A Novel Clinical Application of the Classical Bakamjian Flap in the Reconstruction of a Sternal Chondrosarcoma Defect

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Abstract The deltopectoral flap also called the Bakamjian flap was originally described as a two-stage procedure for pharyngoesophageal reconstruction following laryngopharyngectomy. It became the “workhorse” flap for head and neck reconstruction in the 1960s, but its popularity gradually faded with the introduction of pedicled myocutaneous flaps and subsequently microvascular free flaps. However, the technical simplicity of raising the Bakamjian flap along with its predictable vascular supply has ensured that the flap continues to remain as a time-tested salvage option in head and neck reconstruction. The use of this flap for sternal reconstruction, to the best of our knowledge, has not been described before. We present a rare case of a primary sternal chondrosarcoma and discuss its management challenges and also present, possibly for the first time, a novel application for the well-described Bakamjian flap in this setting as a single-stage procedure.

Keywords Deltopectoral flap · Bakamjian flap · Sternal chondrosarcoma · Sternal reconstruction

Chondrosarcomas are a heterogeneous group of malignant mesenchymal tumours derived from a cartilaginous origin. These tumours are generally known to involve the pelvis and the long bones. They account for about 20 % of the primary tumours of the chest wall, of which 20 % are believed to arise from the sternum [1]. Although chondrosarcoma is a commonly described malignant tumour of the chest wall and sternum, its relative occurrence is rare. We present a case of a primary sternal chondrosarcoma and discuss its management challenges and also present, possibly for the first time, a novel

application for the well-described Bakamjian flap in this setting.

A 68-year-old male without any comorbid illness was referred to our centre for evaluation of a progressively enlarging swelling of his anterior chest wall for over a year. Clinical examination revealed a mildly tender, well circumscribed, 5×4-cm bony swelling in relation to the middle third of the sternum, 3 cm below the sternal notch. There was no significant axillary adenopathy. A chest X-ray and a subsequent computerised tomography of the chest revealed a 5×4×7-cm expansile lytic lesion involving the middle third of the sternum and the adjoining left fourth and fifth costochondral junctions with a large soft tissue component on either sides of the sternum, reaching up to the pericardium posteriorly and up to the skin anteriorly. The pulmonary parenchyma was however normal (Fig. 1a). A bone scan revealed an isolated hot spot in the sternum corresponding to the lytic lesion, as visualised on the CT scan (Fig. 1b). A trucut biopsy from the mass lesion revealed a tumour composed of lobules of atypical cartilage cells, suggesting a diagnosis of chondrosarcoma grade I. A radical en bloc resection of the sternal lesion preserving the manubrium and the xiphoid was subsequently performed; which resulted in a large full thickness skin, soft tissue and bony defect (Fig. 2a, b). The resultant bony defect was bridged with a double layer of polypropylene mesh which was reinforced with a mould of methyl methacrylate. The skin and soft tissue defect was bridged using the medial deltopectoral flap, an axial-pattern skin flap based on the perforating branches from the internal mammary artery (Fig. 2c, d). The final histopathology confirmed the diagnosis of a chondrosarcoma, resected with clear margins. The patient had an uneventful recovery and continues to remain on follow-up without any evidence of recurrence close to 1.5 years following surgery (Fig. 3a, b). Chondrosarcomas are known to occur in adult men; the peak incidence is between the ages 50 to 70. This tumour appears as a

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Fig. 1 **a** Axial section of the CT chest showing a 7×5×4-cm expansile lytic lesion involving the middle third of the sternum and the adjoining left fourth and fifth costochondral junctions. **b** Bone scan revealed an isolated hot spot in the sternum corresponding to the lytic lesion, as visualised on the CT scan

radiolucent mass originating from the medullary region of the bone and is usually associated with cortical destruction and stippled calcification. Surgery in the form of radical en bloc excision and immediate reconstruction is the key to the management of primary sarcomas of the sternum [2–7]. Surgery alone is potentially curative in a majority of the cases, with the 10-year survival rate approaching 97 %. The size and location of the tumour determine the extent of the resection; lesions of the middle third of the sternum are managed by radical resection of the body of the sternum, and an attempt to preserve the manubrium and the xiphoid process is made in order to provide partial stability to the chest wall.

Sternal resection can potentially result in large defects requiring complex reconstructions and various reconstruction techniques using prosthetic or homologous materials that have been described [2–7]. Skeletal reconstruction is considered not necessary for defects <5 cm in diameter. Reconstruction of the upper sternum (the manubrium with ribs 1 to 3) can be performed using muscle flaps alone; in contrast, resection of the lower sternum frequently requires rigid skeletal fixation so as to protect the heart and stabilise the bony thorax. Chest wall stability is generally

achieved by reconstruction of skeletal defect with synthetic meshes such as polypropylene or polytetrafluoroethylene (Marlex) with or without methyl methacrylate reinforcement. The other options include the titanium meshes and metallic implants and the use of allografts [4–6]. A double-layer polypropylene mesh with methyl methacrylate reinforcement was used to achieve chest wall stability in our patient [4].

An extensive full thickness resection generally precludes a primary closure; regional myocutaneous flaps like the latissimus dorsi, rectus abdominis, pectoralis major, external oblique and omental flaps have been used to achieve a skin and soft tissue cover [5, 6].

The thoracodorsal vessel-based latissimus dorsi flap, more commonly used for breast reconstruction, is also used in chest wall reconstructions [5, 6]. The potential advantages of the flap include its straightforward harvest, robust vascularity and an easy arc of rotation. The large calibre, long vascular pedicle can potentially permit a microsurgical transfer if necessary. The disadvantages of this flap include the need to reposition the patient to a lateral decubitus position for flap harvest and the possibility of functional shoulder morbidity.

Fig. 2 **a** Intra-operative photograph showing a radical en bloc resection specimen of the sternal lesion resulting in a large full thickness skin, soft tissue and bony defect. **b** A medial deltopectoral flap based on the perforating branches from the internal mammary artery being

demonstrated. **c** The medial deltopectoral flap being transposed to cover the skin and soft tissue sternal defect. **d** A double-layer polypropylene mesh with methyl methacrylate reinforcement being used to bridge the bony defect

Fig. 3 Comparison of the pre- and the postoperative clinical outcomes. **a** Preoperative clinical photograph. **b** Post operative clinical photograph

The rectus abdominus myocutaneous flap and its variations based on the deep inferior and superior epigastric arteries, popularly used in breast reconstruction, are additional options for sternal reconstruction considering its ease of harvest, reliability and the large amount of tissue that can be harvested and still permitting a primary closure of the donor site [3, 6, 7]. The limitations to the use of the rectus abdominis myocutaneous flaps are mainly related to donor site concerns which include decreased abdominal strength and reported increased risk of herniation.

The pectoralis major muscle flap, which was considered as a workhorse flap in head and neck reconstruction, has also been extensively used for sternal reconstructions. It can be employed either as a rotational flap based on the thoracoacromial pedicle or as a turnover flap based on the medial vessels which perforate the substance of the muscle along its sternal border [6, 8].

We however used the medial deltopectoral flap, as was originally described by Bakamjian with an excellent skin colour and tissue texture match and minimal donor site morbidity. The deltopectoral flap was actually first described by Aymard in 1917, who raised it as medially based fasciocutaneous flap from the shoulder skin and then tubed it for use in staged nasal reconstruction. It did not spark much interest until it was reintroduced by Bakamjian in 1965. Bakamjian originally described it as a two-stage procedure for pharyngoesophageal reconstruction following laryngopharyngectomy. Despite the introduction of various new flaps and the technical advances in microvascular surgery, the Bakamjian flap still possesses multiple unique advantages (technical simplicity, reliable axial blood supply, large size, thinness and pliability) that few other reconstructive options can provide. A potential disadvantage of the flap was the need for a skin graft to cover the donor site, which invariably resulted in an unsightly scar. Another concern with the use of the Bakamjian flap for sternal reconstruction is the proximity of donor internal mammary vessels which can potentially compromise the extent of primary tumour resection, thus precluding its usage from the oncological stand point.

However, the technical simplicity of raising the Bakamjian flap along with its predictable vascular supply has ensured that the flap continues to remain as a time-tested salvage option in

head and neck reconstruction. The use of this flap for sternal reconstruction, to the best of our knowledge, has not been described before. The flap, which was classically based on a dominant perforating branch of the internal mammary artery, was transposed to cover the recipient defect. A primary closure of the donor site was also ensured. This technical modification of the Bakamjian flap adds to the reconstructive armamentarium and is an attractive option to cover the skin and soft tissue defects overlying the sternum.

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References

1. Singh VA, Abreu J, Bowman K, Shariff MA, McGinn JT Jr (2013) CASE REPORT sternal chondrosarcoma after sternotomy for coronary artery bypass grafting. *Eplasty* 13:e7
2. Marulli G, Duranti L, Cardillo G, Luzzi L, Carbone L, Gotti G, Perissinotto E, Rea F, Pastorino U (2014) Primary chest wall chondrosarcomas: results of surgical resection and analysis of prognostic factors. *Eur J Cardiothorac Surg* 45:e194–e201
3. Koto K, Sakabe T, Horie N, Ryu K, Murata H, Nakamura S, Ishida T, Konishi E, Kubo T (2012) Chondrosarcoma from the sternum: reconstruction with titanium mesh and a transverse rectus abdominis myocutaneous flap after subtotal sternal excision. *Med Sci Monit* 18: CS77–CS81
4. Matsumoto K, Sano I, Nakamura A, Morino S, Yamasaki N, Tsuchiya T, Miyazaki T, Nagayasu T (2012) Anterior chest wall reconstruction with titanium plate sandwiched between two polypropylene sheets. *Gen Thorac Cardiovasc Surg* 60:590–592
5. Arnold PG, Pairolero PC (1996) Chest-wall reconstruction: an account of 500 consecutive patients. *Plast Reconstr Surg* 98:804–810
6. Beahm EK, Chang DW (2004) Chest wall reconstruction and advanced disease. *Semin Plast Surg* 18:117–129
7. Noda M, Endo C, Hosaka T, Sado T, Sakurada A, Hoshikawa Y, Okada Y, Kondo T (2011) Dedifferentiated chondrosarcoma of the chest wall: reconstruction with polypropylene mesh using a transverse rectus abdominis myocutaneous flap. *Gen Thorac Cardiovasc Surg* 59: 199–201
8. Almeida MW, Aguiar LF, Costa TV, Rocha FP, Oliveira FS (2009) Use of the pectoralis major muscle flap and Marlex screen for thorax reconstruction after thoracotomy for sternal chondrosarcoma. *J Plast Reconstr Aesthet Surg* 62:140–141