MIRACLE MACHINE: The combination of focused ultrasound and magnetic resonance imaging is a surgical breakthrough INSIGHTEC

Scalpel-free surgery

BERNARD DICHEK visits an Israeli company that uses ultrasound to operate on patients without knives, drugs – or pain

PHYLLIS WALKER, A 77-YEAR-old woman from Ivor, Virginia, was unable to write letters to her grandsons, soldiers serving in Iraq and Afghanistan. She had a neurological condition known as essential tremor that caused her hands to shake uncontrollably.

In August 2011, Walker participated in an experimental study at the University of Virginia where doctors used a procedure known as focused ultrasound. In a matter of seconds, precision-generated sound waves seared away the tiny misfiring nerve center in Walker's brain that was causing the problem. Walker could now use her hand normally again. She could resume writing to her grandsons.

"Conventional treatments for essential tremor normally involve several operations and weeks of recovery time," says Yoav Medan, a member of the core team that pioneered focused ultrasound at the Israeli company of InSightec. He points out that because of the remarkable ease with which focused ultrasound works – the procedure does not involve surgery or drugs, causes no pain and requires little recovery time – many have likened it to something out of a science fiction movie.

Medan tells The Jerusalem Report at InSightec headquarters in Haifa that this is a quintessentially Israeli story, combining many of the elements that drive Israeli innovation: hutzpa, multidisciplinary work, army background, access to high-risk finance and an unabashed desire to improve the human condition.

Focused ultrasound is not new. Medan mentions attempts in the United States to use focused ultrasound to perform brain lobotomies in the 1950s. "But there was something fundamental that they were missing. They were missing the vision," says Medan.

Breakthrough

The breakthrough occurred when InSightec combined focused ultrasound with magnetic resonance imaging (MRI) in order to guide the ultrasound beams to targets that are sometimes mere millimeters in size. "Finding a way to measure temperature changes at the target site within the body was also an important milestone," he adds. "It gave us what engineers call a complete closed loop system." The invention of focused ultrasound, like many other discoveries, now that it has been perfected, may seem like a relatively simple and obvious technology.

But it looked very different when Israeli businessman Motti Zisser purchased InSightec as a start-up venture 12 years ago. "To me it definitely sounded like science fiction. What, to be able to create a virtual scalpel where you could have operating rooms without knives?" exclaims Zisser, the owner of industry pioneer Elbit Imaging, whose main business expertise is in real estate development.

Zisser admits that he knew very little about medical technology at the time. His purchase of InSightec was part of a package deal in which the assets of Elscint, a medical imaging company and the parent company of InSightec, were sold off by General Electric. The corporate giant retained shares in the company but did not want to be the owner of a medical technology that had therapeutic uses and could thereby leave GE vulnerable to lawsuits from dissatisfied patients.

"I spent four hours listening to InSightec founders Kobi Vortman and Oded Tamir explain their dream to me," recalls Zisser, "and I asked myself if I shouldn't just stick to real estate." Zisser nonetheless decided to pump $20 million into the company and give the managers two years to show progress. They put together an R&D team that drew on experts from a wide number of disciplines.

One of them was engineer Yoav Medan, who had worked at the Israeli Research Division laboratory of IBM on projects that included the earliest processing systems for the very first models of personal computers in the 1980s. Medan, today InSightec's Chief Systems Architect, is a quiet-spoken man in his early sixties, whose background is typical of many of the creative thinkers working in Israel's high-tech industries.

The removal of a myoma using conventional surgery often involves a hysterectomy, hospitalization and pain

His formal studies in engineering at the Technion were combined with his military service in the IDF. After completing the academic part of his military duty, he was assigned to a team developing some of the Israel Air Force's first unmanned aircrafts. It required more than just a knowledge of aeronautics.

"You had to be really daring. It took real hutzpa for someone like me, an inexperienced engineer in my early twenties, to take on such a big challenge," says Medan, still apparently awestruck at the magnitude of the task. "No company would ever give you a chance to do something like that so early in your career."

Joining the Elscint founders and Medan were other engineers who had worked in R&D in the army or at Rafael, the defense systems manufacturer that was downsizing at the time. InSightec and a number of other biomed start-ups, leveraged the skills the Rafael veterans had acquired working on military technology, such as being able to work under pressure in multi-disciplinary teams without a hierarchical structure and recruited them to develop biomedical technologies.

At Given Imaging, another successful Israeli bio-med start-up, former Rafael scientists used the principles deployed in guiding missiles to develop a swallowable camera-in-a-capsule for detecting intestinal ailments, which today is in wide use around the world. Medan draws a comparison between the way he designed airplane navigation systems to be as autonomous as possible to what he has tried to achieve in the design of medical systems like focused ultrasound.

"In medical systems the goal is the same. You want to improve both accuracy and safety by creating an autonomous system that is not subject to human error," Medan says, pointing out that one of the advantages of focused ultrasound over conventional surgery is that it equalizes the quality of medical care that patients receive.

"As a patient you don't have to worry about whether the surgeon is an experienced veteran or performing his first operation. All the doctor does is move a computer mouse. The tissue removal is perfectly accurate every time." In addition to improving the technical accuracy of surgery, Medan says that he and his team were motivated by another factor.

"What really spurs me on is knowing that we can reduce a lot of suffering," says Medan, citing the impact that focused ultrasound is having in removing myomas, or uterine fibroids. "Myomas, as many women know, can be very painful even though they are not necessarily life-threatening. But the removal of a myoma using conventional surgery often involves a hysterectomy, hospitalization, pain and results in the woman no longer being able to give birth," says Medan. Focused ultrasound has turned myoma removal into a simple out-patient procedure that does not endanger the reproductive system.

Non-invasive

InSightec chose the removal of myomas to be the first clinical application for its product. Successful clinical studies led to broad acceptance in the medical community and after gaining FDA approval in 2004, the company began to market its focused ultrasound machines. But despite the eagerness with which the public welcomed non-invasive surgery, the company soon discovered that it had to overcome many obstacles before the technology could become widely used.

Unlike myomas, getting FDA approval for other indications has turned out to be a long and arduous process. Clinical studies show promising results in the removal of tumors for breast, prostate gland, liver and other cancers, but the company is not yet able to market its machines for those indications.

Because the technology is multi-disciplinary – overlapping the traditional roles of surgeons and radiologists – turf wars have erupted between specialists from the two fields.

In addition, the novelty of the system has meant that in markets like the US, gaining insurance reimbursement is not automatic

YOAV MEDAN: 'Conventional treatments involve several operations and weeks of recovery' INSIGHTEC

and often involves considerable lobbying.

Competition has also emerged. InSightec machines, distributed internationally by General Electric, were the first ones to reach patients. Philips has recently developed a similar device. The technology of General Electric's archrival may not yet have reached the level of InSightec's innovation, but Philips is aggressively marketing its products on a pay-per-use basis. This may turn out to be more attractive to some potential customers than InSightec, which sells its products outright.

Still, with machines being sold in the range of $1-3 million, the company is already generating more than $20 million in annual sales, and regulatory approval is expected in the next few years for a number of different cancer indications. In addition, progress in clinical studies for neurological conditions, such as essential tremor, movement disorders and Parkinson's, suggest more and more potential uses.

> **All the doctor does is move a computer mouse. The tissue removal is perfectly accurate every time**

Zisser's initial investment of $20 million did not suffice to turn InSightec into a profitable company. Instead, investment in the company has grown to more than $150 million. But 12 years later – during a decade in which Zisser's real estate ventures have developed shopping malls and luxury hotels across the US, Europe and India – he is convinced he did the right thing.

"I did my educational studies in a yeshiva and on the day I graduated I told the head of the yeshiva that I planned to enter the business world," recalls Zisser. "He told me to make sure I did something in a field where I would be helping people."

Medan is also convinced. An online TEDMED lecture explaining the InSightec technology has become one of the series' most viewed talks and he has been inundated with requests for information. "This is the way people want to be treated," he says. "They don't want to have their bodies violated." ●