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Chest wall reconstruction after resection of recurrent breast tumours

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A series of 13 chest wall resections for recurrent breast tumours are reported, the defects being closed by synthetic prostheses. In nine patients the prostheses were covered by a latissimus dorsi flap, while in the last eight patients a rigid 'shield' prosthesis of methyl methacrylate was used, and a stable chest obtained. Mechanical ventilation for more than 24 h was not required in those patients in whom a shield was used.

Reconstruction after chest wall resection using prosthetic materials and myocutaneous flaps, is now recognised as an invaluable method of treating tumours of the chest wall. These procedures, which were previously undertaken by combined plastic/thoracic units are now within the scope of the general surgeon.

We report a series of 13 chest wall reconstructions. The defects were the result of resections for recurrent tumours of the breast—carcinoma in 12 cases and cystosarcoma phylloides in one. The resections ranged from three costal cartilages to excision of the body of the sternum and 12 costal cartilages (six on each side). Reconstructions were performed initially using prolene mesh alone, but in the last eight cases a 'shield' prosthesis of methyl methacrylate cement sandwiched between two sheets of prolene mesh was used (Fig. 1). These prostheses were all covered with a latissimus dorsi myocutaneous flap.

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Materials and methods

Thirteen patients had a chest wall resection for recurrent disease, nine having been previously irradiated and eight having had a mastectomy. All these patients had the tumour resected with a surrounding margin of 3 cm of normal tissue, taking the pectoral muscles plus underlying costal cartilages and pleura in continuity.

In five patients the operation involved a mastectomy. In the last nine patients a latissimus dorsi myocutaneous flap reconstruction was used to cover the defect.

Six patients had resections of three or four ribs only (Type I, Fig. 2). In four cases the chest wall resection necessitated removing the sternocostal joints and hemisection of the body of the sternum in the sagittal plane, with resection of half of the body of the sternum; this was required because the disease was coming through from the underlying involved internal mammary lymph nodes (Type II). In two patients the whole of the body of the sternum was excised, together with costal cartilages on each side (Type III).

In one patient, five costal cartilages were excised and in another all 12 costal cartilages were resected with the

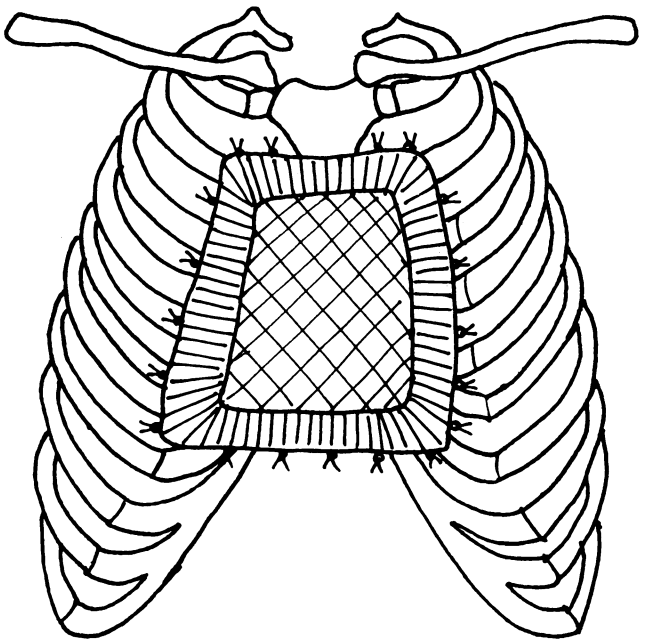

Figure 1. Construction and placement of the shield.

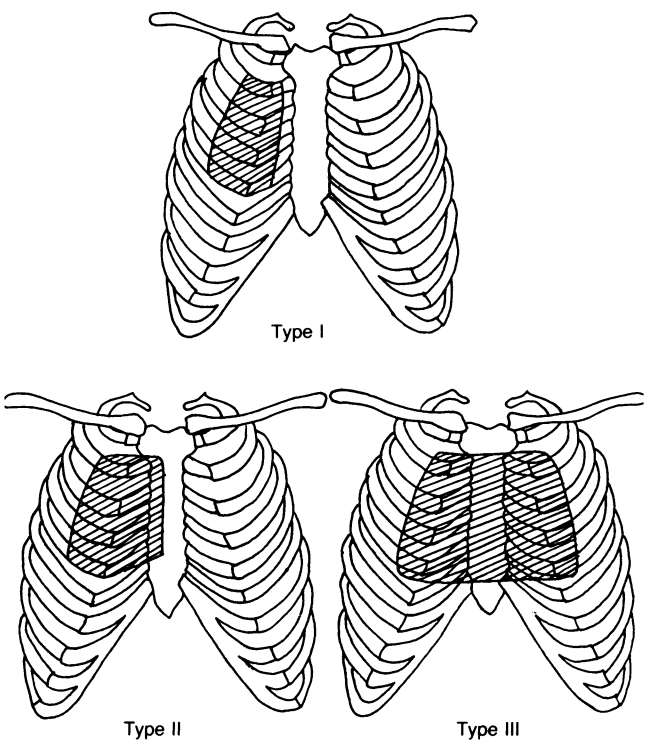

Figure 2. Three types of chest wall resection.

sternum. In all patients the manubrium and first ribs were preserved.

Chest drains were inserted in all patients and ventilation was continued postoperatively if the respiratory function was considered by the anaesthetist to be inadequate. Broad spectrum antibiotic cover was given pre- and postoperatively.

One patient (number 1, Table I) experienced difficulty 7 years after insertion of a Marlex® mesh, with exposure of the mesh. This was replaced by prolene mesh, and cover was obtained with a latissimus dorsi flap.

All operations were performed by the senior author (AGN).

Results

The individual details and results of the 13 chest wall reconstructions are given in Table I.

There were no operative deaths. There were four long-term survivors after these salvage operations, the longest being alive and disease-free 14 years after removal of the sternum and three costal cartilages for recurrent breast carcinoma. Four other patients lived for 5 years or more.

The seven patients treated by insertion of a 'shield' did not require ventilation for more than 24 h, while the six patients treated by mesh alone required ventilation for 1–10 days (mean 5 days).

One patient (Figs. 3 and 4) had 12 costal cartilages plus sternum excised. This was the largest resection of this series, the resulting defect being approximately 300 cm^2 in area. The defect was closed using a shield prosthesis covered with a latissimus dorsi myocutaneous flap.

Discussion

Minor chest wall defects can be closed by approximation of peripheral tissues after local mobilisation. Wide defects may require reconstruction with autogenous grafts, prosthetic materials or a combination of the two.

The ideal prosthetic material would be inert, malleable so as to enable sculpting to the size and shape of the defect, and rigid to avoid paradoxical respiration *(1)*. Early attempts at closing thoracic defects using metal prostheses were described by Gandolphe in 1909 *(2)*. Subsequent reports describe the use of tantalum mesh *(3)*. Complications of this technique included pain, haemorrhage, seroma formation, infection and fragmentation of the mesh with sinus formation. In 1957, Hardin and Harrison *(4)* described the use of Teflon®, preformed Lucite plates and fibreglass cloth in chest wall reconstructions. However, none of these materials completely satisfied the criteria for an ideal prosthetic material.

The use of Marlex mesh was first described by Graham *et al. (5)* in 1960. This material, which is more inert than Dacron®, Orlon® and nylon, is still widely used. It is strong, and may be stretched across a defect to impart

Table I. Data for individual patients

Case	*Year*	*Age*	*Diagnosis*	*Previous treatment*	*Resection*	*Reconstruction*	*Days ventilated*	*Outcome*	*Survival (years)*
1	1976	28	Carcinoma	Lumpectomy and RT 1973 Recurrence, radionecrosis 1976 Chest wall resection 1976	Half body of sternum and 3 ribs*	Marlex mesh	10	Marlex mesh exposed 1983. Reconstructed 1983 with prolene mesh and LD† flap Alive and well	14
2	1977	51	Carcinoma	Mastectomy 1974 Recurrence 1977	Half body of sternum and 3 ribs	Prolene mesh	7	Died 1982 of disseminated tumour	5
3	1978	42	Carcinoma	Mastectomy 1976 Recurrence 1978	4 ribs	Prolene mesh	10	Died 1980 of disseminated tumour	2
4	1981	50	Carcinoma	Lumpectomy and RT 1977 Recurrence 1978: wide excision Recurrence 1981	4 ribs	Prolene mesh	5	Died 1987 of disseminated tumour	6
5	1982	49	Carcinoma	Mastectomy 1979 Recurrence 1980: radiotherapy Recurrence 1982	3 ribs	Prolene mesh	7	Died 1987 of disseminated tumour	5
6	1982	53	Carcinoma	Lumpectomy and RT 1977 Recurrence 1979: mastectomy Recurrence 1982	4 ribs	Shield and LD flap	0	Died 1984; cause unknown	2
7	1983	60	Carcinoma	Mastectomy and RT 1975 Recurrence 1983	Half body of sternum and 4 ribs	Prolene mesh and LD flap	1	Alive (with bone metastases)	7
8	1984	53	Carcinoma	Lumpectomy and RT 1980 Recurrence 1982: chemotherapy Recurrence 1984	Body of sternum plus 3 ribs on right and 2 ribs on left	Shield and LD flap	1	Died 1986 of disseminated disease	2
9	1984	39	Cystosarcoma phylloides	Lumpectomy 1982—'benign' Recurrence 1983: mastectomy Recurrence 1984	Half body of sternum and 5 ribs	Shield and LD flap	0	Died 1987; mediastinal recurrence	3
10	1985	56	Carcinoma	Radiotherapy 1982 Recurrence 1984: excision + LD flap Recurrence 1985	Sternum plus 6 ribs on each side	Shield and LD flap (300 cm^2)	0	Died 1987 of recurrent disease	2
11	1985	54	Carcinoma	Mastectomy 1974 Oophorectomy; adrenalectomy 1976 Recurrence 1982; RT‡ Recurrence 1985	3 ribs	Shield and LD flap	0	Died 1988 of recurrent disease	3
12	1986	49	Carcinoma	RT and chemotherapy 1985 (for locally advanced tumour) Recurrence 1986	4 ribs	Shield and LD flap	1	Alive and well	4
13	1987	38	Carcinoma	Mastectomy and RT 1986 Recurrence 1987: chemotherapy	Half body of sternum and 5 ribs	Shield and LD flap	0	Died 1989 of recurrent disease	2

* The word 'rib' is used for brevity; in most cases the element resected was costal cartilage
† LD flap: latissimus dorsi myocutaneous flap cover for the shield
‡ RT radiotherapy

some stability. Like other prosthetic implants it predisposes to seroma formation and may become infected; an event which invariably requires removal of the prosthesis.

More recently, Vicryl® mesh has been used for reconstruction, with omental transposition and split-skin grafting *(6)*. This results in a lower incidence of wound infection, but because of dissolution of the mesh this type of reconstruction does not impart long-term stability. Hence, it is unsuitable for the closure of large defects.

Grosfeld *et al. (7)* describe the use of a Gore-tex® patch for reconstruction of chest wall defects in children following the extirpation of malignant lesions. Like Marlex, it permits incorporation of tissue but it is softer, is easier to use and has less tendency to fragment.

Monofilament synthetic suture materials may be less likely to be associated with protracted infection than braided multifilament material *(8)*. Prolene mesh, constructed from monofilament polypropylene, has been utilised by Arnold and Pairolero in a series of chest wall reconstructions *(9,10)*. They concluded that for full thickness chest wall defects where primary closure is impossible, prolene mesh or 2 mm polytetrafluoroethylene (PTFE) patches, with muscle transposition, was the treatment of choice. They emphasised the importance of inserting the prosthesis under tension to increase the rigidity of the repair, suggesting that further rigidity was not required. In their study, a mean of 5.4 ribs per person were resected, with, in some patients, partial or total sternectomy. A similar study involving excision of a mean of 3.1 ribs also emphasises the importance of tension in the mesh to prevent paradoxical respiration, and suggests that in larger defects a mesh alone may not be adequate and a lengthy period of mechanical ventilation is essential before the chest is completely stable *(11)*.

Attempts to mould rigid 'shields' for chest wall prostheses were first described in 1971. The prostheses were formed from acrylic resin *(1)* or methyl methacrylate sandwiched between two layers of metal or Marlex mesh

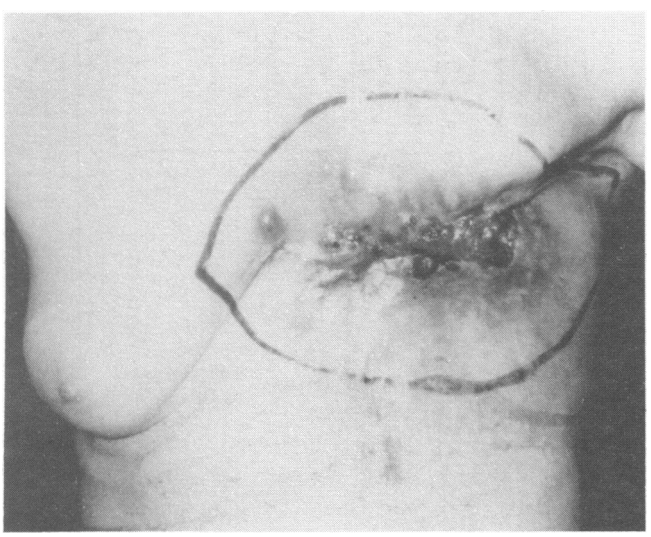

Figure 3. Illustrates local tumour recurrence after mastectomy for carcinoma. The proposed line of resection is marked.

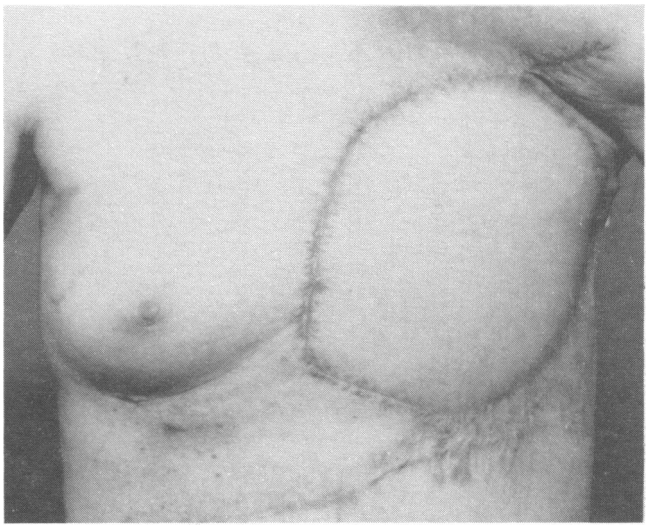

Figure 4. Illustrates the result obtained in this case, cover being achieved using a latissimus dorsi flap.

(12). The result was a biologically inert prosthesis which was malleable until polymerisation was complete. This allowed contouring of the prosthesis to follow the curvature of the chest wall. The final result is a rigid moulded prosthesis, so that the chest wall is stable and long periods of ventilation are unnecessary. The mesh was cut larger than the methacrylate plate to allow securing of the prosthesis by direct suture to adjacent ribs and facia. In this way, massive defects could be closed, thus permitting successful treatment of more extensive tumours *(13)*. The size and shape of the prosthesis can be estimated by using a taut dry gauze to spread over the wound; the resulting pattern of red on white provides a template. The contouring can be performed using another part of the body, such as the anterior thigh, as a mould *(14)*.

The use of synthetic materials in contaminated wounds is not recommended *(10)*. However, in our experience, dealing with ulcerated infected tumours, infection of the prosthesis has not been a problem when myocutaneous flap cover is established.

In order to obtain successful skin closure, a myocutaneous flap is required to cover these prostheses. Various flaps have been used to repair thoracic wall defects, both with and without prosthetic materials. Omental flaps, which provide a good blood supply and mould well to the chest wall, have been widely used *(15)*. However, they give little structural support, necessitate a laparotomy, and are cosmetically unacceptable. The myocutaneous flap most suitable for chest wall reconstruction is the latissimus dorsi flap *(16)*. Adaptations of this technique include the use of lateral or medial segments, or reversal, and use as a free flap. Rectus abdominis flaps *(17)*, pectoralis major flaps *(18)* and, in individual circumstances, any of a variety of more complex flaps *(19–22)*, have been used. Factors dictating the choice of flap include the site, size and thickness of the defect. Damage to a proposed flap or its vascular pedicle by tumour, surgery, or radiotherapy will also influence the choice. The latissimus dorsi flap is probably best, whenever it

can be used, as the shape of the muscle, its size and the nature of the vascular pedicle are ideal for chest wall reconstruction. Very large areas of skin can be utilised in this way, the posterior defect being covered by a split-skin graft if primary closure is not possible.

We describe the use of prostheses formed from methyl methacrylate sandwiched between two sheets of prolene mesh, with latissimus dorsi myocutaneous flap cover, performed as a single-stage procedure, for restoration of mechanical continuity of the thoracic cage after chest wall resection. We suggest that the application of this technique need not be restricted to specialist surgical units. The use of the rigid 'shield' prosthesis has made prolonged mechanical ventilation unnecessary, so reducing the morbidity of the procedure.

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Assessor's comment

The techniques of full-thickness chest wall reconstruction have improved greatly in the last 10 years with widespread use of a variety of axial, myocutaneous and free flaps. Although patients will tolerate moderate chest wall deficits without a rigid component, it is clearly preferable to have rigid stability if this is possible. The authors present a technique which seems simple and effective and has given reliable results. They reported 13 patients with recurrent breast tumours, nine after previous irradiation. The indications could undoubtedly be extended with benefit to primary tumours (particularly soft tissue sarcomas) and radionecrosis. All too often