Interventional Pulmonology

superDimension: Guided Bronchoscopy to the Lungs’ Periphery

Novel tracking and imaging technology keeps the pulmonologist in charge of more procedures, as well as sparing patients from invasive surgeries.

By Nancy Dvorin

The term “restart” doesn’t quite do justice to superDimension Ltd., which has changed direction more than once in its ten-year history. Formed initially to develop a non-medical product, the Israeli company has migrated its founding technology to the emerging field of interventional pulmonology, targeting specialists whose eagerness to use devices far exceeds the tools at their disposal. (See “Pulmonology: The Next Interventional Cardiology,” START-UP, January 2003).

superDimension describes its superDimension/Bronchus as a “global positioning system” for the lungs. Based on electromagnetic localization technology, superDimension/Bronchus combines a novel, steerable catheter that can maneuver in the tiny vessels at the lungs’ periphery, with image-processing and navigation technologies that allow pulmonologists to visualize in real time the path of the catheter as it moves through the lungs.

By far extending the reach of their primary tool, the bronchoscope, superDimension believes its platform offers pulmonologists the potential to expand the scope of their practice. They’ll be able to diagnose more diseases minimally invasively at an early stage. Its ability to reach the lungs’ periphery also opens the door to therapeutic applications: localized drug delivery and radioactive seed placement, for example, as well as tissue ablation and other minimally invasive versions of surgical procedures for large, underserved lung diseases such as cancer and emphysema. Patients will benefit from lower cost, lower-complication alternatives to surgery as well as from earlier detection of the disease, and pulmonologists will benefit from increased procedure volume since they’ll refer fewer cases to radiologists and surgeons than they do today. Payers will save money on procedures that are far less costly than the invasive alternatives.
More than 1.25 million bronchoscopic procedures are performed each year in the US, some 4 million worldwide. Biopsies of suspected cancerous lesions account for the majority of procedures. Nevertheless, existing scopes are too large to penetrate into the lung’s periphery—the site of most cancers today. Consequently, pulmonologists operate without real-time guidance as they advance diagnostic tools towards the lesion. In order to reach the target that pre-operative CT scans have identified, pulmonologists eyeball the location on the CT image and then hope for the best. The alternatives are percutaneous needle biopsy or open surgery.

superDimension hopes to change all that with its superDimension/Bronchus system. At its heart is the Locatable Guide, a disposable flexible catheter with 360-degree steering capability, allowing it to maneuver through the small branches of the bronchial tree. Its ability to steer tightly in soft tissue is “unique in all medical disciplines as far as we know,” says David Tolkowsky, superDimension’s president and CEO.

The tip of the catheter contains a 1mm location sensor that samples over 150 times per second, with a very high signal-to-noise ratio that translates into reliability. The sensor is activated when it enters the electromagnetic field generated by the Localization Board placed underneath the mattress of the procedure bed. The board wirelessly tracks the sensor’s position as it moves through the patient, and that data is displayed in real time on the company’s 3D CT Roadmap, thanks to software that turns standard two-dimensional pre-operative CT data into three-dimensional images that allow pulmonologists to precisely navigate in smaller airways. It enables accurate image-to-body registration, says Tolkowsky, in a manner that is mostly transparent to the physician. The company’s technology also compensates for motion due to the patient shifting, as well as heartbeat and respiration. This enabling technology is vendor neutral and compatible with any bronchoscope or bronchoscopic diagnostic tool on the market today. Currently, the company has 13 issued patents and 10 more are pending in the US, Europe and Asia. superDimension’s first potential home run is in lung cancer, the leading cause of cancer death. Each year, one million new cases are diagnosed worldwide, and one million people die from the disease, which is frequently not diagnosed until it is far advanced. “There’s been a shift in lung cancer over the past two decades,” says Doron Besser, superDimension’s VP of medical affairs and marketing. Twenty years ago, no more than half of lung cancer lesions were in central areas of the lungs, within the bronchoscope’s reach. The advent of filtered cigarettes has resulted in smaller particles penetrating deeper into the bronchial tree, thus as many as two-thirds of cancerous lesions are developing in hard-to-reach areas. Furthermore, with approximately seven million CT chest scans performed annually in the US alone, many more lesions are observed.

CT can detect lesions less than 2cm in size, but imaging alone can’t determine malignancy. Once a lesion has been identified and assessed, subject to certain parameters that are observable by CT such as size and degree of calcification, the next step is a biopsy. The bronchoscope is inserted as far as it can go, which is only one-third of the way in—bronchoscopes cannot proceed past the central airway. (See Exhibit 1.) The pulmonologist then inserts various diagnostic tools through the scope’s working channel.

Pulmonologists currently use fluoroscopy to navigate to peripheral lesions. The problem with two-dimensional fluoroscopy, says Besser, is that lung masses are three-dimensional. Also, fluoroscopy can’t reveal masses smaller than 2cm, which represent the majority detected in CT scans. The pulmonologist is thus forced to memorize the lesion’s location from the CT image and push a tool in rather blindly, hoping to grab a piece of the mass. Conventional tools are not steerable, which makes negotiation of the complex bronchial airways even more difficult. The success rate of reaching lesions in the periphery is
Currently only 35%, says Besser. These blind biopsies also contribute to a high number of false negatives in initial biopsies, perhaps as high as 50%. Consequently, most cancers are not detected until they are far advanced and difficult to treat.

superDimension/Bronchus will not only allow earlier detection, it will also facilitate cancer staging, providing pulmonologists with an easier way to biopsy lymph nodes to determine how far the disease has spread. The lymph nodes are located in center of lungs, behind the trachea. Today, the only minimally invasive way for pulmonologists to reach lesions in the lymph nodes is to visualize them with CT, memorize their location, and then hope that they hit the target when they insert a biopsy needle through the tracheal wall. Physicians are reluctant to insert needles blindly, so they frequently resort to more invasive and expensive options. With superDimension/Bronchus, pulmonologists can identify the entry point to a lymph node and then navigate the biopsy needle to it.

Tolkowsky stresses that use of the system will not require a major change in pulmonologists’ practice, since they’ll use the same CT, endoscope and endoscopic tools, in the same endoscopy suite and by the same staff. The procedure starts as it always does, with a pre-operative CT scan. The patient is then put on table with the Localization Board underneath. The pulmonologist inserts the bronchoscope with the Locatable Guide, and the sensor at the scope’s tip wirelessly communicates its location to the sensing bed. Proprietary software interprets that data and superimposes its location over 3D CT images to enable real-time navigation.

The company believes that its technology could increase the number of bronchoscope-based lung biopsies to 80%, up from 35% today. It should enable pulmonologists to keep more procedures in-house. The implications for patients are significant: many are elderly and fragile, thus rendering highly invasive procedures problematic in the cases where they’re not outright contraindicated. superDimension estimates it could spare one million people from invasive surgery every year.

What a long strange trip it’s been

Pinchas Gilboa founded superDimension in 1995 as a toy company. Gilboa, now the company’s CTO, was part of a team designing electromagnetic navigation systems for Israeli defense contractor Elbit Systems Ltd., and decided to apply an enhanced version of the technology to computer-active toys. David Tolkowsky, whose career up to that point had been in marketing high-tech products, joined as president and CEO in 1996. Making sophisticated toys was a lot of fun, he says, but not a business success. In early 1998, he and Gilboa decided to shift gears and find a new application for the company’s electromagnetic localization technology. At the urging of its investors, superDimension opted for image-guided interventional cardiology. Its strategy was to find a partner for which it would provide localization for myocardial revascularization and cardiac electrophysiology.

SuperDimension laid off its toy specialists, and the remaining eight staffers started work on miniaturizing the sensor down to 1mm from its then 1-inch size, and developing many of the other components in use in superDimension/Bronchus today. The company conducted a few animal studies to see if everything worked, and then set out to find a strategic partner.

Despite superDimension’s complete lack of medical technology expertise, the company in 2000 signed a deal to marry its sensing technology to Boston Scientific Corp.’s catheter for use in cardiac electrophysiology. The deal was worth “millions,” Tolkowsky says, and it was non-exclusive, leaving both entities free to find other partners for the combined technologies. superDimension advanced to late-stage negotiations with General Electric Co.’s medical division and CR Bard Inc. Then the bottom dropped out: Tolkowsky arrived at the office one morning in June 2001 to learn that Boston Scientific had acquired Cardiac Pathways Corp. with its already-FDA approved diagnostic mapping technology, rendering the deal with superDimension superfluous. Tolkowsky says that GE bailed as soon as it heard the news, having no use for the company without Boston Scientific’s catheter. June 2001 was also the month that Tyco International Ltd. announced its plan to purchase Bard. That deal later imploded in the face of the Tyco scandal, but too late to salvage superDimension’s possibility for a deal with Bard.

“Luckily for us,” says Tolkowsky, “in June 2001 we were only six months into our deal with Boston Scientific, so we still had most of the money.” It was back to the drawing board, this time with some medtech experience under their belts. “We established two rules,” he says. One, the company would pick an existing market, not a future market—noting the speed with which superDimension’s initial target, myocardial revascularization, came to an end with results of the DIRECT trial. “Also, we’d come up with a product that we could take to market alone so we wouldn’t have to sell to partners from a position of weakness.” superDimension gave itself three months to come up with another medical discipline that could use localization and navigation technologies.
In August 2001, the company settled on interventional pulmonology, a device-friendly specialist market with few good tools and great unmet needs. It added the steerable catheter, 3D image processing and image-to-body algorithmic registration to its core technologies. In October 2001, in the midst of the funding drought, the company embarked on a financing round. It closed the round in January 2003, "15 months and 100 VC meetings after it started," notes Tolkowsky. superDimension pulled in $14 million—the only money of its $25 million raised to date that came in because of interventional pulmonology. All 28 of superDimension’s employees hung in during this dry spell. "A true testament to the teamwork that is a key fundamental of this company," says Doron Besser, whose own particular fate was to join the company the day after the Boston Scientific deal fell apart.

**Rapid approvals, rapid launch**

Since 2003, the company has moved quickly. That same year, it embarked on its first clinical trials, in Europe and Israel, for biopsies of peripheral lung lesions. Trials for the same application are currently underway in the US at Beth Israel Deaconess Medical Center and the Cleveland Clinic Foundation.

The company obtained a CE mark in 2003 and launched in Europe in 2004. It has established a subsidiary in Germany with a direct sales force of four and is using distributors in 12 additional European countries. superDimension has sold 14 systems to date in Western Europe.

The superDimension/Bronchus was 510(k) cleared in November 2004, "just seven weeks after we submitted," notes Tolkowsky. He views this as a validation not only of the technology, but the great need for it. The company has opened a sales subsidiary in Minneapolis to prepare for US market launch in early 2005. Tolkowsky expects to install a total of 50 systems worldwide in 2005, 20 of them in North America. The company projects revenues for 2005 at $2 million, growing to $24 million by 2007.

Pricing for the US market is not yet etched in stone. The hardware and software that comprise the superDimension/Bronchus system will go for $70,000, and the disposables for each procedure will be in the $600 to $995 range. At launch, the procedure will be reimbursed at the standard outpatient bronchoscopy rates, and the disposables will be paid at cost. superDimension will file for new technology APC codes in May 2005.

With most of the pieces for lung biopsy falling into place, superDimension is advancing its therapeutic programs. A clinical trial is underway at the Thoraxklinik in Heidelberg on using brachytherapy for peripheral lesions—superDimension/Bronchus delivers radioactive seeds into the lungs’ periphery and they are activated with external radiation. Preliminary results on the five patients who have been treated are encouraging, according to Besser. A separate trial using cryotechnology commenced recently.

The company will soon embark on animal studies of radiofrequency ablation for lung tumors. And Tolkowsky reports that the company has initiated discussions with potential pharma partners regarding local delivery of chemotherapeutic agents, as well as delivery of other drugs or biologics. He does not rule out the possibility that the company will have one drug-related deal in place by the end of 2005.

Based on the feedback they have received from clinical investigators, customers, and attendees at medical symposia, Tolkowsky and team are confident that superDimension/Bronchus will receive a warm welcome in the marketplace. They hope for a similar reception from the investment community. The company is in the process of raising a $15 million round now. If all continues to go well, superDimension will file an IPO in late 2006.

At least for the foreseeable future, superDimension will occupy a unique niche. Tolkowsky is aware of similar technology in development in academia, but says it is at a very early stage. He acknowledges that competition will come, but in the meantime superDimension has a significant and growing IP portfolio, acceptance by opinion leaders, and a first-mover advantage.

**Comments?**

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