



Robotic Rib Spreading Tool to help patients hurt less and heal faster.

One advanced technology company is taking on the challenge of developing hand-held, robotic surgical instruments to help patients hurt less and heal faster. High torque maxon motors ensure jerk-free movement of the tool.

It may sound unbelievable, but some tools that physicians use to perform invasive surgery were originally developed in the 1930s and have gone through minimal updating since. Most often, these tools have been efficient enough to do the job, even if patients took a long time to heal. This is especially true when a surgeon has to enter the chest cavity for heart or lung operations. To date, there are two primary methods used to open a space large enough for a doctor to work inside the chest: a thoracotomy or a sternotomy. The thoracotomy is where an incision is made between two ribs to gain access. For a sternotomy the surgeon saws through the sternum and then spreads it apart. In both cases, the surgeon pries apart the ribs or sternum using a hand-cranked, stepping mechanical jack called a thoracic retractor. Large forces are needed to spread the ribs. In fact, the Physcient team discovered that the forces necessary to separate the ribs are roughly equal to the weight of the person being operated on, which means that using a thoracic retractor can result in broken bones, crushed nerves, wrenched joints, and torn ligaments. All of these factors offer adverse post-surgical effects that can be ongoing.

Physcient (Durham, NC) has developed technologies that are expected to greatly reduce the damage of thoracic retraction. “Two of the concerns we ran into,” said Chuck Pell, co-founder (with Hugh Crenshaw) of Physcient, “were that we had to maintain the same footprint as other thoracic retractors being used in the operating room today, plus we had to be able to sterilize the tool repeatedly, to be used for literally hundreds of cycles.” The company’s Assuage™ Smart Retractor™ was designed to apply technology to solve a longstanding problem without changing surgeons’ procedures.

According to Mr. Pell, “We both [he and Dr. Crenshaw] studied biomechanics, and it is that understanding of how creatures move that we use to translate into technology. We recently turned that knowledge to surgical tools, and are finding it very interesting. Many of the tools used in surgery today were invented prior to biomechanics becoming a mature science.”

The National Heart, Lung, and Blood Institute says that over half a million heart surgeries are done every year. Add to that number another hundred thousand lung surgeries, and the need for better tools quickly becomes apparent. Because of the antiquated design of thoracic retractors being used today and the number of surgeries being performed, the incidents of rib fractures has continued to increase.

Crenshaw and Pell recognized that there had been little research pertaining to the forces generated by rib spreaders in the past, and brought together a team to measure the effects and produce the technology to greatly reduce damage. Bones can flex quite a bit before breaking, often due to the rate at which the spreader moves—a sudden bend like that delivered by a hand-cranked thoracic retractor can cause a rib to snap. Bone fibers need a little time to adjust. By placing sensors in the Assuage™ rib spreader, it's easier to detect if fibers begin to break down. This information is then fed back into the tool so that it responds instantly to tissue events. This closed-loop feedback to the motor must have a high degree of precision and be completely reliable to be used inside medical devices.

Physcient designed a prototyped rib spreader around a motor manufactured by maxon motor. One of the more important specifications for the motor was the lack of cogging that often occurs at very low speeds. The rib spreader has to be able to move smoothly without jerking motions that can cause undue damage to the patient. DC brushless motors easily operate from a battery, and an on-board controller and sensor system helps to maintain a controlled spreading process. In order to handle the high forces necessary, Physcient selected high-torque motors. “The motors we use from maxon not only have to handle the greatest retraction forces ever measured in the medical industry, they also have to be precise in order to reduce damage to ligaments and soft tissues,” Pell said.

Powerful drives for soft movements

maxon manufactures a complete line of motors from 6mm motors to 90mm motors for a wide variety of applications. They are electronically commutated for minimal electrical noise. The company's DC brushless motors have no mechanical brushes to wear out, which allows them to provide extremely long motor life. By being designed using high-grade, preloaded ball bearings an additional benefit in longevity is added to the motor. maxon motors provide a low profile design ideal for applications requiring a small footprint.

The Physcient Assuage™ Smart Retractor™ takes into consideration the physics of bone and tissue. As with most cardiothoracic research, tests were run on pigs, which are biomechanically similar to humans. The Physcient team built a prototype that used two rows of curved metal fingers, meant to cradle a single rib. As the retractor automatically spreads the ribs, sensors provide feedback to the maxon motor, providing smooth opening. In the experiments, Physcient's retractor greatly reduced tissue trauma, reduced pain, improved breathing, and resulted in better overall recovery.



and motor controls for the medical market including their EC brushless series, which is particularly suited for use in medical devices. © 2012 Physcient

Once the team at Physcient produces the Assuage™ rib spreader, they plan to look into other medical equipment that hasn't changed over many years. Their aim has always been patient-oriented through offering the right tools for the surgeons, and plans to automate and upgrade the entire surgical toolkit. Physcient plans to bring Assuage™ Smart Retractor™ to market in 2013.

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Figure 1: Detail of a motor housing assembly of a Physcient prototype using the latest motor technology. The Assuage™ Smart Retractor™ will require little training and provide a useful tool for surgeons to help patients hurt less and heal faster. © 2012 Physcient