

Intramedullary reinforcement of sternal fixation with autologous xiphoid tenon

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Abstract: Minimally invasive cardiac surgery through a partial sternotomy or a ministernotomy is popular. However, the transverse nonunion of the sternum will be a potential complication. Valid and valuable techniques have been introduced for securing the sternotomy fixation. Most of them are focused on the materials or methods for extrinsic reinforcement. A new concept, focused on the intramedullary reinforcement of the sternal fixation, was designed by incarcerating a cancellous portion of the autologous xiphoid in the marrow space of the inter-segmental junction of the partial sternotomy. This autologous xiphoid tenon method is simple, reliable, and reproducible without additional requirement of device implantation or an iliac incision for the bone grafting.

Keywords: Autograft; minimally invasive surgery; sternum

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Introduction

Minimally invasive or less invasive cardiac surgery through a partial sternotomy or a ministernotomy was advocated for the cosmetic, respiratory, transfusion, and pain advantages over the conventional surgery (1,2). However, it exposes a patient to the potential risk of transverse sternal nonunion (3). Valid and valuable techniques and materials have been developed for securing the sternotomy fixation (3-6). Most of them are focused on the materials or methods for the extrinsic reinforcement. Instead, we have designed an intrinsic reinforcement method for sternal fixation by intramedullary incarceration of a cancellous portion of the autologous xiphoid in the inter-segmental junction of the partial sternotomy.

Technical note

The entire xiphoid was harvested during the lower-half partial sternotomy. The attached cartilage portion, soft tissue, and the periosteum were removed from this

autologous bone graft. At the end of the cardiac operation, the transverse sternotomy was loosely wired as figure-of-8 fashion and the vertical sternotomy was wired as usual. Before approximation, the interfacial marrow of the transverse sternotomy site was enucleated with curette and the prepared xiphoid was embedded in the bone marrow space, hence this bone graft was incarcerated as an intramedullary tenon in the inter-segmental space of the partial sternotomy site snugly (*Figure 1*). Additional fixation for the bone graft was not needed. The wires were approximated thereafter (*Figure 2*).

This adjunctive technique was applied in 107 patients who received a full-spectrum cardiac surgery through the lower-half partial sternotomy from January 2011 to December 2013 (*Table 1*). There were three patients (2.8%) suffered from mild pseudoarthrosis of the transverse sternotomy site without any adverse sequela. There was no patient requiring second operation for the sternal fixation for dehiscence. In contrast, there were 747 patients who received a full-spectrum cardiac surgery through the

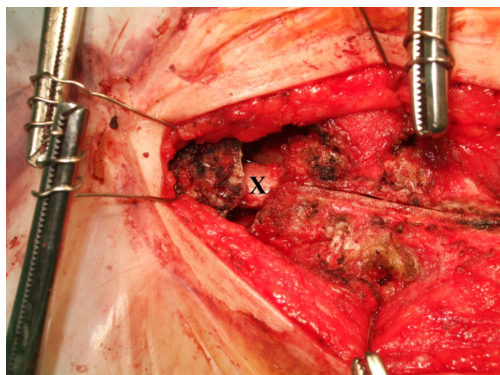


Figure 1 An intraoperative photo demonstrated an incarcerated xiphoid tenon (X) in the marrow space of the inter-segmental junction of the partial sternotomy before approximation.

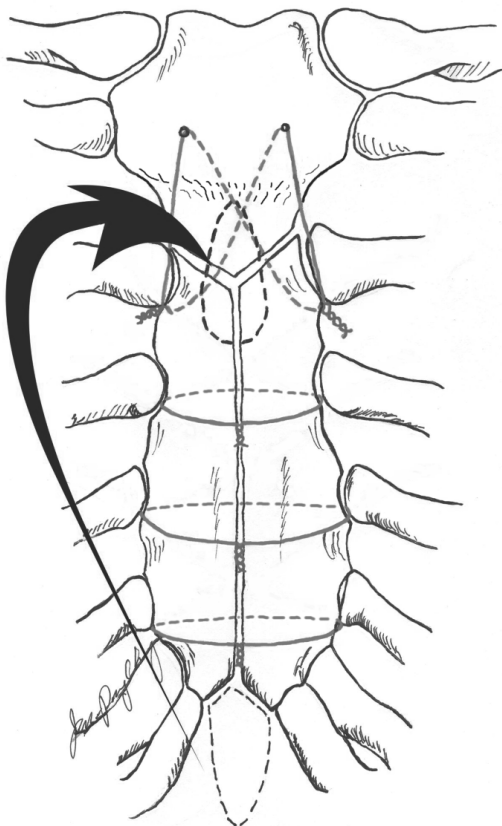


Figure 2 An illustration demonstrating fixation of the partial sternotomy with the xiphoid tenon technique.

Table 1 Demographic data of the 107 patients

Variables	Tenon group (n=107)
Age (year)	1-82 (49.7±20.9)
Gender (male)	55 (51.4%)
Hypertension	45 (42.1%)
Hyperlipidemia	26 (24.3%)
Diabetes mellitus	18 (16.8%)
COPD	17 (15.9%)
Old CVA	5 (4.7%)
Cirrhosis	3 (2.8%)
Regular hemodialysis	1 (0.9%)
NYHA functional class	2.2±0.8
I	20 (18.7%)
II	52 (48.6%)
III	29 (27.1%)
IV	6 (5.6%)
Operation	
Valve	
MVP + concomitant	31 (29.0%)
MVR + concomitant	20 (18.7%)
AVR + concomitant	28 (26.2%)
DVR + concomitant	3 (2.8%)
TVR	4 (3.7%)
Congenital	
ASD	4 (21.4%)
VSD	7 (64.9%)
TOF	4 (7.1%)
Others	
Aortic root	5 (4.7%)
ARCAPA	1 (0.9%)

ARCAPA, anomalous right coronary artery from pulmonary artery; ASD, atrial septal defect; AVR, aortic valve replacement; COPD, chronic obstructive pulmonary disease; CVA, cerebral vascular disease; DVR, double valve replacement; MVP, mitral valve plasty; MVR, mitral valve replacement; NYHA, New York Heart Association; TOF, tetralogy of Fallot; TVR, triple valve replacement; VSD, ventricular septal defect.

lower-half partial sternotomy between January 2000 and December 2010 without this adjunctive technique. The pseudoarthrosis of the transverse sternotomy site was noted in 36 patients (4.8%). No one in these two cohorts of 854 patients experienced any lower vertical sternotomy site dehiscence.

Discussion

Minimally invasive or less invasive cardiac surgery through a partial sternotomy or a ministernotomy was advocated for the cosmetic, respiratory, transfusion, and pain advantages (1,2). This approach is popular in current era. Various types of partial sternotomy have been reported such as lower-half sternotomy (1), J incision, and partial right lower sternotomy (2). Because elasticity and movement of the chest wall during respiration will compromise the rigid sternal fixation, sternal nonunion or dehiscence is a well-known complication encountered in patients after sternotomy. The sternal dehiscence rate was reported to be 18 (1.4%) of 1,268 patients after cardiac surgery (7). Although vertical sternal nonunion has been seldom reported, transverse nonunion may be more commonly associated with the partial sternotomy due to the fragmented sternal interface created by this method (3). Valid and valuable techniques and materials have been developed for securing the sternotomy fixation including modifications of sternal wiring method or invention of new sternal fixation device (3-6). Most of them are focused on the materials or methods for the extrinsic reinforcement.

The superiority of intramedullary fixation in stiffness and resistance to the bending moments is a well studied issue in the plastic and orthopaedic field (8). A xiphoid process composed of cartilage and cancellous bone, exposed during a sternotomy is an on hand bone graft. Excision of this *in situ* structure for autologous bone grafting showed nothing detrimental and another incision for the iliac bone grafting could be spared. By using the cancellous portion of the xiphoid process as an intramedullary tenon, we successfully reinforced the transverse sternotomy site of the partial sternotomy and reduced the nonunion rate from 4.8% to 2.8%. Although statistically not significant, we believe that the reduced odd ratio of 1.76 by this technique will be an attractive merit without any drawback.

The use of autologous bone graft is not a new idea.

Autologous iliac bone transplant after sternal resection had been reported by Piotrowski and his colleagues, however this graft required another incision and not available for intramedullary reinforcement (9).

There are some limitations in this autologous xiphoid tenon method. As a bone graft, only the cancellous portion of the xiphoid is on demand. Therefore, in some younger patients without ossified xiphoid, this method is not suitable for use. Moreover, this method is not suitable for the incisions sparing the xiphoid area such as J incision. Since we report on a technical evolution and refinement, the nature of sequential population enrollment without randomization is the inevitable limitation of this study.

Acknowledgements

None.

Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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