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Editorial

"In My Experience...The Brave New World of Minimally Invasive Spine Surgery"

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The author reviews the current state of minimally invasive spine surgery.

It's been a phenomenal evolution in spine surgery right now. I think that we are truly living through what I would call the golden age of spine innovation. If you look at what's going on today with artificial intelligence, brain-computer interfaces, robotics, navigation, augmented reality, and we have the whole world of minimally invasive spine (MIS) surgery. If you're looking at the evolution of minimally invasive spine surgery, you're really encompassing all these innovations that are going on today. We're really living in a world today where things are changing, if not day to day then month to month with how we're able to look at things and how we're able to provide better care to patients.

The whole premise of minimally invasive spine surgery is clearly well accepted now. I think we know that minimally invasive spine surgery in concept, will certainly provide patients with a less risky operation through two probably major ways. Number one, there's less muscle disruption in general. When you're doing MIS surgery for the spine, we're trying to get away from those big open incisions when we can although there's certainly still an indication for those . But, by doing minimally invasive procedures, we're having less muscle disruption, which leads to less postoperative muscle scarring and certainly less intraoperative blood loss. Certainly, we think hopefully less infection with smaller incisions. What this also leads to, as a benefit to a surgeon like me, is less wear and tear. Some of the procedures that surgeons did many years ago in the OR with big incisions and retracting put a lot of wear and tear on our bodies. What we're seeing now is that these minimally invasive techniques are not only helping the patient during and after surgery, but they're helping us also as physicians, and they're helping our OR staff with these procedures.

What we can see, and I think what the literature will show, is that if you can do a minimally invasive procedure, there will be other patient benefits such as shorter stays in the hospital, cost effectiveness, and quicker return to a level of activity. That's not to say that the traditional procedures won't get you to the same point in time further down the road, but I think we're seeing a quicker recovery to that same level of function when we do minimally invasive procedures.

That's why MIS has really taken off. MIS surgery has incorporated so many other platforms that are evolving at this time. I think what we can focus on is some of the real exciting technologies that we have been able to use in MIS surgery. Some of this goes back to some of the basic imaging techniques that we've seen develop even as an outpatient. We went from simple X-rays to CAT scans, to MRI scans, to more defined MRI scans, to MRI scans with and without contrast. Now what we're seeing are these exciting platforms which allow us to image patients from head to toe in 2D and 3D and use that as a tool to look at balance of the spine sagittally, coronally, and therefore really understand the patient's entire skeletal balance from a bone and joint perspective, which I think helps us in our decision making and allows us to focus on patients specifically with their specific presentation. The imaging portion of spine surgery is fundamental preoperatively, intraoperatively, and even postoperatively.

Another fundamental thing in minimally invasive spine surgery is we need to find a way to put in our widgets. Some of the widgets haven't changed, some have. How can we take these phenomenally mechanically engineered widgets, screws, implants, interbody devices, rods, and put these in now with less invasiveness? That's the trick, right? There's no magic wand. You can't get it in without making some kind of incision. I don't think that'll ever happen in the future, but you have to do something. How do you get it in

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minimally invasively? I think what we can see is that there's different techniques that we've developed, and they keep developing and evolving. We have tubes, we have mini retractors, and now we have the world of endoscopic surgery, which is a whole other world that's evolving. We've seen a lot of what spine innovation is doing now is, based on what our other colleagues have done in other fields. We can see what the arthroscopists have done and what they've developed with these scopes, and we've incorporated that into what we do now. Endoscopic surgery using tubes and special retractors, have allowed us to access the spine now in so many different ways that we never did before.

The traditional spine surgery training where you only went from a posterior approach doesn't exist anymore. If you want to be relevant today, you need to stay on top of these new approaches. We have the OLIF,XLIF, TLIF, the ALIF, and the PLIF. I think the ability to put the instrumentation that's made and engineered from a very high specificity to get that in accurately is really the trick that we have to be able to do now. We can have a wonderful Ferrari, for those that are car collectors, but if you don't know how to drive it or your road is not paved correctly, that Ferrari is not going to get to perform the way it was designed and get you to where you want to get and function the way you want it to. I think with all these technologies, you also have to be a little bit careful. If you're a young surgeon, there's the old expression which goes back to our days of training; are you on the cutting edge or lunatic fringe.? Where are you on that continuum? Where are you comfortable being on the Gartner Hype Cycle in adopting technology? Tough decisions because it impacts patient care.

When you look at technology that's evolving, you can see that there's something that's a new technology that's developed that can be earth shattering and that gets this real hype initially and it kind of gets all this excitement. As it is out there more often, that hype maybe starts to get a little bit tailed back because of disillusionment. Maybe the initial stellar outcomes are not being reproduced. These are people who are the next group of early adoptors that maybe have not seen the same expectations met and it starts to drop in popularity. That's when you get your second generation of technology, and that second generation then goes through different methodologies, different modifications , and retooling that makes it now get its second bump. Finally you get your plateauing of these technologies where they become used by a lot of people and they find their plateau where they're going to use the technology.

I think part of the minimally invasive spine surgery world today is also embracing a concept of what we call indirect decompressions. Traditionally, we always believed that if you want to decompress a nerve or decompress a canal, you need to shave away bone. You need to take away disc. You need to expand the volume of space for those nerves. Today, with some of these new techniques, we're finding that an indirect decompression, you're not doing that directly, but you're changing the mechanics of the spine. You're changing the patient's posture, their balance. You can actually take pressure off the nerves without necessarily cutting away those bones, which leads us to having techniques that we can use now that are minimally invasive without having to directly decompress or shave away bone or take away disc.

The perfect example for that is the classic patient with neurogenic claudication. If you have a patient with neurogenic claudication, their typical story will be that when they're standing and walking, they get the pain shooting down their legs. When they sit, it goes away. Well, that's a mechanical difference, we're not talking about vascular claudication. We're talking about neurogenic claudication. In the case of neurogenic claudication, if you can alter the spine's contour, if you can alter the spine's structure, you can permanently take pressure off the nerves by taking away that change in mechanics that go from standing to sitting. What we're seeing with that is the evolution of these interbody procedures, or for instance , the far lateral procedures where we're coming in from the side of a patient and putting in an inter-body device.. That's a minimally invasive technique, and that's led to the placement of device that accomplishes an indirect decompression without any bone removal and minimal disruption of muscle.

Now, is your implant a static implant or is it an expandable implant? An expandable implant can go in through a small incision, but yet you can increase the height by several fold , that would be very difficult to put in, perhaps through a small tube or a small retractor let alone a small incision.. So, one begets the next, is what we're seeing today, we're seeing that technology is feeding minimally invasive surgery. Minimally invasive surgery is demanding technology to evolve to accommodate what we're doing in minimally invasive surgery. Even the implants have changed dramatically since the last 25 years.

The standard allograft or autograft structural implant that was essentially a donut with a hole in the middle has now evolved to these truss structures or these interbody devices that are now having a presentation more similar to the bone. Instead of having a hole in the middle of a donut, you're having something that simulates a vertebral body with cancellous bone on the inside and the interstices or the honeycomb appearance of inside of a vertebral body. That's led us to believe that we can not only have implants that provide a space and a conduit for bone to form between for a fusion, but they actually partake in the fusion.

So, we're talking about mechanobiology now. Mechanobiology kind of incorporates the benefits of these interstitial lattice structures that have stress and strain within them, similar to cancellous bone in the spine. Those interstitial tissues theoretically encourage bone formation by these energies that they give off through stress and strain.

It's really an exciting time in minimally invasive surgery. The big elephant in the room we even haven't touched upon is world of navigation and robotics. Robotics and navigation today are expanding into the world of augmented reality. Wow, it seems ff you can dream it, it's being evolved. There's always naysayers at the beginning of any technology, but I think at this point it's here to stay. I don't want to make a financial analysis, but cryptocurrency, I don't know how many people have bought into cryptocurrency, but it's

here to stay. It's just too ingrained in our society now. And I think the robotic and navigation world is only going to grow. The beauty of the robotic and navigation world and augmented reality world, is that they really place an emphasis on preoperative planning. You want to use this technology not only in the OR but also preoperatively to give this patient the best plans to get a successful structure implanted during surgery.

The world of minimally invasive spine surgery and the benefits are well documented in the literature. It doesn't apply to every case at this point, but we're seeing it used more and more from traditional elective procedures to trauma procedures. The world of pediatrics where you're dealing with smaller patients, I think that's going to be an area where it continues to grow using all these other platforms that are available now. I am just really excited about where our technology, where the innovations have gone right now. Saying that this is the golden age of spine innovation is almost like, you should appreciate what we're going through now because it's truly really amazing.

Apropos to this communication about MIS surgery, particularly innovation surgery and techniques I recall something that one of my mentors, Richard Rothman, MD said. He once told me when we were in the OR. He said, "Marc, we're just glorified plumbers and carpenters." He said, "The real skill that we have is thinking about stuff and diagnosing patients and picking the right procedure." He said, "The act of doing surgery sometimes is really not what the intellect is. The intellect is figuring out what to do for the right patient in the right circumstance."

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