Reinforcing the Conventional Sternal Closure

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Sternal infection is a devastating complication of heart surgery. It may be the result of unstable osteosynthesis, caused by the sternal wires cutting into the cortical layers, which results in tension loss and gap formation. We describe a technique that prevents the cerclages from cutting into the sternal plates and covers the sternum with a well-capillarized barrier of major pectoralis muscle.

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Osteosynthesis of the sternum after heart surgery, through a midline thoracotomy, is conventionally performed using wires of surgical steel that are passed through the sternal plates. A complication that may arise is sternal instability, either with or without concurrent infection. Deep wound infection in particular is a devastating complication and is reported in the literature with a frequency of 1% to 4% after heart surgery [1–3]. This complication may be the result of unstable osteosynthesis, caused by the sternal wire cutting into the cortical layers, which results in a loss of tension and the subsequent formation of a gap. This gap may become enlarged through normal respiratory movements and exaggerated movements such as coughing. A method is presented here whereby the conventional sternal closure is reinforced, and an increase in the available force between the sternal plates is provided.

This method is simple and particularly beneficial for patients with osteoporotic or small sterna. The method also causes minimal soft tissue damage and does not involve the costal cartilage or the passing of wires through the intercostal spaces.

Technique

Upon closing the chest, the anterior cortical layer of the sternum is dissected free with a diathermy knife, comparable to a "mini pectoralis flap" procedure. The sternal-wires are then passed through both sternal plates, as for a routine closure. The closure is reinforced in the following manner. After passing the wires through the sternal

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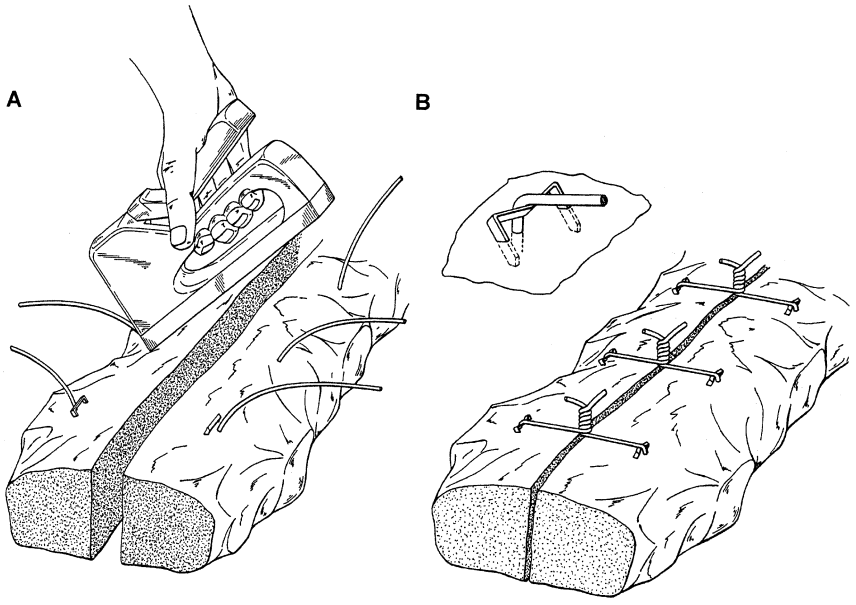

Fig 1. Diagrammatic representation of the reinforcement of the conventional sternal closure by staples. (A) Placing of staples at the anterior outlet of the wire. (B) Completed closure of the sternum. Deformation of the staples after twisting of the wires to the correct tension and prevention of the cutting in of the wires by the staples is demonstrated. (Reproduced with permission of Alpha Research.)

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plates a staple gun (Reinforced Sternal Closure System by Alpha Research, Berlin, Germany) loaded with light staples of the same alloy specification and cross-sectional area as the wires, is run down each wire through a guide notch on the faceplate. At the anterior outlet of the wires, staples are placed parallel to the cut edge of the sternum and at an angle of about 30 degrees (Fig 1A). If the staples are not lying against the cortical layer because of irregularities of the bone surface, it is recommended that the staples be further impressed with a needle holder. If there is a space between the staples and bone, there is a danger of the staples pivoting when crossing and twisting the wires, thus jeopardizing the reinforcing effect. After placing the staples, the wires are twisted together until there is a slight deformation of each staple, which indicates that the optimal force has been applied (Fig 1B). Clinical experience has shown that, especially in osteoporotic bone, the staples are impressed through the wire in the direction of their prongs into the sternum, when tension is applied on the cerclage. The dissected free flaps of the major pectoralis muscle is then adapted over the sternum, thus forming a well-capillarized barrier. This highly immune-competent barrier may also prevent superficial infections from invading deeper wound areas.

The effect of the system is that the staple transfers the load from a single point to the area of the back of the staple and physically prevents the wire from cutting into the anterior cortical bone layer. Without this cutting in, the tension is maintained and the stability of the sternum is enhanced. Moreover, the cutting in of the wire into the anterior cortical layer when twisting the wires is suppressed, which in turn prevents the formation of an unfavorable acute angle at the posterior outlet (Fig 2). When twisting the wires, tension at the posterior outlet is further relieved because of the friction over the staple at the anterior outlet.

The Reinforced Sternal Closure System was applied in 100 patients. Six surgeons were involved in the evaluation of the system. Of the 680 staples implanted in all patients, postoperative x-rays showed 633 (93.1%) staples positioned correctly. Dislocation correlated with the learning curve of the surgeon. Primary wound healing with stable osteosyntheses of the sternum was observed in 98 patients. One superficial wound infection occurred. Sternum healing in this patient was not affected. One female patient, aged 74 years, suffered after coronary artery bypass grafting surgery from mediastinitis. Preoperative risk factors were diabetes mellitus, treatment with insulin for more than 10 years, and macromastia.

The simplicity of this method of prophylactic reinforcement of the sternal closure in patients at risk means that very little training in the technique needs to be undertaken, as compared with other methods, when simple reinforcement is all that is required.

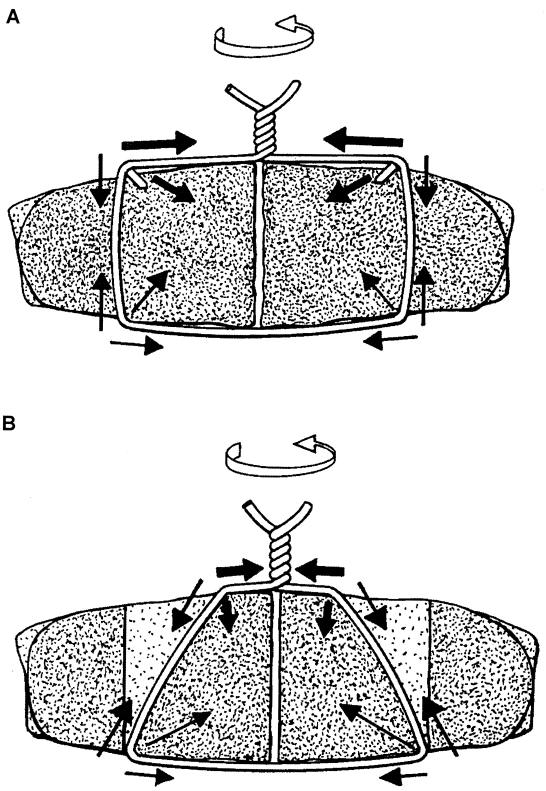

Fig 2. Diagrammatic representation of force vectors exerted on the sternal halves after closure. (A) Reinforced sternal closure, which demonstrates the maintenance of tension and no cutting of the wire into the anterior cortical layer. (B) Conventional sternal closure, which demonstrates the loss of tension due to cutting of the wire into the anterior cortical bone layer. (Reproduced with permission of Alpha Research.)

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