

How the TORQ™ improves sternal closure

The TORQ™ sternal closure device is a simple tool that helps cardiac surgeons achieve improved sternal stability when using stainless steel wires. The superiority of the TORQ device over traditional manual techniques is due to the many technical features discussed below.

TORQ™

Separates tension from twisting



With traditional wire closure, the surgeon applies tension to the wire by pulling up and twisting at the same time. The TORQ device works differently: it separates wire closure into two steps, tensioning and then twisting.

The surgeon first uses the TORQ device to apply tension to the wire, without twisting it. This is important because twisting damages the wire, weakening it and allowing it to break more easily. By eliminating twisting, more tension can be applied without breaking the wire.

The surgeon then uses the TORQ device to twist the wire. The twist does not increase the tension in the wire, but merely “locks in” the tension that has already been applied in the first step.

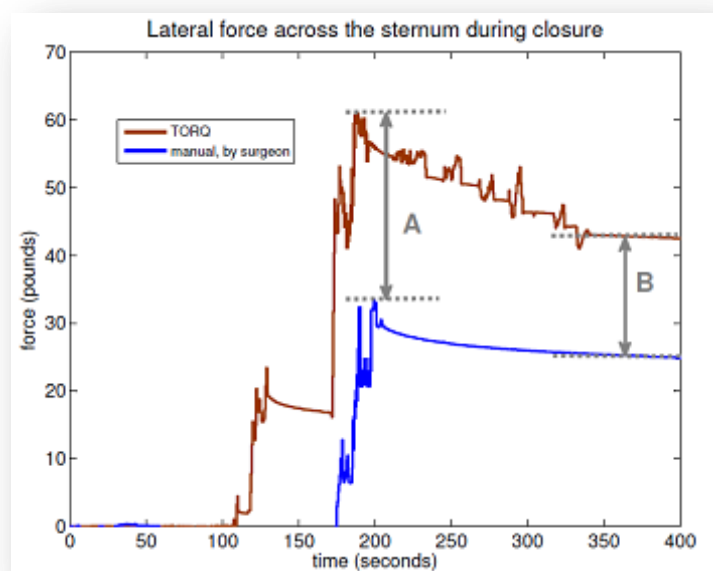
Because the TORQ device separates tensioning from twisting, the surgeon is able to apply an increased tension to the wire without running the risk of breaking it.

Increases the force across the sternum

Laboratory testing was used to compare TORQ closures and manual closures performed by experienced cardiac surgeons. The chart shows the force applied across a sternal jig closed with six wires.

TORQ closures showed an 85% increase in peak force (A) and a 72% increase in final force (B)¹. The increased force across the sternum provides a tighter and more stable closure than can be achieved with manual closure.

Surgeons who use the TORQ state that this increased force results in a noticeably more stable sternum after closure, with very little movement of the sternal halves, reducing post-operative pain for the patient.

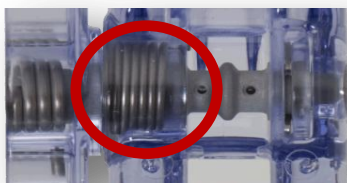


Prevents wire fatigue at the base of the twist

The TORQ device twists the wire from the top of the twist, preventing any damage or yielding to the wire at the base of the twist, thus reducing wire breakages. By twisting at the top, the TORQ device causes the wire to weaken and be cut at the top of the twist.

In contrast, with a manual wire closure, the wire is twisted from the bottom in order to provide enough tension across the sternum. This concentrates the stress at the base of the twist where it can cause metal fatigue and cause the wire to weaken. Surgeons often observe metal fatigue as a change in wire color or the wire getting duller and use this as an indication of when to stop twisting. However, using this as an indication is a problem, because even if the wire does not break, it has passed its yield point and has been weakened. This weakened wire can break later when subjected to distraction forces during and after surgery, for example, when the patient coughs.

Maintains tension in the wire



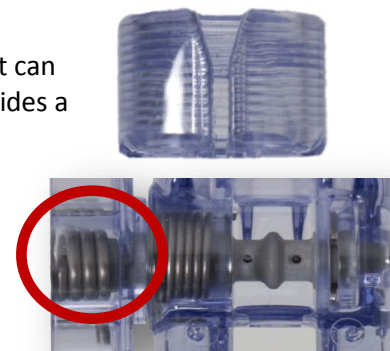
The clutch spring inside the handle of the TORQ device allows the handle to turn in one direction only. This means that once tension is applied to the wire, the tension is maintained by the TORQ device and is not released. This makes it easier to close the sternum in incremental steps. It also separates tensioning from twisting, since the twist is not required to keep the tension on the wire.

Controls tension when twisting

Two mechanisms inside the TORQ device ensure that tension is precisely controlled when the wire is twisted:

- The threaded section moves the top half of the TORQ device downwards when twisting. This motion gradually releases the tension on the wire so that the twist can be applied under decreasing tension. This reduces damage to the wire and provides a tighter twist.
- A tension spring inside the handle continues to pull up on the wire and regulates the release of tension as the twist is applied. This ensures that the tension is maintained on the wire, and not released too quickly by the downward motion of the threaded section.

The interplay between the pitch of the threads and the force on the tension spring ensures that the twist is applied to the wire under a carefully controlled tension. This allows the tension on the wire to decrease while maintaining the approximation forces across the sternum.



Indicates applied tension

The TORQ device provides an indication of how much tension has been applied to the wire. For the first time, surgeons have an aid to help them get consistent tension on each wire, and an indication of how much approximation force is being applied to the sternum.

When the spring in the handle of the TORQ device is at 90° to the two notch indicators, there is no tension on the wire. When the spring is aligned with the notch indicators (shown), maximum tension has been achieved.



Increases twist density

Twist density is defined as the number of twists in a given length of wire: the more twists, the greater the twist density. Twist density plays an important role in resisting the distraction forces placed on the sternum after surgery². The TORQ device applies the maximum twist density to the wire, concentrating fatigue at the top of the twist. This means that the wire is cut in a controlled fashion at the top of the twist once the maximum number of twists is reached.

Surgeons can achieve a greater twist density with the TORQ device than with traditional methods, thereby providing a more secure closure which separates less for a given distraction force.

Twists all the way down

The perfect twist is twisted all the way down to the bottom of the twist, tight against the sternum.

If there is upward tension or pulling on the wire when the final twist is applied, a small triangular gap is created at the bottom of the twist. This results in a poor closure, because the small gap allows the wire to deflect more easily. As soon as a distraction force is applied to the wire, the triangle can flatten out, creating slack in the wire and releasing any tension that was applied to the wire.

In contrast, a perfect twist is tightly twisted all the way down to the sternum. The final twist is applied under very little upward tension, ensuring that the twist is tight against the sternum. When a distraction force is applied to the wire, there is no slack in the twist and the force is directly resisted by the twist, allowing for little or no deflection in the wire.

By carefully controlling and releasing the tension and providing an increased twist density, the TORQ device produces a perfect twist, twisted all the way to the bottom, every time.



The power of many TORQ devices

The TORQ is designed so that multiple TORQs can be used at the same time on a patient. Six to eight TORQs can fit on a patient's sternum. Using multiple TORQ devices has two advantages:

- The tension can be increased on each TORQ device before the wires are twisted. A simple analogy is replacing the wheel on a car: you tighten the bolts once and then go back and tighten them all again, giving a much tighter wheel! This method applies an overall greater force across the sternum and ensures that the closure force is equivalent at all points. This is important to ensure that no points are carrying the entire distraction load.
- The sternal halves can be brought together slowly without applying too much tension on a single wire, thereby reducing forces on the bone at that point.



Clinical results

CT scan images of a female patient whose sternum was closed with the TORQ device are shown below. The images were taken two weeks after surgery. The images show a very tightly closed sternum from the manubrium (left) to the xyphoid (right).



Clinical impressions

Dozens of surgeons around the world have used the TORQ device. From their clinical experience, it is clear to them that using the TORQ device results in tighter, more secure closures and less post-operative pain for their patients. Here's what surgeons say about using the TORQ device:

"It's the best closure I've had in 15 years"

Dr. Gerald Sardella, Cardiothoracic Surgery Head, Concord Hospital, NH

"After using the TORQ it is as if the sternotomy had never been performed"

Dr. Nikolas Tsirikos, Rochester, MN

"Patients closed with the TORQ seem to have much less sternal pain early after surgery, and as a result are able to move their chest wall better"

Dr. James Abel, St Paul's Hospital, Vancouver, BC

Kardium

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¹ Internal Kardium laboratory testing

² S. Glennie et al. / Interactive Cardiovascular and Thoracic Surgery 2 (2003) 3–5 Strength of wired sternotomy closures: effect of number of wire twists.