Delayed fracture of MatrixRIB precontoured plate system

Calvin S.H. Ng*, Randolph H.L. Wong, Micky W.T. Kwok and Anthony P.C. Yim

Department of Surgery, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong SAR, China

* Corresponding author. Division of Cardiothoracic Surgery, The Chinese University of Hong Kong, Prince of Wales Hospital, 30-32 Ngan Shing Street, Shatin, N.T., Hong Kong SAR, China. Tel: +852-26322629; fax: +852-26377974; e-mail: calvinng@surgery.cuhk.edu.hk (C.S.H. Ng).

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Abstract

OBJECTIVES: Use of titanium prostheses for reconstructing chest wall defects following major chest wall resections is rapidly increasing in popularity. Previously, complications including prosthesis fracture have been reported for the system secured to the rib ends using clips following chest wall reconstruction and pectus excavatum repair. By contrast, fracture failure in titanium systems fastening the plate to the rib with locking screws through predrilled holes has not been previously reported, possibly owing to differences in the design and material of the system.

METHODS: We report an index case of plate fracture in the latter design following rib reconstruction and discuss the pathophysiology and relative risks behind such fractures.

RESULTS: Fracture of titanium plate occurred after chest impact during sport at 25 months following initial plate implantation. Surgical excision was performed because of persistent pain and cough.

CONCLUSIONS: Fracture failure can occur in those systems fastening the plate to the rib with locking-screws, and patients, particularly those engaged in contact sports or occupations with chest impact risks, should be informed of this possibility during consent, as surgical removal is most likely required following implant fracture failure.

Keywords: Chest wall · Fracture · MatrixRIB · Reconstruction · Titanium plate

INTRODUCTION

Chest wall tumours usually require radical surgery with adequate surgical resection margins. Conventional chest wall reconstruction, particularly for large defects, can be associated with high rates of complications [1]. Some of the potential problems of using methyl methacrylate, albeit uncommon, include toxicity, prosthesis infection, poor anchorage and fracture of the material with associated chronic pain. Recent advances in rib fixation devices have simplified the whole reconstruction process [2, 3]. Use of titanium plates and bars for chest wall and sternal reconstruction is a relatively novel approach and has rapidly gained in popularity over the past few years.

The currently most favoured prostheses are the STRATOS™ system and MatrixRIB precontoured plate system [2, 3]. The former is secured to the rib ends using clips that resemble claws at the two ends of the titanium bar, whereas the latter system is secured by fastening the plate to the rib with locking screws through predrilled holes. Complications such as prosthesis infection or loosening are rarely reported in such devices [3]. More recently, there have been reports of STRATOS™ system bar fracture following chest wall reconstruction and pectus excavatum repair [3, 4]. By contrast, fracture failure in the latter precontoured plate locking screws system has not been previously reported.

CASE HISTORY

In September 2011, a 23-year old man with a large benign aneurysmal bone cyst of the right rib underwent rib resection. Owing to the patient’s athletic nature, he opted for reconstruction of the rib with the MatrixRIB Precontoured plate. A six-hole titanium plate was inserted to bridge the defect with routine closure of the overlying soft tissue using a technique similar to that previously described [2]. The patient had an uneventful recovery, and follow-ups showed the plate in situ with the patient satisfied with the results. However, 25 months later following direct impact from another player during a soccer game, he experienced pain over the plate region that persisted, particularly when coughing, and he also developed a chronic cough. Chest radiograph showed a fracture of the titanium plate (Fig. 1). The condition was managed conservatively with analgesics for 2 weeks; however, because of persistent pain and chronic cough, the decision was made to remove surgically the plate, which showed a transverse fracture in the region between the fourth and fifth screw holes (Fig. 2). There
was no sign of bone cyst recurrence or screw loosening, and cultures of the surrounding tissue were negative. The patient elected not to have a replacement plate; his postoperative course was unremarkable and he was pain-free at the 6-week postoperative follow-up.

**COMMENT**

We describe the first report of implant fracture in a precontoured plate system fastened to the rib with locking screws through predrilled holes for chest wall reconstruction. In contrast to previous reports of failure in the STRATOS™ system, which happened spontaneously, the current case of precontoured plate fracture occurred following an impact [3, 4]. Titanium implants have been used since the mid-1950s, with the eventual development of the Austin Moore and Thompson orthopaedic prostheses. The strength, corrosion resistance and biocompatibility of the material make it ideal for implants. However, problems with early prosthesis fracture led to modifications in the composition, from using ‘pure’ titanium to stronger titanium alloys. The first alloy used for biomedical implants was Ti-6Al-4V containing 6% aluminium and 4% vanadium, which is the same material used for construction of the NASA space shuttles. Unfortunately, it was found that the vanadium from Ti-6Al-4V prostheses slowly seeped out and became toxic to humans. Hence, the titanium alloy Ti-6Al-7Nb containing 6% aluminium and 7% niobium became the standard for prostheses, which is the same stronger alloy currently used in hip implants of today, as well as in the current MatrixRIB system. Despite the strength of this titanium alloy, studies have shown that repeated stress to the metal can initiate and propagate microcracks, which, in the presence of fine precipitations within the metal, can eventually lead to full-blown fracture failure. Therefore, fracture failure does still occur, although rarely, in modern titanium alloy prostheses. Interestingly, the STRATOS™ system uses ‘pure’ titanium, which has less strength compared with the titanium alloys used in other prostheses. This might partly explain the higher frequency of reports on fracture failure of the STRATOS™ system [3, 4]. One of the main reasons for choosing ‘pure’ titanium as the material for systems that use crimping of the clips by pliers at the bar ends to secure the bar to the rib end is that the metal is pliable enough for this function. By contrast, systems that use the precontoured plate and screw design allow the stronger titanium alloy Ti-6Al-7Nb to be used for its bars. Another possible reason for the STRATOS™ system being more prone to fracture is that along the STRATOS™ bar are areas of narrower profile as well as more acute angulation that might be subjected to higher stresses, which can contribute to metal fatigue and fracture failure [3, 4]. In theory, the smooth contour of the precontoured plate and screw systems should prevent development of areas of focused high

Figure 1: Postero-anterior and lateral chest radiograph of the fractured MatrixRIB prosthesis at 25 months following implantation.

Figure 2: Intraoperative view of fractured implant; removed implant with a transverse fracture of the titanium plate.
stress, therefore reducing the risk of stress fracture when compared with the STRATOS™ system. These differences could partly explain why fracture failure of MatrixRIB precontoured plates is yet to be reported. Nevertheless, our index case shows that fracture failure can occur in MatrixRIB precontoured plates, and patients, particularly those engaged in contact sports or occupations with chest-impact risks, should be informed of this possibility while obtaining consent, because surgical removal is likely to be required following implant fracture failure.

Conflict of interest: none declared.

REFERENCES