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Scanning electron microscopic aspects of arterial dacron prostheses examined before and after long term implantation

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BIASI G., P. MINGAZZINI, V. SFORZA, P. TANGANELLI, U. RUBERTI and G. WEBER. *Scanning electron microscopic aspects of arterial dacron prostheses examined before and after long term implantation.* — Seven arterial grafts implanted for a period variable from 8 months to 12 years and removed for clinical failure were examined by means of a ISI-Super Mini SEM (Scanning Electron Microscope) at 7.5 Kv.

Three specimens of dacron protheses before implantation were also examined.

The material observed resulted very adapt for scanning electron microscope.

The SEM findings are reported.

Key words: Arterial reconstruction, vascular grafts, scanning Electron Microscope (SEM).

As it has been recently stated [7] scanning electron microscopy (SEM) has been « invaluable in evaluating prosthetic materials and studying interactions between host and prosthesis. Understanding of mechanisms of prosthesis failure plus suggestions for design modification and advances in prosthetic surface coatings have been among the benefits derived from SEM studies ».

It must be noted that satisfactory prostheses for cardiovascular system have been largely searched for, utilizing the SEM which is unique in the evaluation of blood compatible surface which can rapidly be examined at SEM to find out a thrombus or a disruption of the endothelial lining or other irregularities of the examined surface.

Evaluation of different surfaces as for their relative lack of thrombogenicity [2 5] has been conducted by means of SEM studies also in vivo [6] and different thrombogenicity of different surfaces was discovered by SEM examination. The mechanism of thrombus formation on polymeric vascular graft materials may differ extensively depen-

dent upon surface composition of polymeric vascular grafts [1].

Thrombus generation on artificial surfaces was studied at SEM and transmission electron microscopy (TEM)[5 6 8] and much was learned on the aspects of intimal deposit. Also in the attempt to reduce thrombogenicity, SEM was largely used to evaluate the effect of different coatings or different surface configurations [3].

Authors having studied short term material have established that after few minutes the surface was covered by blood cells and fibrin [4 9].

Leukocytes and platelets disappeared at each end of the prostheses at 24° hour and 6 days after in the mid portion, the covering resulting then chiefly constituted by erythrocytes and fibrin. After 2-8 weeks, the matryx on the surface was composed chiefly by cells similar to fibroblasts or in transition to smooth muscle cells (SMCs).

The development of pseudointima has been also studied at SEM and TEM in « long term » studies (up to 27 months) [7]. After 5 months, typical SMCs covered the surface: after 27 months, both in canine and human dacron by-pass prostheses, the graft presented patch coverings of endothelial cells while elsewhere collagen was exposed with occasional adherent platelets. Also in mitral valve prostheses similar findings were observed [7].

Development of pseudointima or neointima progresses through continued thrombus deposition up to a layer of various thickness reaching a point of relative quiescence.

It may be noted that, as far as we are aware, no SEM observations have been up to now conducted on prosthetic material removed after far longer periods. It may be therefore of some interest the presentation of some aspects of luminal surface of prosthetic devices removed after many years.

Materials and methods

Seven arterial by-pass prostheses (aorto-iliac; aorto-femoral; aorto-popliteal) from five men and two women, age ranging among 40-84 years, were examined.

The dacron prostheses had remained « in situ » for periods variable from 8 months to 12 years and were examined at the time of arterial graft reconstruction for clinical failure (aneurysm, occlusion of the graft, etc.).

Also three specimens of dacron prostheses (« Woven », « Velour », « Knitted ») before implantation were examined.

After removal, the grafts were shortly rinsed with heparinized physiologic saline and then fixed in 2.5% buffered glutaraldehyde for 2 hours; after rinsing over-night in phosphate buffer 0.1 M, pH 7.4, samples for SEM were cut into segments, and further fixed in 1% buffered osmium tetraoxide over-night in the cold.

The segments were dehydrated through ethanol and dried at CO_2 critical-point. Dried specimens were metalized in a Vacuum Evaporator Jeol and examined by means of a ISI-Super Mini SEM at 7.5 Kv.

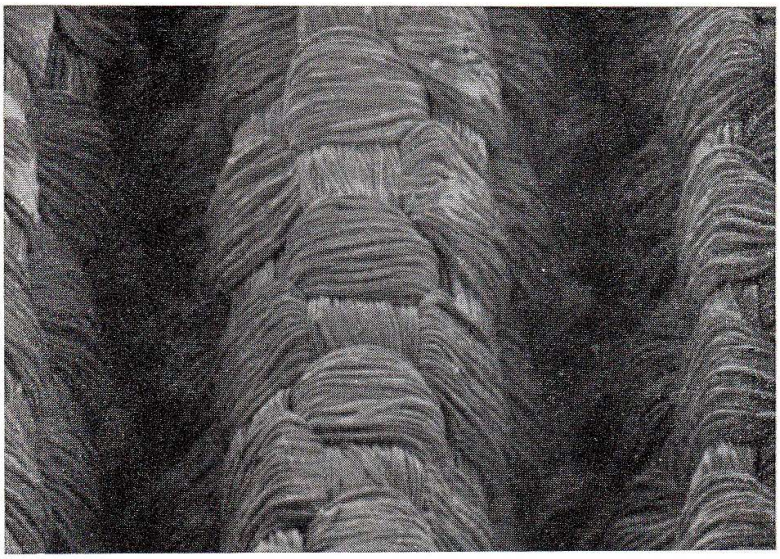

Fig. 1, 2, 3, 4, 5 and 6. - Aspects of the different types of dacron prostheses before implantation at lower and higher magnification: Woven (fig. 1), 50x and fig. 4, 200x); Velour (fig. 2, 50x and fig. 5, 200x); Knitted (fig. 3, 100x and fig. 6, 200x).

Fig. 1.

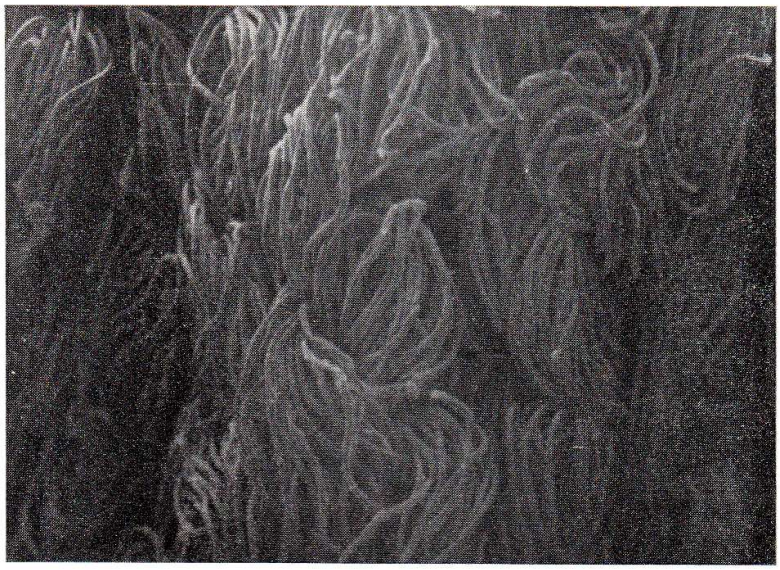

Fig. 2

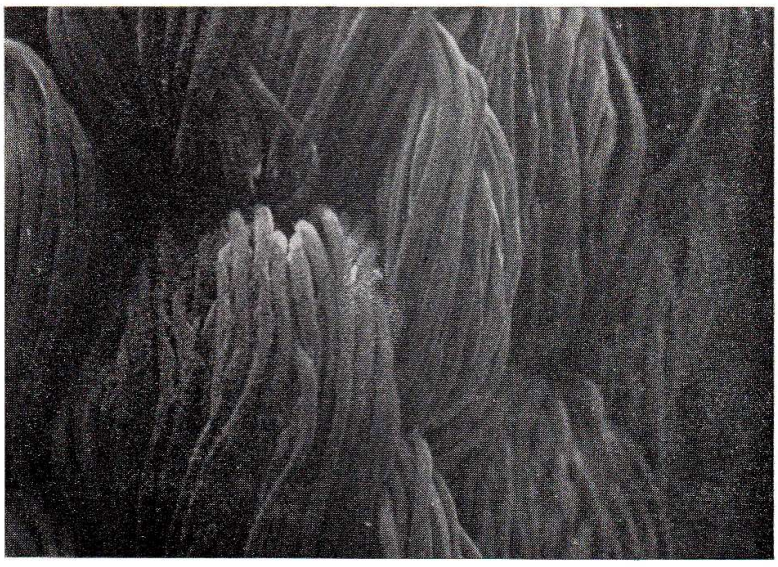

Fig. 3.

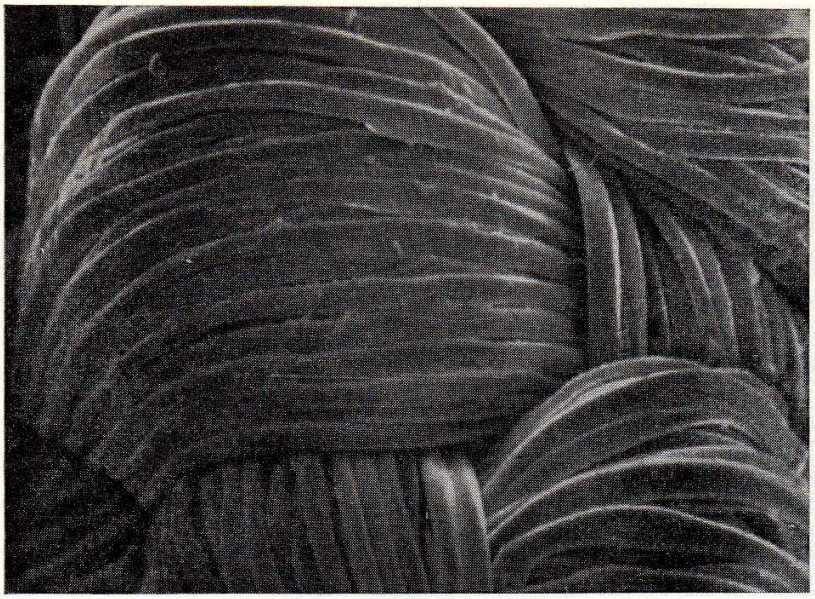

Fig. 4.

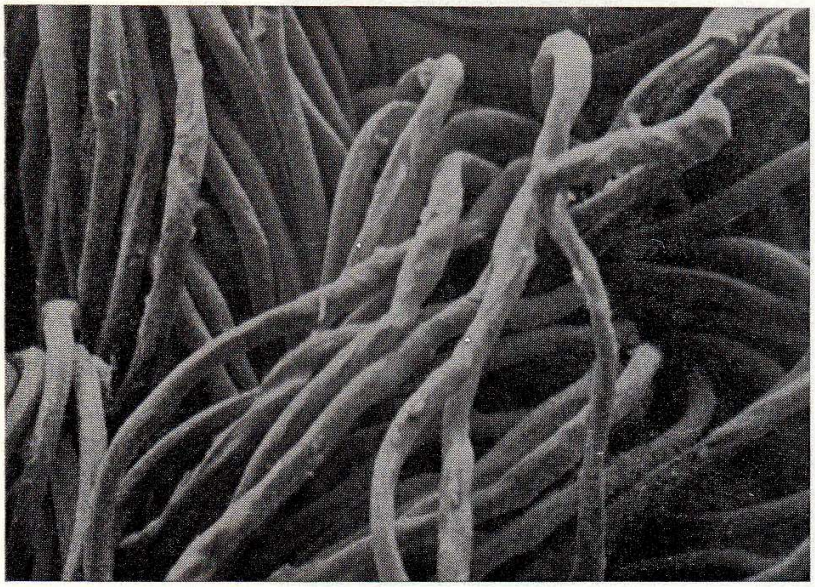

Fig. 5.

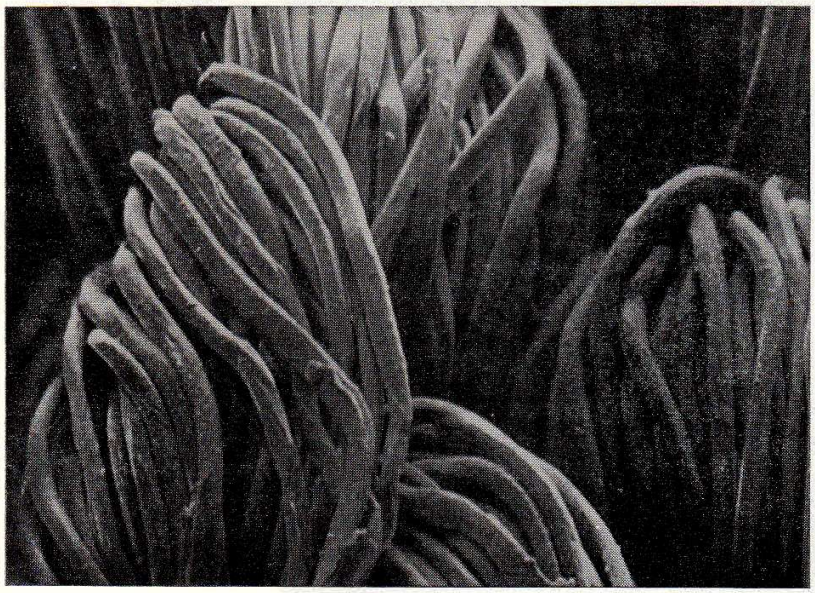

Fig. 6.

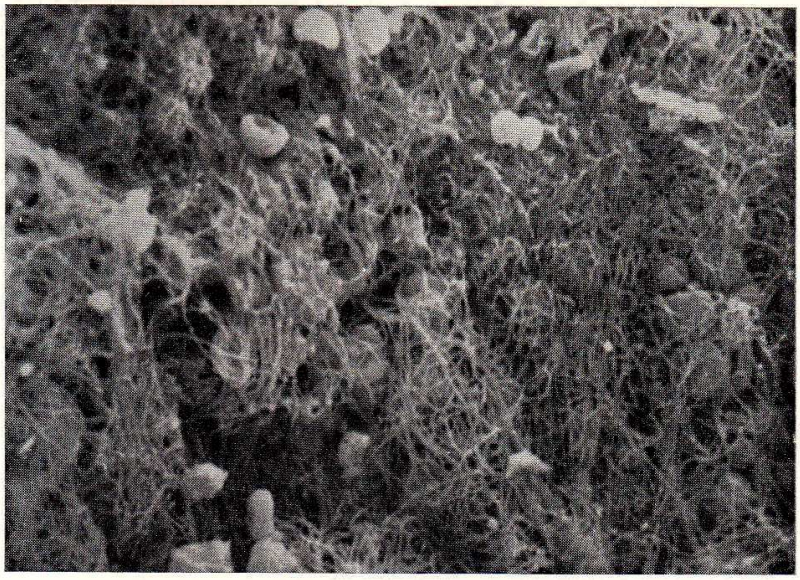

Fig. 7, 8 and 9. - The intimal surface is covered by fibrin and red blood cells (fig. 7 and 8, 1000x). Nearby « nude » areas show sometimes elongated cells laying over the surface of the prosthesis (fig. 9, 200x).

Fig. 7.

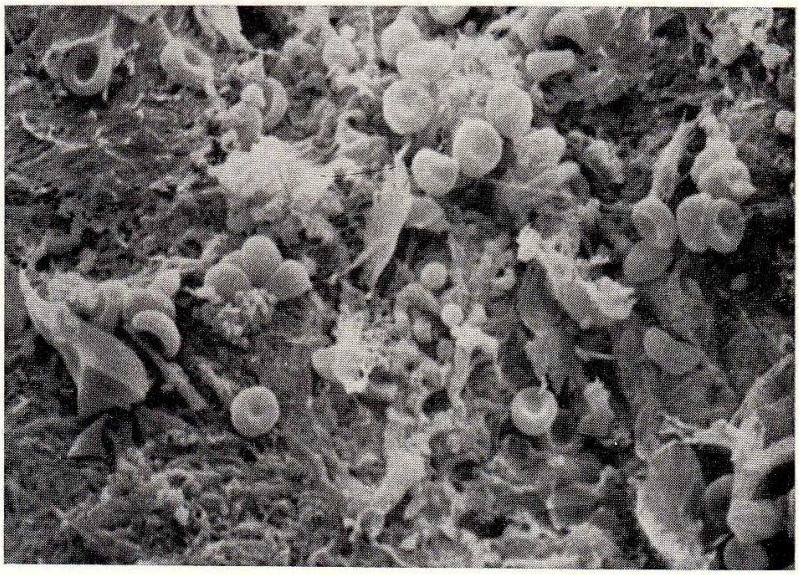

Fig. 8.

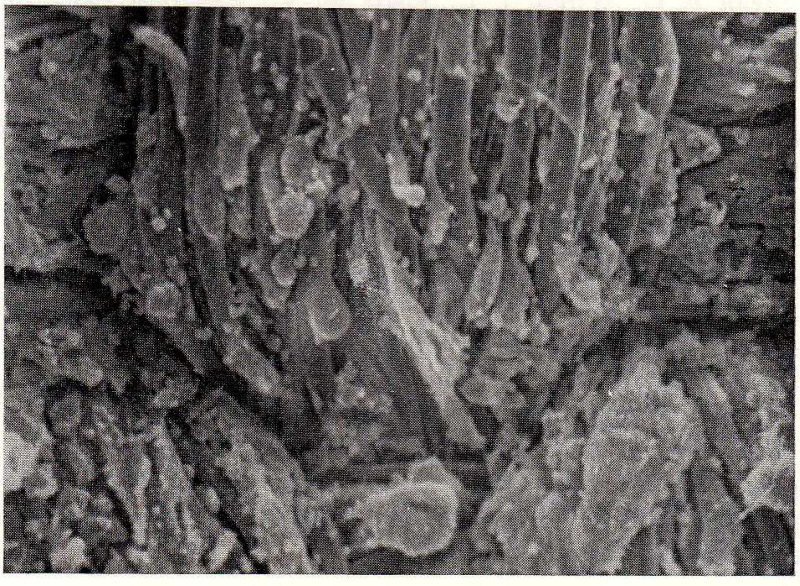

Fig. 9.

Results

The luminal surface of material removed after 7-12 years always appears covered, more or less largely, by thrombus. Thrombus cells and fibers lay between the prosthetic fibers and partially cover those. Sometimes fibers belonging to the dacron prostheses are exposed in areas of different amplitude. Rather seldom the prosthetic fibrils are partly covered by aggregated platelets, leukocytes and fibrin.

Of course, we have no means of assessing, through the examen of our material, what may have been the picture during earlier phases, if prostheses have been or not more or less endothelialized: at any rate it must be reminded that our material has been removed from patients because of clinical failure of prostheses (chiefly thrombosis); consequently our observations have always evidenced surfaces largely covered with thrombus and juxta-posed areas surprisingly not covered by thrombus formation but also without neointima. In other areas cells of various origin are present on the surface: some of which probably represent SMCs migrating over the prosthetic surface. We have not been able to observe, up this moment, a regular endothelial layer over the neointima.

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