspects of clinical case

At the mandibular level, a mixed prosthesis was used, which brought together the concomitant solidarity of the remaining elements with the prosthetic prosthesis.

It is necessary to mention the muscular hypertonicity met in the lifting muscles, a clinically important aspect, which correlated with the fact that the antagonist jaw is mixed prosthesis, exerting a much larger masticatory force, pleaded for the realization of an acrylic protector reinforced by the metal net. A very important role is played by the judicious adaptation of the metal mesh to the functional model, most of the failures being associated with the lateral tilting element having the clinical end result of failure(Figure no.10).

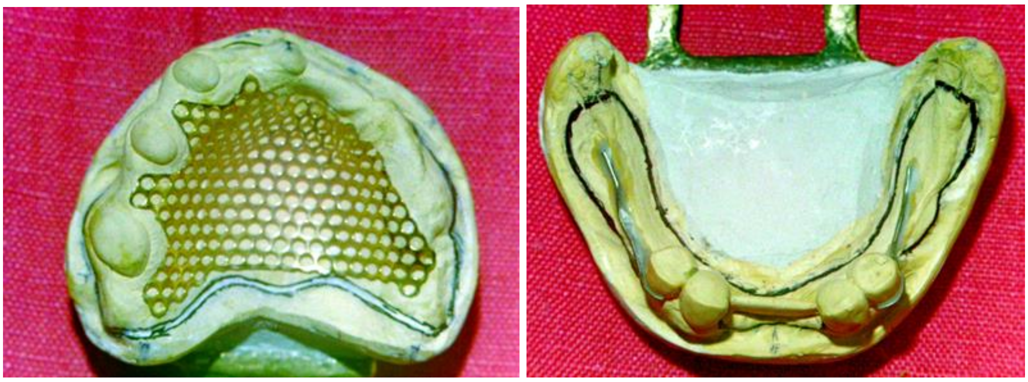

Figure no. 10. Adapting the net to the functional model; the functional model of the antagonist jaw

The clinical-technological algorithm followed its natural sequence, the mock-ups of the two prostheses were properly modeled, at the maxillary level, with a lot of fidelity reordering the phonetic articulation areas.

After the printing, in the step of introducing the acrylate, the metal net is prepared, interposed between two layers of acrylate.

In this case digital clinical laid tert shown that the metal mesh due to the presence of metal CAPE contributed to the stability during the insertion acrylate, stability and maintained during the use of force or press(Figure no.11).

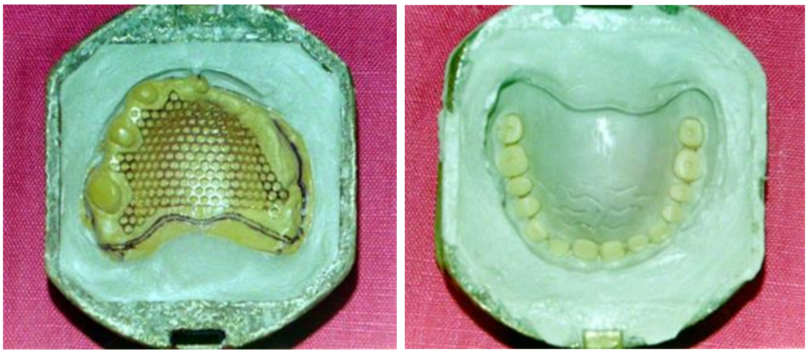

Figure no. 11. Preparing the print for the introduction of acrylate

The final appearance of the prosthesis harmoniously restores the physiognomy of the patient, the vestibular slope of the prosthesis being an effective support of the soft parts, the patient supporting 20 years ago a cystectomy in the frontal area, whose scarring was difficult because the patient was not cooperative with regard to wearing the obturator(Figure no. 12).

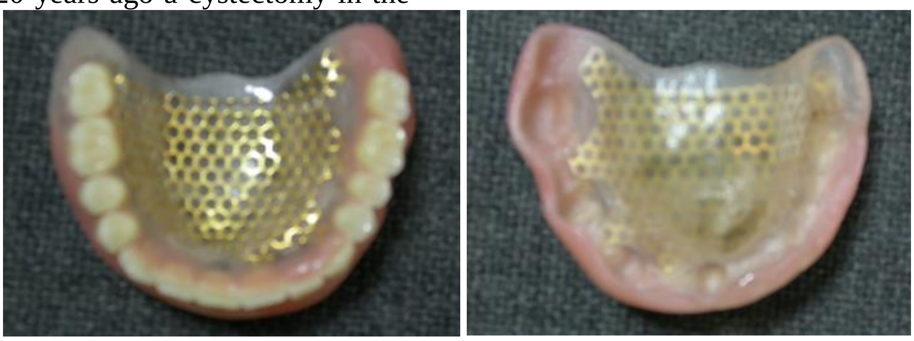

Figure no. 12. The final appearance of the total prosthesis (from the overlay reinforced metal mesh solution

An essential role in shaping the final aspect of dental restoration in patients with total prosthetic construction is the choice of shape and appearance of the teeth. Thus, the shape of the central incisors must reflect the outline of the patient's face, be in harmony with the patient's sex, their selection taking into account personality, age, elements that influence the final choice and underlie the creation of the natural illusion.

Femininity or delicate personality must be characterized by its round, smooth shape, outlining the fluid appearance of the teeth presenting these attributes. On the other hand, frontal teeth are chosen for shaping the masculine force with clear, vigorous lines with well-rounded angles. Visual perception is the result of fitting artifacts in harmony with the general shape of the patient's facies. The waist of the front teeth is sometimes more important than the shape, leading in some cases to the very wide arcade appearance, outlining the image of anesthetic oral corridor(Figure no.13).

Figure no. 13. Aspects of particularities of clinical case and aspects of individualized rehabilitation

The difference between the facial width and that of the dental arcade always produces the impression of the absence of the natural and the certainty of prosthesis.

The dental industry has as main objective the provision of dental flanges that should allow the realistic replacement of the lost substructures. One thing worth to be noted is that most of the artificial teeth are much smaller and sharper in size than the natural ones. Unfortunately, the aesthetic effort is limited to the anterior maxillary teeth in most cases, while the appearance of mandibular teeth is equally important in shaping the final result. A coarse error, commonly found in dental practice, is the extremely rigorous symmetry encountered at the level of inferior incisors. The aesthetic appearance can be improved by the coloring of the front teeth as well as through the edges of the incisors. An extremely important role has the inclination of the teeth of the teeth, offering the appearance of oblique occlusion.

The influence of gingival modeling on the final facial expression is crucial in achieving harmony with the age of the patient, a determinant factor in choosing contour details.

The emphasis on youthful appearance is possible through the elongated modeling of the gingival papules with dental pack coverage in full agreement with the short, flat and neutral appearance of the teeth(Figure no.14).

Figure no. 14. Aspects of gingival modeling in complete denture rehabilitation

For the middle aged, dental pack coverage by the gum should stop at the enamel coronary limit. The shape of the teeth in this situation takes long and accentuated shapes.

I. CONCLUSIONS

Based on the results obtained, the following conclusions can be drawn: The specimen subjected to a maximum breaking force was polyethylene fiber reinforced acrylate, .

longitudinally disposed (F = 1750 N);In the optimization of the therapeutic solutions excellent results are obtained in the case of reinforcement with polyethylene fibers disposed longitudinally;For patients with muscular hypertonia, the optimal therapeutic solution remains polyethylene fiber reinforcement because of the very good adhesion of polyethylene fibers to acrylate, followed by metal mesh reinforcement

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