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HOMOTRANSPLANTATION OF FASCIA PRESERVED BY LYOPHILISATION

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Abdominal or other types of hernia sometimes present great difficulties to the surgeon. If the defect cannot be repaired by making use of adjacent tissues, these being insufficient qualitatively or quantitatively, one has to resort to transplantation or to the use of alloplastic materials. In spite of the good results reported from the use of plastics (meshes of perlon, nylon, orlon) and of metals and alloys not noxious to tissues (stainless steel, tantalum meshes), it still seemed justified to search for better possibilities in the field of tissue transplantation.

For the repair of herniae, which can be cured by making use of adjecent tissues only with difficulty, Kirschner [11], Gallie and Le Mesurier [7, 8], Wangensteen [20] and others have recommended the use of autoplastic fascia lata of the thigh, as a most resistant tissue. Ali [1], then Djuvara *et al.* [6] have recommended for strengthening the abdominal wall in cases of inguinal hernia of excessive size the use of autoplastic, free skin flaps deprived from the epidermis. Although the above procedures have proved to be valuable, they could not gain wide acceptance, because the operation required to obtain autoplastic tissue makes surgical treatment complicated and prolonged.

In the light of earlier experiments [23] and after the introduction of adsorptive lyophilisation for preserving tissues (I. Szilágyi [18]) it has been thought that a procedure has become available for the prolonged preservation of the fascia, which had been successfully stored also in isotonic penicillinised solution under refrigeration (at +4° C) for use as a transplant. Usher [19] has realised a similar theory, but in so doing he followed *Gallie's* earlier method, in which thin strips cut from lyophilised fascia lata have been used as living suture. Thus, the fascia was used not for repairing a defect, but merely as a means for avoiding that tissues under tension be cut, as often occurs when conventional sutures are used.

In the present experiments the fascia was used in the form of flaps, based on the consideration that with extensive herniae the tissues cannot be brought to unite even by exposing them to extreme stretching and the abdominal wall has to be "patched up". This technique of hernorraphy had been employed,

in experiments and practice alike, by RITTENHAUS [15], LEVIT [12], GREGGIO[9], STEWART [17], LINGLETON and STEHOUWER [13], with autoplastic fascial flaps. As far as we know, nobody has so far used homoplastic fascia for this purpose. We decided to subject the latter possibility to experimental trials.

Being a bradytrophic tissue, the fascia lata can be transplanted under the conditions of homo-, or even heterotransplantation and, in addition, its relatively low moisture content makes it very suitable for lyophilisation (freeze-drying). In general, bradytrophic tissues are better homotransplants than tissues accustomed to more active vital functions (for example skin, kidney), because the former suffer less from tissue incompatibility than the latter. This point has not been fully elucidated, this is presumably because the bradytrophic tissues are gradually connected into the circulation of the recipient organism and, consequently, antibodies are formed at a slower rate.

The theoretical and practical aspects of adsorptive lyophilisation have been dealt with in detail [3, 18]. All we now wish to point out in this connection is that the procedure has proved of great value, especially for the preservation of vessels and bones, and offers numerous advantages over other methods of tissue preservation [4]. Lyophilised tissue can be stored at room temperature for almost unlimited length of time and stored in glass tubes sealed under vacuum, it can be readily transported.

To confirm the validity of our theory, animal experiments were carried out. The fascia lata of the dog, and, in particular, its lateral, stronger part corresponding to the iliotibial tract, seemed to be most suitable for use as the tissue to be preserved. Rectangular flaps, averaging 6×8 cm. in size, were cut from the fascia freed from muscle and fat, washed in penicillinised isotonic solution, spread on a glass cylinder and lyophilised. The transplantation experiments were carried out in 15 adequately prepared dogs, under intraperitoneal Evipan anaesthesia. From paramedian laparatomy a laurel leaf-shaped defect was created in the abdominal wall, varying in extent from 6 to 8 by 4 to 6 cm, according to the size of the animal. In this area everything from skin to peritoneum was removed, creating thereby conditions similar to what the surgeon has to face when treating an abdominal hernia by operation. Meanwhile, the lyophilisation tube was opened, a preserved fascia of suitable size selected, placed into a penicillinised, warm physiological solution for 10 minutes. The lyophilised fascia thus treated regained its orginal moisture content and became even histologically completely similar to freshly removed fascia. After mobilising and suturing the peritoneum at the margin of the artificial defect in the abdominal wall, the fascia was sewed circularly to the margins of the muscles with knotted silk sutures and the skin wound was united. Thus, what we did was to repair by preserved fascia the defect produced by extirpation of the bilateral rectus abdominis muscle and part of the linea alba (Fig. 1). In operations on larger animals not one, but two layers of fascia were used and care was taken that

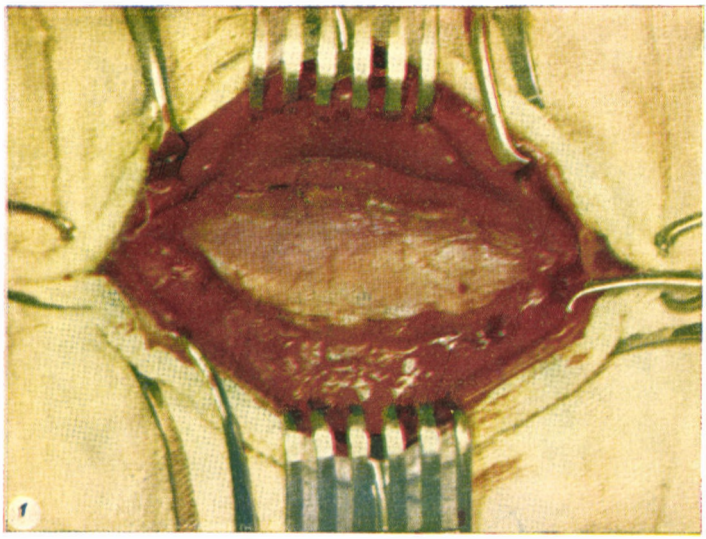
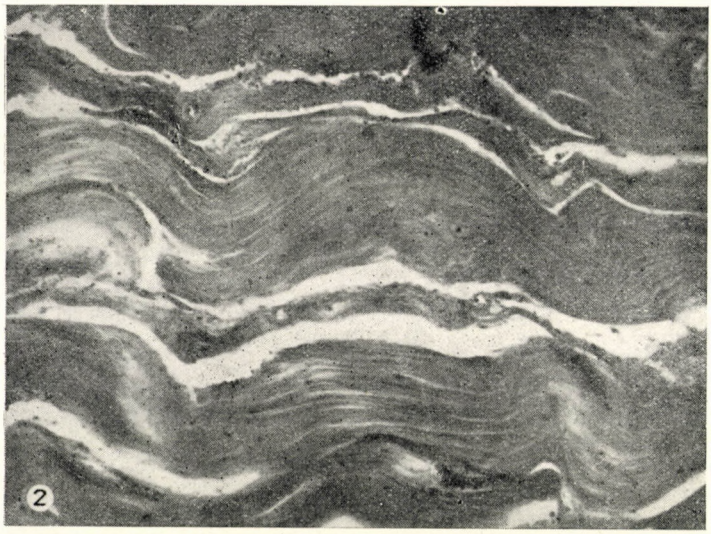


Fig. 1. Repair of abdominal wall defect by means of fascial transplant preserved by lyophilisation

the fibres in the two fascial grafts should meet crosswise. This method seems to be the most suitable in human subjects, too.



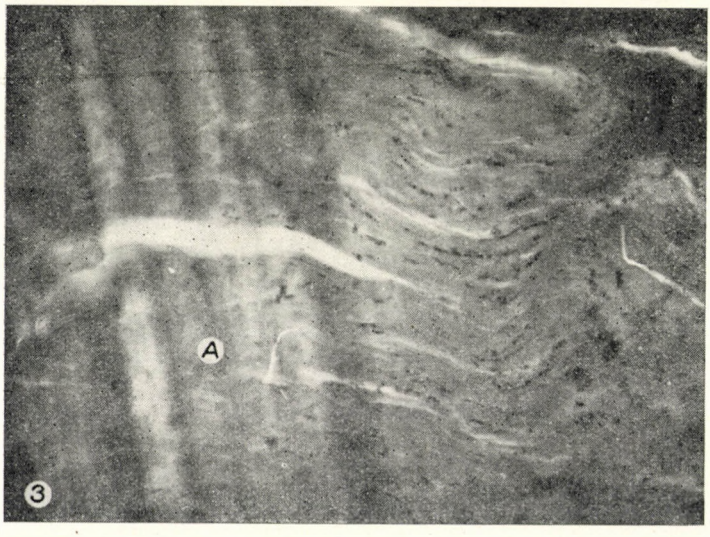
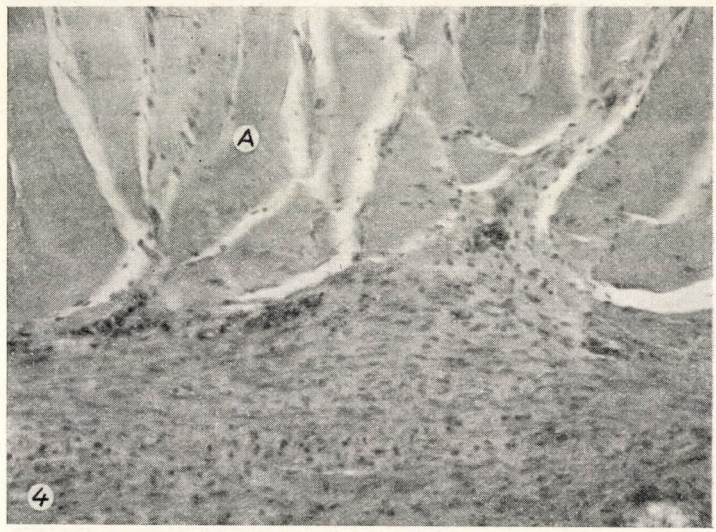


Fig. 2. Histologic appearance of a fascial transplant four days after transplantation. Nuclear staining is absent, the collagen fibres are slightly undulant, a few immigrated leucocytes can be seen

Fig. 3. Histologic appearance of transplant 14 days after transplantation. Fibroblasts have penetrated from the environment between the collagen fibres (A = transplant)

In the experimental animals the surgical wound healed primarily, except in one case in which suppuration due to extrinsic causes resulted. Where primary

wound healing had occurred, no hernia developed later. Twelve animals were killed at intervals from 1 day to 10 months after the operation for examination. The remaining animals are still alive.



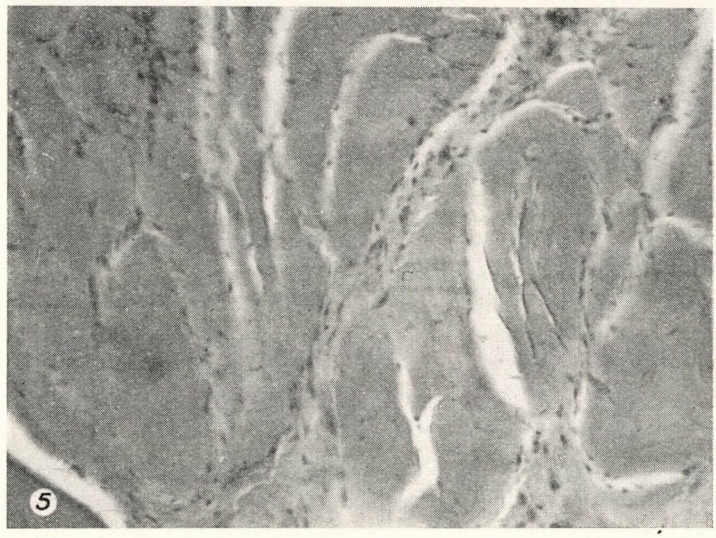


Fig. 4. 3 months following transplantation the transplant can still clearly be distinguished from the adjacent tissues (A = transplant)
Fig. 5. Richly cellular connective tissue septa are visible between groups of collagen fibres in the transplant

In the animals killed during the first 3 months after operation the outlines of the transplant were visible to the naked eye. The fascia was found to be

tense and held well. The outlines of older transplants became more and more indistinct and 6 months after operation they were hardly visible. In the latter cases the border between the fascial transplant and the recipient tissues could be visualised only in serial histological sections.

Histologic studies revealed the following. In the animal killed one day after transplantation the nuclei in the fascial transplant showed no staining. In the animal killed after 4 days the pattern was similar ; the collagen fibres were maintained, slightly undulating (Fig. 2). At sites, there was some round cell infiltration around the transplant. 14 days after transplantation cells have infiltrated between the collagen fibres of the transplant from the adjacent connective tissue and remained in the interfibrillar space (Fig. 3). In the animal killed after 3 months the fascial transplant could still clearly be distinguished from the surrounding tissues (Fig. 4). The transplant was slightly "undulating" in appearance, the collagen fibres were swollen, with occasional homogeneous areas. As compared to the neighbouring tissues, the transplant was poor in cells, but connective tissue septa rich in cells were present between the single groups of collagen fibres (Fig. 5). In these connective tissue septa, and at sites also between the swollen collagen fibres, there were collagen fibres, newly formed vessels growing in from the environment. Foreign body giant cells were not visible either in the transplant, or in its environment, except at the site of the sutures. The transplant was surrounded by young, richly cellular connective tissue with abundant vascularisation (Fig. 6). This connective tissue could sharply be distinguished from the fascial transplant poor in cells and formed an intermediate between the transplant and the muscles of the recipient (Fig. 7). In the animal killed 6 months after transplantation the fascial transplant with the connective tissue septa in it showed a niche-like pattern ; the collagen fibres were not any more swollen (Fig. 8). There was no inflammatory reaction, vascularisation was sufficient, the preperitoneal fatty tissue and the peritoneum under the fascial transplant were normal. The 6 to 10 months old transplants became more and more similar to normal fascia in histological appearance. Thus, the devitalised fascial homotransplant has become "live tissue" again, gradually, over a period of half a year ; in this process, functional stress undoubtedly had its role.

In earlier experiments, PEER [14] proved that the fate of the fresh fascial homotransplant (which has not been preserved and consequently, whose vitality has not been interfered with) is closely similar to what we have outlined above. Here, too, cellular elements soon perish and are replaced by fibroblasts penetrating from the environment.

It is more difficult to form an opinion concerning the fate of the collagen fibres and of the few elastic fibres in the transplant. We do not know of any method that could offer decisive proof regarding this point, so that we are unable to make any definite statement. Attempts have been made to elucidate the

problem by impregnation, because collagen fibres of different ages are known to stain differently, but no decisive proof could be obtained to show that, for example, whether or not 6 months after transplantation the collagen fibres are

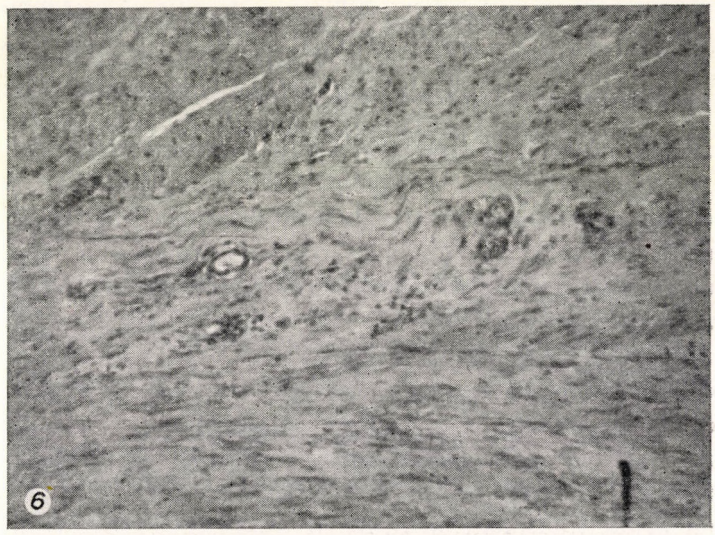


Fig. 6. Richly cellular, abundantly vascularised connective tissue around the transplant (3 months after operation)

Fig. 7. The junction between connective tissue shown in *Fig. 6.* and muscle fibres of the recipient organism (3 months after operation)

identical with the original fibres. It is believed that the process taking place in the fascial transplant is similar to that occurring in homotransplants of bone[3]; the collagen fibres are gradually broken down, but meanwhile new collagen

fibres are produced by the fibroblasts originating from adjacent tissue and the two processes, breakdown and neogenesis, create a dynamic equilibrium making the transplant wholly capable of function. The ability of fibroblasts to produce collagen has been confirmed by WOLBACH [21], STEARNS [16], HAM [10] and by others. HAM has suggested that fibroblast would be capable of producing elastin, too, though this statement is still debated. As far as the success of the operation is concerned, this problem is not at all significant because the trans-

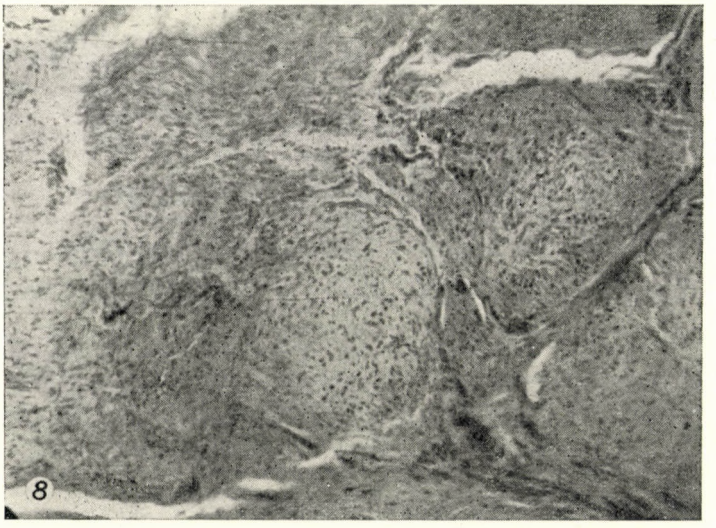


Fig. 8. Histologic appearance of transplant 6 months after transplantation

plant retains its original structure even after reorganisation. Evidence supporting this view has been obtained by CHANDY [5] who over a period of 4 years followed up the fate of fascial strips from cattle after preservation in 70 per cent alcohol, and transplantation into man. After 4 years the transplants were still distinguishable from the recipient tissue, exhibited characteristic structure and had sufficient strength, in spite of the fact that as heterotransplants they were more exposed to the noxious effects of tissue incompatibility than homotransplants. To this should be added the more recent observation made by PEER [14] that the fascial transplant preserved in alcohol elicits severe tissue reaction even when used as a homograft; no such tissue reaction has been caused by lyophilised material in our transplantation series. USHER [19] removed a strip of preserved fascial transplant 37 days after transplantation and found it to be equal in tensile strength to fresh fascial strips, in spite of the fact that at that time reorganisation was well advanced.

On grounds of the above experimental evidence and data in the literature we believe that fascia preserved by lyophilisation is suitable for use as homo-

transplant, so that the patient can be spared the additional operational stress of obtaining the autoplastic fascia.

Fascial transplants can be used in a wide variety of pathologic conditions. Apart from the surgical treatment of hernia, fascial transplants have been employed successfully in arthroplasty, in surgery for rectal prolapse, in muscle paralysis (for example in trapezoid palsy), for the repair of dural, urethral and tracheal defects, for replacing tendon, in the surgical treatment of spina bifida and meningocele, in facial paralysis, in neurolysis for covering the affected nerve, for the external strengthening of aneurysmus of greater vessels, in nephroptosis, in habitual dislocation of the patella and of the humeroscapular joint, in rupture of the liver for preventing incision by sutures, etc.

In our own experiments, lyophilised fascial transplants have been used for repairing defective tendons, as tendineosus, gastric-intestinal suture and for the repair of vascular defects. An account of the latter experiments will be published at a later date.

Summary

Homotransplantation experiments involving the use of fascial grafts preserved by lyophilisation for the repair of artificially created abdominal wall defects in the dog have been described. The results have been satisfactory. Histological examinations showed that although the staining of nuclei soon ceased in the fascial transplant, from the environment fibroblasts penetrated between collagen fibres, revascularisation took place and the transplant became capable of fulfilling the actual functional requirements. On the basis of successful experiments the authors feel justified to recommend the use of preserved homoplastic fascia in the surgical treatment of abdominal or other hernias of excessive size and also in other fields of surgery.

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ГОМОТРАНСПЛАНТАЦИЯ ФАСЦИИ, КОНСЕРВИРОВАННОЙ ЛИОФИЛИЗАЦИЕЙ

ДЬ. БОРНЕМИСА, Г. БАКО и Л. ФАРКАШ

Авторы излагают свои эксперименты гомотрансплантации, проведенные фасцией, консервированной путем лиофилизации. В ходе своих опытов они замещали вызванный у собак дефект брюшной стенки таким способом. Их результаты оказались удовлетворительными. Гистологические исследования выявили, что окраска ядер прекратилась в фасции за короткое время, но из окрестности врастали фибробласты в промежутки между коллагенными волокнами, в трансплантате произошло вторичное образование сосудов, причем он полностью исполнил возложенные на него функциональные задачи. На основании результатов своих экспериментов авторы рекомендуют применение консервированной гомопластической фасции при оперативном лечении грыж брюшной стенки или прочих грыж, а также и в других областях хирургии.

HOMOTRANSPLANTATION DE FASCIA CONSERVÉ PAR LYOPHYLISATION

GY. BORNEMISZA, G. BAKÓ et L. FARKAS

Les auteurs rendent compte de leurs expériences concernant l'homotransplantation de fascia conservé par lyophylisation dans les solutions de continuité de la paroi abdominale du chien. Les resultats étaient satisfaisants. Les examens histologiques montrent que les noyaux du fascia transplanté sont devenus incolorables, que des fibroblastes des tissus environnants se sont glissés parmis les fibres collagènes et que la transplantation revascularisée était apte a remplir entièrement les fonctions qui lui incombaient. Se basant sur les résultats de leurs experiences, les auteurs recommendent l'utilisation du fascia homoplastique conservé dans les hernies de la paroi abdominale, dans le traitement chirurgical d'autres hernies étendues, ainsi que dans d'autres domaines de la chirurgie.

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