Treatment of Aortic Aneurysms by Wrapping with Foreign Body*

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The distorted anatomy, invasive tendencies, large size, and friable thin walls of both syphilitic and arteriosclerotic aortic aneurysms contraindicate any attempt at extensive surgical manipulation in the form of resections and anastomoses of these aneurysms. The pounding, pulsating pressure exerted by these aortic dilatations presents an almost malignant tendency to invade and penetrate any adjacent soft tissue. Even the walls of the bony thorax can be eroded by an expanding pulsating aneurysm.

The intense foreign body reaction produced by cellophane and impure polythene film with its constricting fibrosis seems to offer the simplest and most satisfactory method of at least curbing the expansion of these aneurysmal dilatations. This possibility was suggested by the report of Harrison and Chandy1 who had gradually eliminated two arteriovenous aneurysms of the subclavian vessels by cellophane. Harrison's clinical application of the material resulted from the report of Pearse,2 who had demonstrated the ability of cellophane to produce gradual obliteration of the lumen of important blood vessels, such as the internal carotid, in the place of the previously devised and somewhat unsatisfactory clamps and bands. This constricting property of cellophane had been demonstrated originally by Page,3 who used it in 1939 to produce artificial nephritis and hypertension in dogs by wrapping it around the kidneys.

A dilemma arose, however, from the reports of McKeever4 and others that cellophane produced no reaction and was suitable for reconstructing tendon sheaths and lining joint spaces. An experimental study was undertaken at Washington University School of Medicine with several chemically different varieties of cellophane and plastic material, supplied through the courtesy of the DuPont de Nemours Company of Wilmington, Delaware. The results of this investigation published in greater detail elsewhere,5 suggested that a new impure plastic known as Polythene film produced the most intense foreign body reaction, whereas some of the other types produced little if any reaction. This fibrotic

reaction produced by the impure polythene film was somewhat surprising since it was supposed to have been chemically inert. Considerable confusion has arisen during the past year since Ingraham, Alexander and Matson reported pure polythene especially refined for medical use to be physiologically inert and suitable for covering exposed brain tissue. This was not the result observed by Renault and myself in our animal experiments with impure polythene film supplied by the DuPont Company (Figs. 1, 2 and 3). Hasty comparison of results with other experimental research workers in various parts of the country indicated that four other groups had obtained definite scar tissue formation from the use of impure polythene film obtained from the DuPont Company. Several others are still carrying on animal experiments but do not have their final results available as yet. Yaeger and Cowley recently reported their experimental results at the American Surgical Association Convention in Quebec in which the contaminant dicetyl phosphate present in the DuPont polythene film was found to be the irritating factor. It is hoped that polythene film with an even greater percentage of dicetyl phosphate can be obtained for further experimental work to create a more intense reaction and fibrosis.

Impure polythene film was selected, therefore, to wrap aneurysms of the thoracic aorta to induce an intense foreign body fibrous tissue reaction around the aneurysm, thereby preventing its further expansion and rupture.

**Operative Technique**

The patient is placed on the side opposite the aneurysmal dilatation of the thoracic aorta using endotracheal ether and oxygen. Through a para vertebral incision extending around the angle of the scapula, the entire length of the fifth or sixth rib is resected and the pleura opened through the bed of the resected rib. The lung is retracted and the mediastinal pleura dissected free from the aneurysm, exposing as much of the surface of the diseased aorta as can be safely freed without danger of rupture. It is frequently impossible to free the entire circumference of the descending aorta because of beginning erosion of the vertebrae and ribs around the origins of the intercostal vessels. The pleura may be too attenuated and adherent over the thin bulging areas to permit its complete removal. A sheet of impure polythene film is then cut to fit the dilated portion of aorta without extending over adjacent normal structures. This film is then sutured loosely to any suitable mediastinal tissue with fine silk sutures, care being taken not to pass any sutures directly into the wall of the aneurysm.

One other saccular aneurysm of the ascending aorta was ex-
SUMMARY OF RESULTS

Polythene film was used to wrap or patch the nine syphilitic aneurysms of the thoracic aorta reported below.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Place</th>
<th>Type</th>
<th>Location</th>
<th>Symptoms</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>W.W.</td>
<td>Barnes Hosp., St. Louis, Mo.</td>
<td>Fusiform</td>
<td>Descending aorta</td>
<td>Pain anterior and posterior chest</td>
<td>Complete relief of pain 1 yr. later</td>
</tr>
<tr>
<td>2.</td>
<td>L.P.</td>
<td>Colored City Hosp., St. Louis, Mo.</td>
<td>Saccular</td>
<td>Ascending aorta</td>
<td>Pain anterior chest and weakness</td>
<td>Cannot be traced, believed dead</td>
</tr>
<tr>
<td>3.</td>
<td>J.E.</td>
<td>Barnes Hosp., St. Louis, Mo.</td>
<td>Saccular and fusiform</td>
<td>Ascending aorta and innominate</td>
<td>Chest pain and weakness</td>
<td>Relief of pain but tires easily</td>
</tr>
<tr>
<td>4.</td>
<td>D.H.</td>
<td>White City Hosp., St. Louis, Mo.</td>
<td>Saccular</td>
<td>Ascending aorta</td>
<td>Cough and pain anterior chest</td>
<td>Cannot be traced, believed dead</td>
</tr>
<tr>
<td>5.</td>
<td>F.K.</td>
<td>Good Samaritan Hosp., Portland, Oregon</td>
<td>Fusiform</td>
<td>Descending aorta</td>
<td>Cough and chest pain</td>
<td>Relief of chest pain, died, hemorrhage esophagus 1 ½ yrs. later</td>
</tr>
<tr>
<td>6.</td>
<td>W.H.</td>
<td>Veterans' Hosp., Portland, Oregon</td>
<td>Fusiform</td>
<td>Distal arch and descending aorta</td>
<td>Chest pain</td>
<td>Relief of pain</td>
</tr>
<tr>
<td>7.</td>
<td>J.L.</td>
<td>County Hosp., Portland, Oregon</td>
<td>Fusiform</td>
<td>Distal arch and descending aorta</td>
<td>Chest pain, chronic cough, Hemothyses and dyspnoea</td>
<td>Died, hemoptysis</td>
</tr>
<tr>
<td>8.</td>
<td>C.E.</td>
<td>Veterans' Hosp., Portland, Oregon</td>
<td>Saccular and fusiform</td>
<td>Ascending aorta</td>
<td>Anginoid pain on exertion</td>
<td>Moderate relief of pain, increased exercise tolerance</td>
</tr>
<tr>
<td>9.</td>
<td>A.J.</td>
<td>St. Vincents Hosp., Portland, Oregon</td>
<td>Saccular and fusiform</td>
<td>Distal arch</td>
<td>Posterior chest pain and dysphagia</td>
<td>Died, hemorrhage 3 months later</td>
</tr>
</tbody>
</table>
explored at the Portland Veterans' Hospital but found unsuitable for wrapping due to erosion of the anterior chest wall and inability to dissect away the superior vena cava which was imbedded in the aneurysm wall. Several other patients have been considered unsuitable for surgery either because of severe cardiac decompensation or obstruction of the left main bronchus by pressure from the aneurysms.

Four of the nine patients whose aneurysms were reinforced by polythene have already survived from one to three years with moderate to complete relief of symptoms of pain in all cases. A period of from three to six months was required to obtain maximum benefit in most patients. Little if any improvement has been noted in strength, although the relief of pain has permitted one patient to return to full time employment and the other three to increase their activities. The patient who died of rupture of his aneurysm into the esophagus one and one half years after wrapping had obtained considerable relief of his pain and resumed light work six months after his operation.

Comments

Relief of the throbbing, pulsating anterior chest pain or the constant dull ache in the back appears to be the most gratifying result of wrapping these intrathoracic aortic aneurysms. Although the original purpose of the procedure was to patch or reinforce weakened artery walls and prevent or delay their rupture, the patients frequently seem more concerned about their immediate symptoms. The one patient who has been examined at autopsy one and one half years after wrapping his aneurysm failed to show any actual shrinking of the aneurysm cavity, although the vessel wall was thickened by a layer of fibrous tissue on both sides of the polythene film. The lack of any decrease in size of the X-ray shadows is to be expected from the pathologic reaction noted in animals in which a thick layer of dense scar tissue is deposited on both sides of the film.

Fusiform aneurysms of the descending aorta offer more favorable opportunities for successful reinforcing with impure polythene than the saccular aneurysms of the ascending aorta and its arch for the following reasons. They are more accessible with less important branches and adjacent vital structures offering a wider surface for covering. They are more apt to produce pain which can be relieved by wrapping. The incidence of cardiac involvement with aortic insufficiency and decompensation appears to be lower in this group.

An obstruction of one of the main bronchi or encroachment on the trachea presents an absolute contraindication to surgery.
Figure 1 and 2 together: Preoperative chest x-rays of J. E. No. 3, with saccular syphilitic aneurysm of ascending aorta, which was wrapped with polythene film two and one half years ago. This patient is still alive without chest pain although the aneurysm was about to involve the anterior chest wall at the time of operation. Figure 3: Preoperative bronchogram on J. L. No. 7, with saccular syphilitic aneurysm of distal arch of aorta. Bronchogram failed to show obstruction of left main bronchus indicating suitability for surgery.
Severe cardiac decompensation with insufficiency of the aortic valve or erosion of the anterior chest wall both preclude any very satisfactory end result from the procedure even though the patient may withstand the immediate surgery. Arteriosclerotic aneurysms of the abdominal aorta also can be reinforced satisfactorily with impure polythene provided the disease has not already interfered with the circulation of the lower extremities.

CONCLUSIONS

1) Commercial unrefined polythene film has been shown experimentally to produce an extensive fibrous tissue proliferation when placed within the body.

2) This irritative reaction is apparently due to chemical substances added to the pure polythene during its processing.

3) This fibrous tissue reaction of polythene can be employed to reinforce the weakened vessel walls of aneurysms.

4) Nine patients whose intrathoracic aneurysms have been wrapped or patched with polythene are reported.

5) Five of the patients survived for one to three years after surgery with varying degrees of improvement in their symptoms.

6) Four of the patients are still alive, the others having succumbed to their disease.

CONCLUSIONES

1) Se ha demostrado experimentalmente que películas de politena comercial no refinada producen una proliferación extensa del tejido fibroso cuando se las coloca dentro del cuerpo.

2) Aparentemente se debe esta reacción irritante a sustancias químicas que se añaden a la politena pura durante su preparación.

3) Se puede utilizar esta reacción fibrosa de la politena sobre los tejidos para fortalecer las paredes debilitadas de aneurismas de vasos sanguíneos.

4) Se informa sobre nueve pacientes cuyos aneurismas intratorácicos han sido envueltos en politena o remendados con esta substancia.

5) Cinco de los pacientes sobrevivieron de uno a tres años después de la operación con varios grados de mejoría de sus síntomas.

6) Cuatro de los pacientes viven todavía, mientras que los otros han muerto de su enfermedad.

REFERENCES


Discussion

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It is a great pleasure to discuss Dr. Poppe's paper because I have many pleasant memories of working with him and it was his work that instigated my interest in the subject. I would like to emphasize that I think both our interests were fundamentally aroused in this subject by Dr. Evarts Graham. This work is still in an experimental phase. It has been our policy to consider that experimental surgery must be done essentially on hopeless cases. The individuals on whom we have done this work in Atlanta have, in the main, been patients who came in with the diagnosis of cardiac decompensation or pneumonia in one or both sides. These are the patients Dr. Poppe mentioned as being non-candidates for the operation. They have been our main candidates and we have learned many things from them.

I would particularly like to emphasize the statement of over-soaking in alcohol as we had a sad experience of no reaction at all from the material used after it was soaked too long a time. The boiling method is much better. A few slides will show how we have attacked this problem much of which is purely experimental surgery on the hopeless case. In many cases we have been pleased, in others we have been most displeased, and we feel there is much more to learn about the problem. Certainly in our experience of following up patients who have had partial wrapping of the aneurysms, the results have been quite poor; only 40 per cent of them have had relief of pain and the majority of them that we have had a chance to follow have ruptured the aneurysm within one or two years after the operative procedure. We now make it a routine method, that whenever we wrap an aneurysm incompletely there is concomitant internal wiring of the aneurysm. We have now operated on 32 patients, in whom the aneurysm has been wrapped, and there have been six more in whom decompression has been done, many of whom have felt so well that they have refused further surgery and have thus given us