We thank Dr. Jutley and associates for their comments. Hertzian contact analysis predicts the elastic behaviour of contacting surfaces and was first described by Heinrich Hertz in 1882. We do not believe that Hertzian contact analysis applies to contact between wire and bone in sternotomy closures because:

1. The theory does not apply for conforming surfaces e.g. when wire is pushed through and embedded and surrounded by bone [1].
2. The theory applies to a hard body indenting an elastic surface. Bone is not an elastic material, strictly speaking it is a visco-elastic material (differing strength and elasticity depending on speed of load or applied strain rate).
3. Using Jutley’s figures for stress for polyester suture (nominal 0.5 mm, 240 MPa stress) versus steel (0.7 mm, 203 MPa stress) would not explain why polyester cut through at more than 4 times the rate of steel.
4. We do not agree that a Sterna-band (3.64 mm wide per unit length) is necessarily equivalent to a wire of 2.32 mm diameter. This was not tested by us; and would need to be tested experimentally before such information could be used as a statement.

We agree that demonstration of stress magnitude can lead to a better understanding of the mechanisms of dehiscence. Fig. 1 compares levels of von Mises stress in wire and Sterna-band.

We believe that sternal cortical bone behaves rather like femoral trabecular bone since it fails by gradual yielding rather than fracturing; and the rate of yield (or rate of wire cutting through bone) is proportional to the force and inversely proportional to the area of contact [2]: rate of yield \( \propto \frac{\text{force}}{\text{area of contact}} \).

Yielding takes place when the mean pressure exceeds the yield stress. Since bone is visco-elastic, low ratios can induce a permanent plastic deformation, whilst high ratios induce collapse. With good quality bone, compaction occurs increasing the effective contact area and slowing the rate of cutting through. This does not occur with osteoporotic bone.

It follows that in order to decrease cutting through bone, any combination of three strategies may be used namely:

1. The use of better quality bone by recruiting the lateral cortex of the sternum by placing the device parasternally [3].
2. Decrease the force per device by increasing the number of devices [4] or using an external chest compressing device.

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Fig. 1. Von Mises contact stresses induced in the sternum by conventional stainless steel wire no. 5 and Sterna-band as shown by finite element computer analysis. Note the higher levels of localised stress (darker grey) with the wire. After Soroff 1999, personal communication.
3. Increase the area of bone contact by the use of flexible braided wire [5], bands [6], cannulated screws, grommets [7], struts [8] or simply by reinforcement with staples [9].

Sternal-bands are useful in that all strategies are applicable as opposed to, for example, the case with cannulated screws since these cannot be placed parasternally.

References