Improving Outcomes of
MEDIAN STERNOTOMY AND OSTEOGENESIS
A Medical Research Review
By Dr. David W. Mc Kinney, M.A., M.D., FAAFP

INTRODUCTION

Consistently, clinical papers over the past 30 years have discussed the difficulty and the grave risks resulting from closure procedures including the most efficient and popular "twisted wire technique" for closure. This is a particularly acute problem among high-risk patient such as the obese, diabetic, osteoporotic and large breasted women. The problem is to maintain the integrity of the thorax by re-acquiring constant proximal closure of less than 2 mm. (McGregor, supra)

BIO-MECHANICAL ANALYSIS

Until the time the median sternotomy is performed, the thorax is a single unit, that is, a united sternum. It is capable of maintaining coughing, sneezing, high body weight, large breasts as well as moderate physical insults, not unlike a shield. Upon the median sternotomy, the thorax becomes two distinct hemispheres articulating to the spinous processes by ligaments that are essentially collagen, and as such, relatively inelastic.

> The hemispheres are then separated by retraction, permitting full and easy access. At closure, the sole and exclusive source of support of the retracted sternum is 6-8 #5 twisted stainless steel wires. One need only recognize that the deformity caused by retraction not only must be restored to exact position; the medical need for healing is immediate through tight and constant proximal attachment, as well as the maintenance of this proximal attachment for a significant period of time. "Steel wire sutures remain popular in median sternotomy closure because it is simple, inexpensive and familiar. This incision provides excellent exposure of vital chest structures, is rapidly performed and well tolerated by most patients."
>
> McGregor, Walter E. MD; Trumble, Dennis R. MS; McGovern, James A., MD. *Mechanical analysis of midline*

sternotomy wound closure, Journal of Thoracic Cardiovascular Surgery, June 1999;1144-1150, 1145.

In this study, McGregor and associates, using 7 of the standard #5 wires ended their distraction/separation analysis at 2mm. that caused complete dehiscence. This clearly illustrates the need for extremely close and continual proximal attachment. Yet even this may be insufficient to prevent separation (dehiscence). Mc Gregor, at page 1152 (op. cit.), concludes that standard sternal closure methods, for which multiple twisted wires were used, may not always provide sufficient mechanical stability.

STERNAL INSTABILITY

For the most part, surgeons and medical researcher have concentrated their research within the medical centers during the immediate post-op time frame when infection and palpable movement were readily observable. In addition, they have challenged, in various forums, the use of wire largely due to the disastrous consequences, in both mortality and cost, when proximal short and long-term attachment fails.

According to Dr. Grossi, and associates, 75.3% of patients with sternal infections have noted sternal instability by the time they returned from the operating room.

Grossi Edward A., M. D., Culliford, Alfred T, M.D. *A Survey of 77 Major Infections. Complications of Median Sternotomy: A Review of 7,949 Consecutive Operative Procedures*, Annals of Thoracic Surgery, Vol. 40, #3 Sept., 1985. 214-223, 217.

We may then infer at least two conclusions: **(1).** The proximal reattachment was not acquired in the Operating Room despite the best efforts of the surgeons and nursing staff; **(2).** The movement of the HBMI patient from the table to the gurney-transport and then from the gurney-transport to the bed in the CVICU dislodged or strained the capacity of the wire sutures, or began to cut through the bone of the patient with sternal osteoporosis.

When the analysis of the #5 wire itself is reviewed, this becomes the most likely cause of separation. Dr. Casha, and associates, advises that the #5 wire's tensile strength, at which the wire irreversible unwinds, is 20-22 kg. (**44-48.5 lbs**.)

> "Casha A. R., Yang L, Saleh M, Cooper G. L. *A Biomechanical Study of Median Sternotomy Closure Techniques"* European Journal of Cardio-Thoracic Surg. 15 (1999) 365-369, 365.

Inducing the patient to cough is imperative to obtain bronchial clearance. This is particularly true of smokers. The dangerousness of this necessary process is not always sufficiently understood to undertake supporting precautions.

> "During maximum coughing, a force of 150 kg. (333 Lbs.) is placed upon the closure. Since twisted wire untwists at 20-22 kg., then, in a chest closed with 6 'straight wires' we also conclude that there is a risk that the severe coughing may cause the wires to untwist." "The rate of sternal separation carries a mortality rate of 10-40%."
>
> Casha and associates, (op. cit.) p.365, 368

Despite the known efficacy of using the twisted wire sutures, the disruption and dehiscence rate among the sternotomy patients has remained depressingly consistent. This is largely due to body mass and the unpredictable healing variables of cardiovascular patients, which by definition, have reduced blood flow.

The first aspect of closure is re-formation. Re-formation implies a return of the hemispheres to the exact pre-sternotomy position (-2mm) and without the tendency to remain separated as during the retraction since the articulating tissues are fibrous cartilage that are relatively inelastic. This causes a tendency to remain in the retracted position. Re-formation strain is first to be overcome. Then the closure is completed using the "twisted wire technique".

Bone is living tissue, made up of living bone cells (osteocytes). After the incision trauma, the healing dynamic is the creation of 'the callus', primarily internal", usually within 2 days of the osteotomy. "When using internal fixation devices, i.e. wire, little or no external callus forms, creating greater dependence upon the internal callus and an extended period for healing. Turek at 57-58, (Infra.)" This internal callus is cemented to the old bone but is considered "primitive". This occurs within 2 days of the surgery. During Stage I of reformation and fixation, the only current support for the unconscious patient, is the 6-8 #5 wires.

It is then unreasonable to expect the wire to support the re-formation of the thorax hemispheres and retain together the two hemispheres as a single unit that in many cases exceeds the lateral weight of 20-22 kg, throughout the initial healing process. This is even less reasonable when the patient is diabetic with its attendant reduced blood flow. This is also true of the obese large chested male and the large breasted female patients. In the latter situation; it is the total weight of both breasts, moving in lateral distraction that easily exceeds the 20-22 kg. limits. This is particularly so when the patients are supine.

In the orthopedic literature, the enhancing solution is to externally support the sternum during the time frame from the OR to the pyknotic stage of approximately six (6) months.

> "Pressure within the physiological limits of force exerted by the musculature stimulates or enhances osteogenesis. Pressure force acting in line of the bone axis is more likely to cause osteogenesis. Even in the presence of infection, osteogenesis is stimulated by compression. "Over a period of 6 months, the induced cells, osteoblasts, osteocytes and even osteoclasts become pyknotic" (thick)
>
> Turek, Samuel L. M.D*, "Othopaedics, Principles and their Applications,* 3 ed., 1977, p.48-52. J. B. Lippincott Press, 1977.

Therefore, continual close approximation for complete and early onset osteogenesis remains the critical feature. There is little more to be done to provide internal support; the support to the thorax must then become external and that the external contra-force must be both constant and primarily in the lateral direction.

> "In obese women or in women with large breasts, **we recommend that they wear a supportive brassiere or corset immediately after the operation** in order to minimize lateral tension on the incision generated by pendulous breasts and to keep the lower part of the incision covered for the initial few days after the operation.
>
> Snow, Norman J. M.D., Massad, Malek G. M.D., Geha, Alexander S., M.D., Complications *of Thoracic Incisions;* Complications of Cardiothoracic surgery, Avoidance and Treatment, Alex G. Little, Editor, 2004, Blackwell Publishing.

Proper fitting in the OR will be more efficient when the intake protocol determines the patient's bra size. Then staff will have the knowledge to choose the proper bra size and apply in an expeditious manner.

Most of these studies and analysis provide answers and suggestions to sternal instability within the time frame before the patient resumes the normal in-patient routine of daily hospital activities of bronchial clearing by coughing, sneezing or pulling themselves up in bed, to mention a few situations.

It is then concluded that the wire suture process, as an internal fixation is the better of other internal fixation devices, it will continue to be utilized but should be enhanced by external means.

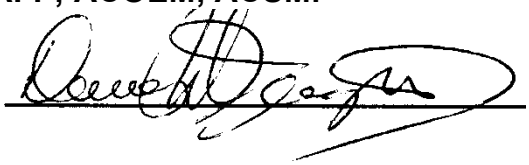
CONCLUSION

Medical practitioners now accept the “casting” findings for healing by Turek (Ibid.) and the requirements that large breasted patients must acquire the support in the OR, before transport (Snow, (Ibid.) Obviously, then “osteogenesis” must be achieved with the required external constant support. Being familiar with the three major post-operative external support products utilized by the medical centers; two are outside the parameters necessary for enhanced healing by not providing the proper physiological support:

1. The pillow is the oldest. There is no constant support to the sternum unless the patient is holding the pillow, in place, 24/7. This is quite impossible when the patient is heavily medicated and/or asleep. The heart shaped pillows are cute but without a therapeutic purpose.
2. There is a wide circuitous strap around the thorax activated by the patient squeezing attached handles to prevent pain when coughing and upon movement. Again the difficulty is that the patient must be conscious and sufficiently strong to squeeze the handles, (questionable). None of which may be performed when asleep. Unfortunately the strap crushes the breasts without placing the necessary pressure directly upon the thorax.
3. Only two products conform to the requirements of Turek (Ibid.) for light pressure on a 24/7 basis coupled with ease of use. These are the AztecHeart™ TLC Surgery Support Bra and the AztecHeart™ Cardiothoracic Harness. Both are available to medical centers and for private purchase at AztecHeart.com.

I have reviewed this research and endorse the conclusions drawn as within reasonable medical outcomes for these patients.

Dr. David W. Mc Kinney, M.A., M.D., FAAFP, ACOEM, ACSM.



Dated: 03/3/14