ALLOPLASTIC CLOSURE OF DEFECTS IN GROWING ORGANISMS*

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The importance of operative correction of congenital and acquired defects of the diaphragm has been well demonstrated by the numerous articles published on this subject over the past 30 years. The site and size of the diaphragmatic defect will seldom prevent primary closure; when it does, different methods of plastic repair can be employed (Gross, 1911; Sauerbruch, 1928; Rehn, 1919; Rives and Baker, 1942). Some have suggested muscle flaps for the closure, while others have tried to close defects by interposition of different organs.

Monahan (1951) and Quénu and Herlemont (1953) independently initiated the use of synthetic material in diaphragmatic surgery, and these synthetics have been tried in animal and in clinical experiments.

In contradistinction to the closure of abdominal and chest wall defects, the synthetic material for closure of diaphragmatic defect is in contact with body tissues only at its edge. Even if we assume that the lung in the chest, and the liver and omentum

in the abdomen, become adherent to the plastic material, the ingrowth of tissue fibres will take a much longer time than it does in primary closure.

The prosthesis has to suffer constant tension both from the tone of the diaphragm itself, and from the continuously changing pressure and tension resulting from the movement of the diaphragm and the

(b) Dacron net. ($\times 60$).

FIG. 1—(a) Teflon net (Harrison mesh). ($\times 60$).

(c) Marlex net. ($\times 60$).

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FIG. 2.—(a) Teflon mesh with very tight interlocked stitches. (b) Porous 'teflon' mesh.

nighbouring organs. The tension on the sutures may increase very much during active increase of abdominal pressure: 100 to 160 mm. Hg within the abdomen and up to 200 cm. H₂O (150 mm. Hg) in the rectum have been measured.

Material and Methods

We used 47 young pigs weighing between 30 and 45 kg. in the experiments. Artificial defects of varying sizes

from 3×4 cm. to 8×11 cm. were created in the left diaphragmatic vault. For the creation of larger defects the phrenic nerve had to be sacrificed. Atrophy of the affected vault invariably followed. The defects were closed with prosthesis of 'teflon', 'dacron' and 'marlex'.

The porous knitted prosthesis, I have termed net, and the tight knitted prosthesis, mesh. I used 'teflon', 'dacron' and 'marlex' as net, and had two additional types of 'teflon' mesh, a tight one and a porous one.

FIG. 3a.—Tight knitted 'teflon' mesh, size 7.0×10.5 cm.

FIG. 3b.—Autopsy specimen five months later shows good healing.

FIG. 4a.—Cross-section of tight 'teflon'. Note the more intensive development of fibrous tissue on the chest side of the prosthesis.

FIG. 4b.—Cross-section of a 'dacron' net prosthesis shows a thicker layer of fibrous tissue on the pleural side. The prosthesis is ruptured on the left side.

FIG. 4c.—Cross-section of 'marlex' net, showing inadequate healing.

FIG. 5a.—Microscopic view of a cross-section through tight 'teflon' mesh. On the upper border there is the synthetic material, followed by a thick layer of collagen tissue and then sub-pleural tissue with many blood vessels. The pleura itself is recognized by its elastic fibres. ($\times 50$.)

FIG. 5b.—The abdominal part of the same prosthesis. Here the layer of collagen tissue is not so thick. At the foot of the figure is a part of the liver. ($\times 50$.)

FIG. 6.—'Teflon' mesh cross-section ($\times 140$). Around each string of the plastic material thin tissue fibres are twisted. On the left there are foreign body giant cells.

Results

The Figures illustrate the results, which show that 'teflon' and 'dacron' are superior to 'marlex' in the healing process. The meshes with very high porosity, which I called net, do not withstand the mechanical strain, and they burst; in addition, they do not give the fibrous tissue a sufficient skeleton upon which to build a strong capsule.

Tight meshes prevent the development of strong fibrous tissue cords, which should connect the two layers of the fibrous tissue on the surface of the prosthesis.

For the use of synthetic material in diaphragmatic surgery we need meshes that have a higher porosity than the one used by us, but not as wide as net.

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FIG. 7.—Microscopic view of 'marlex' net: loose fibrous tissue and multiple cell reactions.