Thermoreactive Clips for Sternotomy Closure in Sternal Dehiscence
Vassilios S. Avlonitis, Vivek Shrivastava, John Wallis, Steve Hunter, Andrew Goodwin,
Andrew Owens and Simon Kendall
Ann Thorac Surg 2008;85:2164-2165
DOI: 10.1016/j.athoracsur.2007.12.014

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://ats.ctsnetjournals.org/cgi/content/full/85/6/2164
Gamma irradiation played an important role in our decellularization process. The original purpose for use of gamma irradiation was to remove the cell components from the porcine aortic valves in conjunction with polyethylene glycol (PEG). Because the radiation effect can reach the entire tissue evenly, it contributed to complete decellularization of such porcine aortic valves that had complex structures (eg, variety of tissue thickness). Gamma irradiation also brought supplemental benefits to our decellularized tissue, such as elimination of both the DNA sequence of porcine endogenous retrovirus and α1,3-galactosyl epitope (ie, they could be the sources of infection or rejection, or both), and the possible reinforcement effect due to polymerization of PEG by gamma irradiation, as described in our article [2]. Therefore, Dohmen and Konertz’s [1] comment that “gamma irradiation was not used to decellularize but to sterilize the decellularized scaffold” is definitely incorrect. Although it is true that decellularized tissues get sterilized through our process with 100 kGy gamma irradiation, it is of limited significance in our study. On the other hand, we agree with their comments that we need further studies on hemodynamic functional evaluations and long-term impact of gamma irradiation, which were described as limitations in our article [2]. However, we believe that it was inappropriate to refer the article by Cohen and colleagues [3] to discuss the use of gamma irradiation and its negative effects, because it had a completely different setting from ours (ie, the homograft).

Regarding the use of DNase, we used it for enhancing removal of debris of nuclei after gamma irradiation. There is no evidence to support Dohmen and Konertz’s [1] comment that “deoxyribonuclease also damages and alters the extracellular matrix.” Theoretically, any kind of chemical reagents could damage biological tissues to somewhat of an extent. In addition, the article [4] to which Dohmen and Konertz [1] referred to in their letter did not describe anything about what they insisted.

Finally, we were impressed with their excellent decellularization method and clinical outcomes [5, 6]. However, we believe that mechanical property has to be evaluated only by in vitro mechanical strength studies and by the electron microscope. They should not claim that there was no evidence of extracellular matrix destruction in their decellularized tissue by their clinical articles [6, 7] in which there were no mechanical studies, and the scaffold was implanted only in the right ventricular outflow tract, not even in the left heart (ie, the high blood pressure environment).

Yutaka Okita, MD, PhD
Department of Cardiovascular Surgery
Kobe University Graduate School of Medicine
7-5-2 Kusunoki-cho
Chuo-ku, Kobe 650-0017, Japan
e-mail: toota-cvo@umin.ac.jp

Yoshiki Sawa, MD, PhD
Department of Surgery (E1)
Osaka University Graduate School of Medicine
2-2 Yamada-oka
Suita, Osaka 565-0871, Japan
e-mail: saw@surgl.med.osaka-u.ac.jp

References

Thermoreactive Clips for Sternotomy Closure in Sternal Dehiscence

To the Editor:

We have read with interest the article by Plass and colleagues [1] describing a plate fixation technique in 3 patients with sternal dehiscence. The authors state that the technique is simple because it does not require dissection behind the sternum; however, their technique requires raising extensive tissue flaps to expose the ribs. We have been using thermoreactive clips to close the sternum in patients with dehiscence. This is a simpler technique requiring less extensive surgery. The technique has been proven to reduce sternal dehiscence in a previous study [2].

The clips are made of nitinol. They allow 10% to 15% deformation in width during coughing or movement. Their contact surface with bone is five to seven times greater than steel wires, so they are less likely to break or cut through the sternum. The clips are thermoreactive, becoming malleable at low temperatures (<10°C) and returning to their original shape when the temperature increases. The memory effect begins at temperatures exceeding 27°C, and the definitive shape is retained at 35°C. Their thermoreactivity makes application easy and without trauma [2].

To apply the clips, 3 steel wires are applied on the sternum: 2 in the manubrium and 1 near the xiphoid. In patients with dehiscence, it is often possible to tighten the existing wires in the manubrium and lower end of the sternum. Then, electrocautery is used to create a groove in the intercostals spaces on either side of the sternum. The distance across the sternum is measured for application of the correct clip size. The clips are cooled in ice water and mounted onto an applicator that splays them open. The clips are then applied around the sternum. On rewarming, the clips return to their original shape and strength, clasping the sternum together.

We have read with interest the article by Plass and colleagues [1] describing a plate fixation technique in 3 patients with sternal dehiscence. The authors state that the technique is simple because it does not require dissection behind the sternum; however, their technique requires raising extensive tissue flaps to expose the ribs. We have been using thermoreactive clips to close the sternum in patients with dehiscence. This is a simpler technique requiring less extensive surgery. The technique has been proven to reduce sternal dehiscence in a previous study [2].

The clips are made of nitinol. They allow 10% to 15% deformation in width during coughing or movement. Their contact surface with bone is five to seven times greater than steel wires, so they are less likely to break or cut through the sternum. The clips are thermoreactive, becoming malleable at low temperatures (<10°C) and returning to their original shape when the temperature increases. The memory effect begins at temperatures exceeding 27°C, and the definitive shape is retained at 35°C. Their thermoreactivity makes application easy and without trauma [2].

To apply the clips, 3 steel wires are applied on the sternum: 2 in the manubrium and 1 near the xiphoid. In patients with dehiscence, it is often possible to tighten the existing wires in the manubrium and lower end of the sternum. Then, electrocautery is used to create a groove in the intercostals spaces on either side of the sternum. The distance across the sternum is measured for application of the correct clip size. The clips are cooled in ice water and mounted onto an applicator that splays them open. The clips are then applied around the sternum. On rewarming, the clips return to their original shape and strength, clasping the sternum together.

In our center, thermoreactive clips were used for sternotomy closure in 8 patients during reoperation for dehiscence after standard closure with steel wires at the first operation. The dehiscence was due to deep infection in 6 patients. They were all men with a mean age of 66.5 years, a mean European System for Cardiac Operative Risk Evaluation (EuroSCORE) of 5.4, and a mean body mass index of 28.4. Closure was successful in all patients, and none required further surgery. Our experience with the use of thermoreactive clips in patients with sternal...
dehiscence suggests that this simple technique is highly effective in this group of patients.

Vassilios S. Avlonitis, MD, PhD
Vivek Shrivastava, MRCS
John Wallis, FRCS
Steve Hunter, BMedSci, BM BS
Andrew Goodwin, FRCS (CTh)
Andrew Owens, MD, FRCS
Simon Kendall, MBBS, FRCS (CTh)
Department of Cardiothoracic Surgery
James Cook University Hospital
Middlesbrough, United Kingdom
e-mail: avlonitis@hotmail.com

References

Reply
To the Editor:

We read with interest the letter by Avlonitis and colleagues [1] and have to bring different comments into this discussion.

We did not mean that plate osteosynthesis is a simple technique, because there is no need for retrosternal dissection. The handling and the principle of the plate system is easy to learn, although it has to be used very carefully because serious injury to the heart and the lungs is possible [2]. However, the fact that no dissection retrosternally is necessary represents a huge advantage compared with other sternal closure systems currently available, including the thermoreactive clips. In this operative technique the required dissection and lifting of both pectoral muscles is the reason for the most frequent complications like seromas and bleeding.

However, it can be kept minimal depending of the bone quality and also the experience of the surgeon in this technique. The tendency is clearly to shorter plates and less soft tissue dissection as possible.

We used the thermoactive clips in 3 patients instead of the stainless steel wires in clinical routine. The patients showed no special risk factors for complicated sternal healing. One of these 3 patients showed a complication where the left sided parts of the clips completely tore out and ripped through the bone of the left sternal half.

The question is the indication. The authors mentioned that they used these thermoactive clips for sternal dehiscence. Not only the dehiscence but also the bone quality of the sternum is important (especially in strong osteoporosis or multiple fractures). Certainly the contact surface of the clips is larger compared to the wires [3], but this is still not enough for complete stabilization. The efficacy of the clips is reduced due to the fact that they cannot be placed complete circumferentially around the sternal body, which enhances the danger for shifting of the clips. With the sternal plates “bridging” over missing bones structures is only possible with this technique. In addition the presence of retrosternal adhesions is important. There is no information as to how many days postoperatively the second closure with thermoactive clips was performed. In 6 patients, the dehiscence was due to deep sternal infection. Because of that it can be assumed that the primary surgery was only a few days before and the substernal adhesions were only minimal. In addition, it is important which kind of surgery the patients received: coronary bypass grafting or valve surgery. The thermoactive clips partially encompass the sternal body. If strong adhesions are present, the efficacy of clips could be reduced and the insertion of the clips can cause serious retrosternal bleeding if bypass grafts are injured or adhesions are impaired. In case of sternal pseudarthrosis we already treated 7 patients with plate osteosynthesis where quite strong forces were necessary to approximate and stabilize both sternal halves. We do not believe that thermoreactive clips are able to develop the necessary force in these cases.

However, the thermoreactive clips may be used in patients with a normal sternum or in patients with slight osteoporosis and dehiscence, or both, where stainless steel wires are normally used. An advantage of this technique might be the timesaving aspect wires and more gentle handling of the sternal bone compared with installation of the sternal plates. On the other hand, the cost factor will eventually influence the decision against the clips because they are significantly more expensive than steel wires. However, sternal plate osteosynthesis is the most expensive closure material.

In our opinion, there is no comparison between the thermoactive clips and the sternal plates, because the indication to best treat sternal complications are different for both closure techniques.

Andre Plass, MD
Jurg Grunenfelder, MD
Ivo Guber, MD
Michele Genoni, MD
Clinic for Cardiovascular Surgery
University Hospital Zurich
Rämistr. 100
Zurich 8091, Switzerland
e-mail: andre.plass@usz.ch

References

Dr Plass discloses a financial relationship with Synthes.
Thermoreactive Clips for Sternotomy Closure in Sternal Dehiscence
Vassilios S. Avlonitis, Vivek Shrivastava, John Wallis, Steve Hunter, Andrew Goodwin, Andrew Owens and Simon Kendall
Ann Thorac Surg 2008;85:2164-2165
DOI: 10.1016/j.athoracsur.2007.12.014

Updated Information
including high-resolution figures, can be found at:
http://ats.ctsnetjournals.org/cgi/content/full/85/6/2164

Citations
This article has been cited by 1 HighWire-hosted articles:
http://ats.ctsnetjournals.org/cgi/content/full/85/6/2164#otherarticles

Subspecialty Collections
This article, along with others on similar topics, appears in the following collection(s):
Chest wall
http://ats.ctsnetjournals.org/cgi/collection/chest_wall

Permissions & Licensing
Requests about reproducing this article in parts (figures, tables) or in its entirety should be submitted to:
http://www.us.elsevierhealth.com/Licensing/permissions.jsp or email: healthpermissions@elsevier.com.

Reprints
For information about ordering reprints, please email: reprints@elsevier.com