SPINEGUARD: Taming Of The Screw

Much of the innovation in spine over the past decade has aimed at replacing fusion, still the standard of care. SpineGuard's novel sensor technology is betting on fusion's long-term prospects, helping patients and surgeons by making the procedure safer.

- More than a decade ago, Paris-based SpineVision sought to tap into a spine market that was just beginning to explode with a broad-based line of implants and other devices. SpineVision struggled and as part of its re-start strategy, spun off its novel sensor-based technology designed to help surgeons place spinal screws more safely and accurately.
- Studies show that misplaced screws may occur in up to 20% of cases, and can have dire consequences for both patients and surgeons.
- SpineGuard's novel technology emits audible signals to guide surgeons to make certain that they are placing screws properly. An added benefit: as surgeries go more quickly and efficiently, radiation exposure for surgeons is reduced, eliminating a major health risk.
- In contrast to SpineVision's broad portfolio, SpineGuard officials have consciously followed a niche strategy, arguing that companies with novel technologies require strategic focus, particularly in a spine market that has slowed dramatically from its dynamic growth of just a couple of years ago – a niche, moreover, that embraces fusion surgery, long a gold standard.

Executive Summary >> 89

BY DAVID CASSAK

Like its sister segment in orthopedics, total joint replacement, the spine market has long benefited from favorable dynamics and, particularly in its early boom, strong pent-up demand as new, procedure-enabling technologies came to market. But spine has historically differed from joint replacement in one crucial aspect, even as the market soared: significant unmet clinical need.

Indeed, total joint replacement proved such a robust market in large part because procedure success rates quickly reached astronomical levels, while in spine, for all of its dynamic growth, surgeons over the past decade continued to turn to a variety of different approaches and technologies to treat a wide range of different spine problems. That – and the fact that spine procedures were exploding in volume while the rest of the medtech industry had slowed – may explain why the 2000s saw a virtual tidal wave of spine start-ups with novel technologies, in marked contrast to the 1990s in total joint arthroplasty, which saw relatively few start-ups with novel total hip and knee replacement products.

One of the myriad spine start-ups was Paris-based **SpineVision SA**, a company with a vision to be a broad-line supplier, backed by some of Europe's leading investors. But as the spine market grew more and more crowded, with more and more companies and technologies competing for a piece of the clinical pie, companies like SpineVision found the going tough – particularly as a European company trying to tap into a growing, but complex US market. Faced with the need to raise capital, SpineVision half a dozen years or so ago explored a number of options before settling on the sale of a novel technology the company had developed – a sensor-based device that would help surgeons place pedicle screws more accurately by audibly warning them when they were off line during surgery – to a group of former executives who created a spin-off, **SpineGuard SA**.

But if SpineVision was, strategically at least, similar to many spine start-ups of the early 2000s, bringing to market a wide array of devices, SpineGuard has long pursued a niche strategy, focused on building a portfolio of products around its *PediGuard* platform. More, where many start-ups of the past decade sought to develop novel technologies that would replace what is arguably spine's gold standard procedure, fusion, SpineGuard's niche targeted pedicle screw procedures, placing a long-term bet on fusion's sustainability.

THE TURN OF THE SCREW

Alan Olsen has a long and intimate history with the difficult pedicle screw issues that spine surgeons and companies have faced over the years. One of the original founders of spine giant Danek Group, Inc. (later merged with French spine company Sofamor in 1993 to create Sofamor Danek Group Inc., now **Medtronic Inc.**'s Spinal

and Biologics business unit), Olsen retired from Sofamor Danek in 1994, only to return that same year to be a member of a legal oversight committee when the company was hit with the bone screw litigation that was rocking the spine industry at that time.

The bone screw litigation looms large in the history of spine; the successful resolution of the problem would usher in a period of dramatic growth that lasted for more than a decade, in the process transforming spine into arguably the most dynamic market in orthopedics, if not all of medical devices. But 25 years ago, spine offered a very different profile than the dynamic market of the 2000s: a submarket that was small, with precious little in the way of gold standard technology, and that was confronted with a looming liability problem. Indeed, back then, bone screw liability was only part of the picture for emerging spine companies. "In those days, most of the companies we competed with were hip and knee companies," Olsen recalls. "There was very little interest in the early stages of the spine market." In fact, when Danek officials, prior to the company's IPO in 1991, put the company up for sale, the leading orthopedic implant companies all passed and the company received no offers at the price at which the officials had valued it. "When Danek first got started with devices used by spine surgeons," notes Olsen, "no one thought there was a substantial market potential in spine."

In many respects, Danek's IPO was reflective, if not the cause, of the remarkable transformation spine was about to undergo. The company's $125 million valuation was several times the (unrealized) value company officials had put on Danek when they had sought a buyer. Led by a strong management team that included CEO Ron Pickard and Alex Lukianov, then Danek's VP of sales and marketing and now CEO of spine leader **NuVasive Inc.**, Danek itself had begun to show dramatic growth. "Suddenly, it became clear there was this tremendous opportunity in spine," Olsen goes on. "And companies like Danek, Sofamor, and Acromed became really hot."

For about a five-year period in the mid-1990s, however, the bone screw litigation, alleging off-label use of the devices (bone screws were indeed routinely placed in vertebral pedicles), cast something of a pall over the burgeoning spine market: a high-profile report on the television show *20/20* in December of 1993 sparked a wave of concern that affected everyone in the industry. "That was the beginning of the sky falling," Olsen recalls. The litigation would soon engulf not just product companies, but surgeons, those earning royalties from screws they had helped develop as well as others who served as consultants to spine companies, professional societies, "even journalists who had published anything about pedicle screws were dragged into it for being part of the process," says Olsen.

And even though the early product concerns arose around a competitor's devices, Sofamor Danek took a hit, as over one 12-month period the company's stock went from the upper $30s to below $12. In fact, Sofamor Danek became a target of many lawsuits because as the leading spine company, it became, as Olsen puts it, "the deep pockets" attracting the attention of litigants. Hence the special litigation task force the company put together.

AS SPINE BOOMS, A START-UP STRUGGLES

By the late 1990s, the bone screw litigation was largely over, with most cases either settled or dropped, and the industry's dynamic growth would in a very real sense soon make the litigation a distant memory. Whether the resolution of the problem triggered spine's dramatic growth or simply removed a major impediment, by the late 1990s, spine was exploding. By the end of the decade, Sulzer's acquisition of Spine-Tech for $595 million and Sofamor Danek's own 1999 deal with Medtronic for $3.4 billion would usher in a decade of high growth, explosive valuations, and rampant company and technology development.

Launched in September of 1999, Paris-based SpineVision was one of literally hundreds of spine start-ups that arose as companies and their investors sought to tap into the fast-growing market spine had become. Founded by five Sofamor Danek executives – Gerard Vanacker, SpineVision's first CEO, Dominique Petit, SpineVision's first chief technology officer, Xavier Leroy, a manufacturing engineer, Hervé Garbe, a sales executive, and Stephane Bette, a product design engineer and currently chief technology officer and US general manager at SpineGuard – SpineVision was backed early by Sofinnova Partners, a Paris-based venture capital firm with a strong track record of success in medical devices. The company's mission was to develop a broad-line of spine implants to treat conditions such as degenerative disc disease and scoliosis. As part of that broad portfolio, the company also had developed the PediGuard line of pedicle screw-assist devices. (*See "SpineVision: Meeting the Competition Head On"* — IN VIVO, *March 2003*.)

Despite the booming opportunity in spine, however, by the mid-2000s, SpineVision, like a lot of spine start-ups, was struggling. Pierre Jerome is a former Sofamor executive who left in 1997 to join Boston Scientific before taking over sales and marketing for SpineVision in 2005; he is now CEO of SpineGuard. "If I had to boil it down," says Jerome, "I think [SpineVision's] problems stemmed from the fact that it was a European-based company, with a full-line strategy in spine going head to head against large American firms in a US market that was moving very fast and requiring lots of resources to succeed."

Trying to tap the US market, in particular, was "blood-draining," he goes on, in terms of capital spent; SpineVision's technology still showed enormous promise, but that alone was hardly going to satisfy the company's investors. By 2006, Gerard Vanacker was replaced as CEO and the investors began to explore ways to continue to fund the company without pouring lots of additional venture dollars into it. (SpineVision continues today as a privately held company, with devices featuring a percutaneous approach to dynamic stabilization and minimally invasive spine surgery, treating scoliosis and a variety of other spine problems.)

By the summer of 2008, it became clear that, promising though the PediGuard technology was, it didn't fit into the broader-portfolio strategy that SpineVision had begun to put together. SpineVision's investors entertained a number of offers for the PediGuard technology, including one from a large US-based strategic, before selling it to SpineGuard, the start-up launched by Jerome and Stephane Bette, who at the time was the San Francisco-based manager of SpineVision's US operations. "SpineVision needed cash, and they needed something to happen quickly," Jerome continues. "And Stephane [Bette] and I saw the clinical and market potential of this [i.e., the

PediGuard technology]. It just needed a dedicated effort."

Jerome argues that one advantage that he and Bette had in putting together a deal for PediGuard was that "we knew the company well and could move quickly." And, in fact, by August of 2008, SpineGuard had started to assemble a syndicate of VCs led by Omnes Capital (the former Credit Agricole Private Equity), a leading French venture firm. But SpineGuard's fundraising soon hit a snag; facing a deadline from SpineVision's investors to raise the capital necessary for the deal, Jerome and Bette were in London talking to investors in September of 2008 when the Lehman Brothers bankruptcy was announced, sending the global economy into a tailspin. "We were having some great meetings when the whole Lehman Brothers thing happened," Jerome recalls. "And because of the financial crisis, we unfortunately hadn't raised the required amount by the time of the deadline."

By that time, however, the large strategic acquirer had also begun to back off, deterred less by the financial crisis than by some legal issues raised by the fact that it was dealing with a French company. "We knew there were some legal subtleties that could play in our favor, so we stuck at it," Jerome goes on. By the spring of 2009, SpineGuard had found its investors among a syndicate of three French firms, Omnes, A-Plus, and Innoven (now called IPSA), and Irish venture firm Delta Partners, all of which participated in a long, extended Series A that raised €11 million, part of which went to acquire the PediGuard assets, and part to fund the operations of the start-up. (A second round of funding in 2011, drawing on the same investors, raised an additional €4 million.)

Joey Mason, a partner with Delta, notes that by the time Delta was contacted, the French syndicate was already in place and seeking a fourth investor. The deal terms and valuation were obviously attractive, Mason says, though he adds, "what attracted me was the fact that the company was in a niche position with a potential platform technology in a continuously growing industry at the time without any direct competition. It had a product already on the market, albeit early in its commercialization and had a major US focus, with a strong team in place." SpineGuard's real challenge was execution, Mason says, and though the company was at the time "driven from France, the primary engine was the US market," he goes on. "A diligence road trip highlighted the need [i.e., of the product in the market] and how easily it fit with a wide variety of distributors and agents."

CHANGING OF THE GUARD

The fact that Innoven was also an investor in SpineVision was also important, says Stephane Bette: "We didn't want to have more than one [SpineVision VC], but having one was, we thought, necessary for continuity and for credibility with other investors." Indeed, Bette goes on, one of the things that made SpineGuard's bid attractive was precisely that "we would also ensure a certain continuity of activity" for many of the folks remaining at SpineVision. "Within SpineVision, there were many people who were convinced of the value of PediGuard and were eager to [support] a company focused on the technology. The co-inventors Maurice Bourlion and Ciaran Bolger were also very supportive of our initiative."

Having left Sofamor Danek after the litigation task force was disbanded, Alan Olsen, who now serves on the board of SpineGuard, spent much of the 2000s working with small orthopedic and spine companies and doing some charitable work. In 2009, two former colleagues, Rick Treharne, the former VP of R&D at Danek, and Randy Betz, MD, a prominent spine surgeon, both told Olsen he ought to take a look at a promising new technology they had run across, SpineGuard's PediGuard. For Olsen, the importance of PediGuard was immediate: "I can't tell you the number of nights I'd lay awake, knowing that one of our implants had had some difficulty because of a misplaced screw," he says. "Knowing there's a company totally focused simply on directing a proper direction of a pedicle screw" was appealing.

The fact that PediGuard also helps physicians deal with the problem of too much radiation exposure was also important. Reflecting on the passing of a surgeon friend who had died from thyroid cancer, Olsen points to the "importance of reducing radiation exposure in the OR as a result of spine procedures and the safety of the surgeon."

But if SpineGuard's technology got Olsen excited, others saw reason to pause. Even Delta's Joey Mason, who eventually backed the company, notes some early issues Delta had to overcome: "We were concerned about the trans-Atlantic nature of the business and the challenges of a non-US company competing in the US market," he says. In addition, Mason worried that SpineGuard's management team had been through so much at the prior company that they'd be "bruised by the experience." And of course, an issue that has arisen only more recently: the downturn in the spine market.

Interestingly, one of Delta's early concerns had to do with the SpineGuard's narrow focus. "We worried that this was a one-trick pony to start with and might take a long time for the potential of the platform to be realized," says Mason. But on the contrary, SpineGuard officials have argued from the beginning that the company's narrow focus was and long has been more of an asset than a liability. "Back in the days of Danek and Sofamor, having a full-line strategy in spine was probably the best strategy," notes Pierre Jerome. "It was the beginning of the market [growth], and it was important to offer a wide range of [product] options," he says." Indeed, as noted, SpineVision's original strategy was to be a broad-based spine company.

A decade later, Jerome argues, that strategy made little sense, and part of SpineVision's struggles came precisely from the fact that, as the spine market matured, even in a dynamic market, a full-line strategy for a small, venture-backed company became both unsustainably expensive and competitively challenging. By the mid-2000s, the market was more mature and the major players in spine had substantial critical mass and sales volumes. For small companies, in particular, says Jerome, "it became much more difficult to differentiate and create value as a full-line player. Stephane Bette agrees: "Developing enough products to satisfy the customer, managing a demanding supply chain, having enough inventory – all that was difficult if you also wanted to minimize the burn rate."

And the fact that a lot of companies were all pursuing the same strategy made the approach that much more challenging. "If you think back to that time," says Alan Olsen, "there were a lot of companies like SpineVision. It was very competitive." But, he goes on, "To duplicate the Danek or Acromed experience [was very difficult]. Look at all the companies that have come and gone over the years." That's why SpineGuard's strategy was

consciously built around an innovative technology niche. "Not only did we believe in the PediGuard technology, we also believed in being totally committed to one differentiating technology," says Pierre Jerome. "If, as a small organization, you want to break through, you have to be extremely focused."

Indeed, one of the things that convinced Jerome and Bette to launch SpineGuard was that, running the US operations from San Francisco in the mid-2000s, they saw that although SpineVision was having trouble competing in its core spinal implant business, the PediGuard business was attracting a lot of attention among physicians. But choosing a niche strategy begs the question, which niche to focus on? SpineGuard officials point to several novel technologies that arose at the height of the spine market, all heralded as transformative technologies, only to fall by the wayside. Motion preservation was "overestimated," notes Pierre Jerome. "There were a couple of artificial discs that did great in terms of a trade sale, but they never really materialized as a major product category." Dynamic stabilization, nucleus replacement, disc replacement – all proved to be categories that have fallen far short of their original promise.

Ironically, in its focus on a technology addressing pedicle screw issues, SpineGuard's niche is kind of a contrarian one; where many of the novel technologies developed were supposed to replace spine's core fusion/pedicle screw procedure, PediGuard rides the coattails of a procedure that has proven to have an amazing resilience, particularly in light of the litigation that almost brought the spine industry down a decade and a half ago. "People thought [those other technologies] would replace the base pedicle screw/fusion business," notes Stephane Bette. "But while dynamic stabilization, lumbar and cervical disc replacement, and interspinal devices represent a sizeable market, they're still five to 10 times smaller than the fusion/pedicle screw market," which he pegs at around $7 billion today.

MAKING SURGERY SAFER

Built around its PediGuard technology, SpineGuard bills itself as "the only spine company dedicated to making spine surgery safer." Pierre Jerome notes that "there are dozens of companies that are pure plays, totally focused on spine. We're the only one that's all about safety." And given the current size of the fusion procedure base, with around one million cases performed each year, Jerome estimates SpineGuard's total market opportunity at $1 billion at least. "It could even be bigger," he says, as favorable demographics in established markets, a boom in emerging markets, and the growth of minimally invasive spine surgery push the opportunity even more. "It's big and still growing," he says.

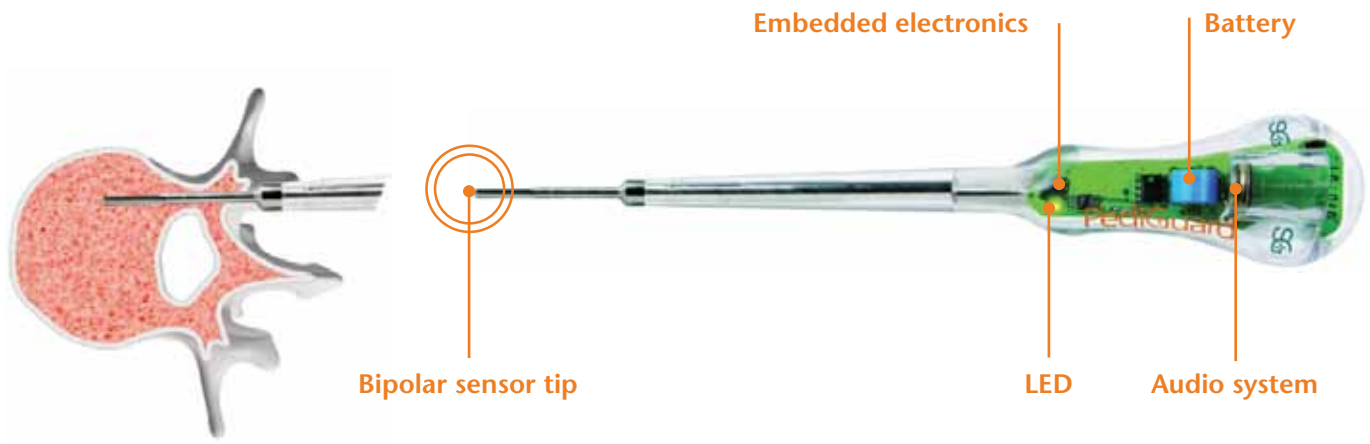
The PediGuard device is a handheld unit with a bipolar sensor at the tip and electronics embedded in the handle. The unit generates an electronic impulse at the tip that flows through the bone from the inner electrode to the outer electrode and is analyzed in the handle, measuring the conductivity of the tissue at the tip within a detection field smaller than a millimeter. Because electrical conductivity is much lower in cortical bone than it is in cancellous bone, as the surgeon moves the tip, an audible signal tells him when he's drifting away from the bone and toward a cortical wall. "At that point, the beeping gets lower and the surgeon has an opportunity to check the direction he is taking and re-direct before a breach occurs," says Jerome. "It's like the sensor on your car that tells you when you're about to hit a wall."

Surgeons can use whichever spine company's pedicle screw they want, and each case, regardless of the number of screws being implanted, requires a single PediGuard unit. For now at least, SpineGuard officials have resisted the temptation to develop a proprietary line of screws. Jerome notes that one of the commercial challenges that SpineVision faced, aspiring to be a full-line spine company, was finding top distributors willing to take on and sell the whole line. "We can work selectively with the best distributors; whatever pedicle screw line they carry, they're happy to take on PediGuard" because it doesn't disrupt their current distribution relationships with the major spine companies.

Moreover, with about 0.5% market penetration, Jerome adds, the company has more than enough on its plate without having to worry about developing its own

Exhibit 1

The PediGuard Technology



SOURCE: SpineGuard

implant. "We have very limited capital requirements," he goes on. "As soon as you go into the implant space, you have to elevate your QA, regulatory, and supply chain capabilities."

The company has proprietary IP to place its sensing technology on the screw itself and in fact is currently working on a so-called Smart Screw that would have the sensor technology embedded in it. But, adds Jerome, "We'd be very willing to co-develop an implant with another company." SpineGuard has already had discussions with most of the major spine companies on additions to their devices that would enable them, Jerome says, to differentiate their screws. Whether SpineGuard offers its smart technology to one spine company or multiple firms is part of the current discussions within SpineGuard. "It's like if we had anti-locking brakes in the auto industry," notes Stephane Bette. "We could license the technology to everyone one or make a deal with one specific company. But we don't want to become a car manufacturer."

Alan Olsen says that the big spine players are still trying to figure out where the value lies in the PediGuard technology and how much value there is. "As a company, SpineGuard clearly has an opportunity to do this on its own, but doing this by itself at this point is not the focus," he goes on. "There's too much opportunity in just building out the technology platform."

A RISING BAR FOR INNOVATION

One other benefit of the PediGuard system: reduced radiation exposure for surgeons. "As surgeons get comfortable using PediGuard, they gradually reduce the use of imaging," notes Pierre Jerome. Today, with minimally invasive surgery, a highly imaging dependent approach because of the lack of direct visualization, and one that is growing rapidly, the level or duration of radiation from imaging is becoming more and more of an issue for surgeons. "Because they lose the direct visual and, to some degree, the tactile feel [of open surgery], they rely even more on images when they do those procedures," he goes on. With PediGuard, surgeons are faster and more efficient and hence use less fluoroscopy – as much as 15% faster, according to a clinical study published last year in Singapore by a Chinese surgeon.

The study suggested that PediGuard resulted in a 25% reduction in radiation; while another study showed a 30% reduction. And unpublished data from Belgium presented at a recent European clinical congress suggested a radiation reduction of more than 50% during minimally invasive surgery. Jerome notes that "the more experienced and respected the surgeon, those doing difficult cases, the more they recognize the value of [reduced radiation]." For Alan Olsen, reduced radiation is "the lightening rod" of spine surgery. "I go toe-to-toe with top surgeons all the time, asking 'Why would you continue to expose yourself?' And the answer is, 'I can't afford not to.' And that's a shame." In time, he says, "this is going to emerge as a huge issue."

The implications of reduced radiation exposure, though more of a surgeon benefit than a patient benefit, are significant. Pierre Jerome points to one study that showed that after 10 years of high-volume surgeries, spine surgeons often approach the radiation limits placed on workers in nuclear plants. "After reaching this level, the worker in the nuclear plant would have to change jobs," he notes. "What surgeon would want to face having to stop doing surgery after just 10 years?"

Throughout the 2000s, spine was the fastest growing opportunity in medical devices, with 15% average annual compound growth, as it leapfrogged total joint arthroplasty to become the largest orthopedic segment as well. Moreover, as noted, it did so with amazing stability, largely on the back of pure procedure volume growth rather than radical technology shifts. Jerome notes that within spine's $9 billion market, $7 billion is based on pedicle screw-based procedures, with half of that total being devoted to pedicle screws specifically, the other half to cages, bone substitutes, and other adjunct technologies.

QUALITY, NOT QUANTITY

But just as certainly, the spine market has over the past two to three years hit a wall, and that dynamic growth has been replaced by a dramatic slowdown and, for some companies, even decline. SpineGuard officials point to a number of factors to explain spine's reversal: the global economic crisis and the perception, more narrowly, of the need to rein in health care costs, uncertainty over US health care reform, the advent of evidence-based medicine and, related to that, a tougher, more skeptical mind-set on the part of payors regarding coverage of specific spine procedures, and shifting sales and commercialization models, including the evolving role of the sales rep, to name just a few.

As a result of these pressures, SpineGuard officials note, the bar on innovation keeps getting higher. "There's a double pressure," says Jerome. "There's pressure from the hospital to reduce prices and, at the same time, a lot of competing technologies that struggle to differentiate and demonstrate their value." But while other spine companies feel the new dynamics as a downward pressure on their market, Jerome insists, "when you look at all of those trends, they fit our strategy very well."

Take for example the intersecting dynamics of health care reform and the shifting role of distributors and their sales reps. As accountable care becomes the norm, hospitals will measure value not in terms of quantity – in the number of procedures performed – but in terms of quality, in better outcomes and fewer revisions and errors; that is, surgeries not performed almost as much as surgeries performed. The fusion market is, by all accounts, a huge market; "it's still the bread and butter of key spine players," Jerome notes, but it gets more and more difficult for reps to show that their products are meaningfully different and better than their competitors given the new economics of health care reform. "PediGuard offers a way for the rep to differentiate what he has to offer, to bring value in the eyes of the surgeon because we're all about improving the quality and the safety of the procedure," he says.

Other companies, too, have made similar arguments. Jerome notes that NuVasive, with its neuro-monitoring technology, "paved the way" for PediGuard. "They did an excellent job of positioning their technology for improving the safety of the placement of pedicle screws." It was, in fact, NuVasive's success in making the case for safety that convinced SpineGuard officials of the opportunity to build a business around PediGuard.

But, SpineGuard executives argue that though they help surgeons better understand where and how to place implants, conventional navigation and neuro-monitoring systems simply aren't enough. Stephane Bette notes that with navigation systems, the surgeon works with a combination of cameras and markers attached to the spine that re-create a kind of model of the spine. "The greater the distance

from the markers, the greater the risk of geometrical error," he explains. To place a pedicle screw precisely requires accuracy measured in sub-millimetric variances. "I have a lot of respect for navigation technologies," Bette goes on. "They're very good at pointing in the right direction and helping with the entry point. But when it comes to being millimetrically accurate, they necessarily and by their very design, have limitations."

Neuro-monitoring systems similarly have limitations, adds Pierre Jerome – for one thing, they only detect problems located close to nerves; for another, they tend to have poor sensitivity and specificity as you move up the spine from the lumbar region, resulting in a lot of false-negatives and false-positives. And they have limitations even in the lumbar region; because many lumbar problems stem from compressed nerves, the ability of the nerve is compromised. In addition, neuro-monitoring systems often don't work well reading lateral breaches; patients under anesthesia need to have the muscle blocker removed for the nerve to transmit signals. Lastly, all such procedures need to be performed with a neurophysiologist present, which can make scheduling difficult.

Alan Olsen notes that most navigation and/or monitoring systems today "can only tell you that you've misplaced your screw after the fact. PediGuard tells the surgeon in real time what's happening at every step of the process." Indeed, for all the success in highlighting safety issues, the problem of misplaced pedicle screws is as enduring as fusion itself. "People tell us a lot of screws were misplaced in the past but that doesn't really happen anymore," says Jerome. "But that's not true." SpineGuard's review of the scientific literature, from just the last two to three years, suggests that with conventional techniques and approaches, about 20% of pedicle screws are misplaced. One study done in New York suggests that in around 40% of cases, CT images indicated what the study's authors called "screws of concern," cases in which at least one of the screws was shown to be placed either near a nerve root or the aorta, or somewhere in the spinal canal. These screws don't necessarily indicate an immediate problem, but they run a higher risk of some complication later and clearly suggest that the screws could have been placed better. "It's one thing to say 20% of the screws are misplaced," notes Jerome. "It's another to say that in 40% of the deformity cases, there are concerns about how the screws were placed."

In short, says Jerome, overall, studies suggest that somewhere around 4% of all patients have some sort of complication due to misplaced screws, and the range of issues and complications is broad. Not only are there the obvious structural issues, which can lead to early revisions, there are also vascular and neurological issues; for example, injury to the vertebral artery in the cervical spine can lead to fatal hemorrhaging if the aorta is punctured, and potential paralysis should the spinal cord be breached. Needless to say, the result of all of these potential complications can be devastating for the patient.

Moreover, it can sometimes take years for the problems to manifest, problems that might have been avoided entirely if only the screws were properly placed from the start. Jerome notes that proper screw placement is critical for the long-term stability of the implant. "If the screw isn't placed perfectly, biomechanically, you won't have the right stability of the construct, which can lead to a revision later on because the original construct wasn't strong enough," he explains.

SpineGuard officials point to studies that show screw misplacement in between 15% and 27% of all cases using conventional surgical approaches; using a navigation system helps, but screw misplacement still occurs in around 8% of cases. PediGuard's studies suggest accurate screw placement, on average, 97% of the time. "The implications for patients are obviously great, but no less so for surgeons," says Alan Olsen. But spine implant companies face risks just as great. "For manufacturers, the question is, how many problems can we afford to have?" Some companies do six sigma analyses, modeling out a predicted failure rate, he notes. But who wants any failures at all? "If you knew there was a means to avoid failures, why would you not want to have that in the procedure?"

Perhaps most importantly, as SpineGuard builds its clinical data, surgeons are coming on board. The company has now recorded more than 25,000 surgeries in which PediGuard was used, with about 300 surgeon adopters and sales to approximately 20% of US academic medical centers. "I think we can safely say that surgeons today believe that it works," says Stephane Bette. "And that was not something we could have said three years ago."

CHOOSING THE RIGHT NICHE

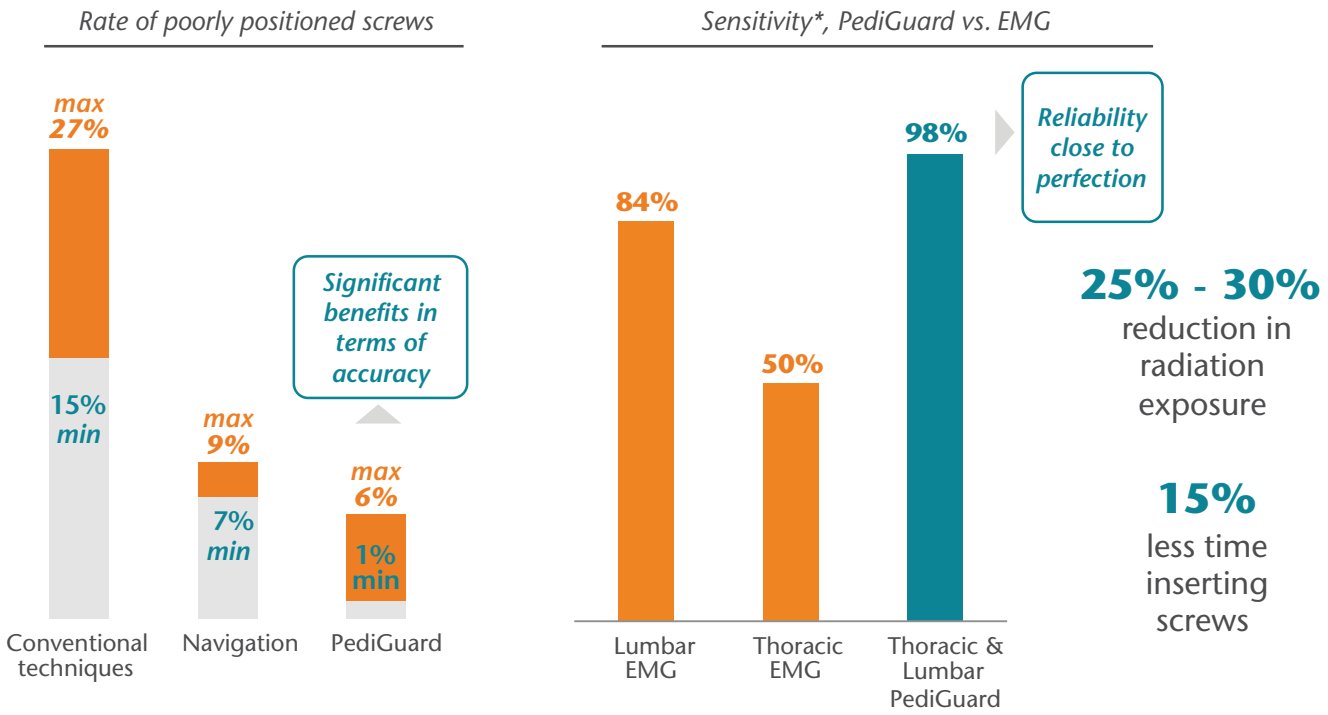
For all of the promise of the booming spine market, the lives of most spine start-ups in the 2000s were far from easy, and the pronounced market slowdown of recent years has only made things more challenging. In part, SpineGuard has benefited from its decision to take a niche approach – many of the start-ups and their investors invested heavily in the enormous promise of spine by trying to build broad-based businesses that would play in a number of spine segments, only to find that strategy increasingly difficult as a handful of market leaders have captured huge segments of the market. Spine isn't quite an oligopoly today, the way the total joint market is, but the number of major players with measurable market share reflects a more mature market rather than a fast-growing one prey to the shifts of a dynamic market.

Then, too, SpineGuard benefited from not only choosing a niche strategy, but also from choosing the right niche – one that fit nicely with a core fusion/pedicle screw volume that has sustained even in the face of a number of clinical and technical challenges. But then SpineGuard in 2008 wasn't really a typical spine start-up. For one thing, the PediGuard technology had had years of development within SpineVision. In fact, the company had established offices in both France and San Francisco that gave it a strong commercial presence in two critical markets and, just as importantly, a global perspective on SpineGuard's opportunities. The PediGuard received CE mark and FDA approval when the technology sat within SpineVision.

Today, five years after the company's launch, SpineGuard sells its technology in 45 countries around the globe, including, in addition to the US and Western Europe, Brazil, Mexico, the Middle East, and Australia, largely through independent agents and distributors. In the US, the company has its own sales organization, with sales managers and product specialists coordinating the efforts of a network of agents. Says Jerome, "The US is not only our number-one market, strategically, it's also a laboratory for us because we are directly invoicing the hospital and collect a lot of data that helps us continuously refine our strategy."

Exhibit 2

Fixing Misplaced Screws: PediGuard Vs. The Competition



*Percentage of poorly positioned screws detected. Sources: Tian 2011, Gelalis 2011, Verma 2010/Parker 2011, Raynor 2007, Reidy 2001.

SOURCE: SpineGuard

Today, SpineGuard does all of its R&D and supply chain functions as well as overseeing its international (i.e., ex-US) business from its Paris office, while San Francisco coordinates sales and marketing for its US business. "It's unique for a start-up, but we thought it would be very valuable to have offices in both places," says Pierre Jerome. "We're basically very symmetrical; we have half of our operations in Paris and half in San Francisco." (The company's sales reflect the dichotomy, with half of its unit sales coming from the US.) And although SpineGuard has tried hard not to duplicate functions in its two locations, it also has made sure that it has, as Jerome puts it, "some sort of presence of every aspect of the company in both locations." Thus Stephane Bette works out of the SF office, but is the chief technology officer of the whole company, while Pierre Jerome sits closest to the R&D function and also offers "a sounding board on most sales and marketing issues."

Such a structure forces Bette and Jerome "to talk on a regular basis on all aspects of the company," Jerome goes on. "Stephane is really our person in the US and I'm the one outside the US, so we have our individual responsibilities. But we talk about issues all of the time." Moreover, having two offices has allowed SpineGuard to be more balanced in dealing with the two markets. Bette, who ran SpineVision's US operations, notes, "I've been in the situation where you have an office in the US and headquarters in Europe, and there are a lot of conflicts and trust issues. Americans tend to think that the Europeans don't understand or take into account their needs, and Europeans tend to think the Americans are burning cash, very extravagant, and not cost efficient." Having two offices with senior executives in each gives both an equal footing. Says Bette, "We were convinced that the two marketplaces are both equally important, strategically and in terms of revenues."

Perhaps most importantly, at the time of the spin-off SpineGuard had behind it a team of seasoned executives eager to bring the technology to market. Jerome notes that "there's a human aspect" to SpineGuard's success: "We were essentially a group of people sharing the same passion for the great potential of the PediGuard technology who at some point faced increasing uncertainty and re-grouped to start their own company."

Discussing SpineGuard's options regarding licensing its technology to others versus developing its own implants, Jerome notes that "we've been so busy building the fundamentals of our business. We needed more clinical data and we needed to fill out our product line. At the founding of SpineGuard, we had only part of what we needed to help surgeons do screw placements properly. And we've had to solidify the sales execution by picking the right commercial partners. That's kept us very busy."

Indeed, over the past couple of years, SpineGuard has been rapidly building up both its technological and commercial operations; 2012 saw the company's first peer-reviewed publications in the US and Asia, a reinforced US sales organization, and product approvals submissions in Russia, Japan, and China, securing approval in Russia. Notes Jerome, "Emerging markets are a great opportunity for us and we've been working on that since the very beginning." Japan is a particularly promising market because surgeons there implant a lot of pedicle screws in the upper part of the spinal column as a result of specific problems that affect Asian patients.

In addition, Jerome notes that emerging markets like China and India are also promising because the health care providers there tend to lack sophisticated navigation and neuro-monitoring equip-

ment. PediGuard's simple and effective technology helps surgeons in those countries leapfrog, so to speak, to greater safety and efficacy. "It's like cell phones in Africa," notes Jerome. "They're not going to build the infrastructure of land lines, so cell phone use is very high."

The company is also working on new iterations and new market opportunities. In addition to its classic (straight) and curved devices, the latter launched in 2011, SpineGuard did a pre-launch last year of a cannulated version of its device featuring a needle and a shaft to address the fast-growing market of minimally invasive spine surgery. And it is working on a wireless, Bluetooth-enabled version that would enable surgeons to capture data on a screen, offering a visual counterpart to the audible signal, and a more accurate measurement of bone quality. "We can do a lot with that," says Stephane Bette. "We can collect and record data, for liability reasons, and provide visual feedback. We can also do an interrogative diagnostic about the quality of the bone. Surgeons can, for example, visualize and compare the signal they're getting with the signal 10 second ago."

TAMING OF THE SCREW

In addition, the company has started to miniaturize its sensor and has developed the IP around what it is calling a Smart Screw, with embedded electrodes to enhance the sensing experience – all of this in an effort to refine and extend its product line, giving surgeons more options with the PediGuard technology. "We need to make sure that we have all of the right shapes on our instruments and that we're addressing all of the tactile expectations of the surgeons," says Pierre Jerome. "Surgeons are like painters. They like to have the exact brush for whatever they're painting, and they don't like to make tradeoffs on their tactile feel." More importantly, he notes, "That's something we've learned as SpineGuard; at SpineVision, we'd never have had that appreciation. When you focus, you start to see these things."

The importance of focus notwithstanding, SpineGuard officials have also identified opportunities for the technology beyond spine – in hip revisions for accurate placement of hip screws, in long-bone trauma, and in cranio-maxillofacial surgery. SpineGuard's recent IPO should, company officials believe, give it the horsepower to move aggressively on both its clinical and product development efforts and also to build out its commercial infrastructure. In a public offering launched this past April on the European exchange Alternext, SpineGuard raised €8.1 million (around $10.5 million), in a float that went out at the low end of the range. Jerome says "that SpineGuard could have held out for a higher price but the lower price gives us more room to move up." And indeed, the offering was 100% subscribed, and SpineGuard's share price was up around 10% two months later.

The capital raise was obviously a big part of reason for the IPO: Jerome says the company will significantly accelerate its clinical studies, including a new MIS study in Europe and a US study to show how PediGuard can improve the training of surgical residents in spine procedures. Notes Jerome, "We need more clinical data to reinforce our message with the surgeons and increase their confidence and the confidence of hospital administrators." The money will also be used "to accelerate commercial expansion and develop product extension for the PediGuard platform," he goes on. In R&D specifically, where SpineGuard is recruiting for two new engineers, the new funds will be used "to complete the line of drilling instruments to match surgeon preferences and the needs of different surgeries," Jerome explains, as well as further building out the wireless platform and the smart screw technology.

But Jerome points to another benefit of the IPO: to further the maturity of the company and to increase its visibility among investors and other device companies. He notes that with senior management spending a considerable amount of its time preparing for the IPO, the last several months offered "an opportunity for the rest of the SpineGuard team to step up. It was very healthy for the organization." Simply meeting the requirements of French officials to go public "forces the whole company to ask some very important and very useful questions" about where the company is and how well it's operating, Jerome goes on. "There are things that you do as a company as you grow and evolve, and the IPO is part of the process and accelerates that."

For now, many of the adjunct technology projects, especially the Smart Screw and the opportunities in hip revisions and long-bone trauma, will likely be done in collaboration with another company, if they're done at all, raising the question of what kinds of relationships SpineGuard will forge with other orthopedic and spine companies as it matures. Talking about the PediGuard platform generally, Alan Olsen says, "I believe the company is either going to grow market share or block market share for the majors, and sooner rather than later," and he adds that if SpineGuard doesn't find willing partners, the company is more than capable of developing the opportunity on its own. "At some point in time, if they [i.e., one of the majors] do not do this, the company is capable of doing it itself." SpineGuard officials are betting on the fact that not just the enhanced clinical outcomes – specifically in terms of fewer misplaced screws – but the need for real differentiation in a fusion market that is both large and mature will lead them to find willing partners.

The large strategics, says Jerome, "need innovation," though he concedes that the most recent acquisitions, following the high-priced deals for motion preservation of the mid-2000s, haven't been a success. The big companies, he goes on, "have cash, but they've become more cautious, more selective, more diligent. They have to be smarter" about the deals they do.

Indeed, reflecting more broadly, mindful of the recent slowdown of the spine market, SpineGuard officials don't expect a return to the high-growth days of a decade ago anytime soon. "I think the market's going to struggle for the foreseeable future," says Jerome. There will be an increase in procedure volumes overall, but much of that will be driven in emerging markets, not easy geographies to tap into. "There will be more and more physicians able to do these procedures and more and more patients who can afford this kind of surgery. But there will be continuing pressure on prices in the US and Europe." Increasingly, he says, in a market driven by customers, both hospitals and surgeons will demand "innovation that brings value to the quality of care." It's a dynamic that fits SpineGuard's strategy very well.

[A#2013800131]

COMMENTS: *Email the author: D.Cassak@Elsevier.com*

RELATED READING

"SpineVision: Meeting the Competition Head On" — *IN VIVO*, March 2003 [A#2003800057]

ACCESS THESE ARTICLES AT OUR ONLINE STORE
www.ElsevierBI.com