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The 6 T's of Minimally Invasive Spine Surgery

Minimally invasive spine surgery (MISS) can be defined as a "suite of technology-dependent techniques and procedures that reduces local operative tissue damage and systemic surgical stress enabling earlier return to function striving for better outcomes than traditional techniques."[1,2] From experience, there emerge at least 6 surgery and surgeon-related aspects that should be considered when engaging in the process of acquiring and perfecting surgical skills. For this special issue and didactic purposes, we refer to them as the "6 Ts of MISS":

1. *Target:* appropriate patient and procedure selection
2. *Technology:* specialized technology that enables or facilitates MISS
3. *Technique:* surgical skills and perioperative techniques and procedures
4. *Training:* adequate training and teaching of the surgeon and collaborating team and trainees
5. *Testing:* critical review and testing of surgical outcomes (research)
6. *Talent:* development of surgical talent

MISS strives to leave the smallest possible "surgical footprint" while attaining the same or better outcomes as those of traditional open surgery. An emphasis is placed on achieving the best functional outcome that is free of unnecessary iatrogenic risk exposure for the patient. With approximately 1.2 million spinal procedures being performed annually in the United States, nearly 75% of all spinal surgeries could be performed with complete or partial use of MISS over conventional techniques.[3] The full potential of MISS has yet to be recognized, with the treatment of significant and multilevel deformities presenting as the most challenging aspect of MISS. Nonetheless, progress has been made to utilize some benefits of MISS including navigation, lateral approaches, percutaneous screw placement, and so on, in these cases. The "benefit zone" for MISS includes treatment for pathologies that range in the mid zone of complexity, for example, from lumbar spinal stenosis to moderate deformities (Figure 1).

The "6 T's of MISS"

The 6 T's of MISS represent 6 key elements—target, technology, technique, training, testing, and talent—that interact with each other and determine the success of MISS.

Target

Target is defined as choosing the appropriate operation for the patient and pathology—one that offers maximum benefits and minimal complications. A surgeon's experience, background, training level, and the patient's expectations and beliefs can affect surgical decisions. In this special issue, we address this with the contribution by Sertac Kirnaz and colleagues on indirect decompression failure after lateral lumbar interbody fusion.

Technology

The surgical tools and instruments used to perform MISS are rapidly evolving and include access tools such as an endoscope[4] or tubular retractors,[5] visualization and illumination with a surgical microscope or exoscope, an intraoperative imaging system with 2D and 3D navigation,[6,7] surgical planning and augmented reality software,[8] special implants, and curved, bayoneted, and extended instruments.[5] Imaging in MISS is important in order to accurately localize the pathology, avoid wrong level surgery, and insert implants properly. Therefore, the modern surgical microscope is especially helpful for MISS as it gives the surgeon both the necessary depth resolution to work in a field with limited exposure and can be equipped with navigation technology and high-definition video documentation systems. Three-dimensional navigation, including robotic surgery, can increase the accuracy of localization and hardware implantation and eliminates radiation exposure to the surgical staff and, thereby, improve the surgical workflow.[7] We address this with the contributions by Oded Rabau and colleagues,

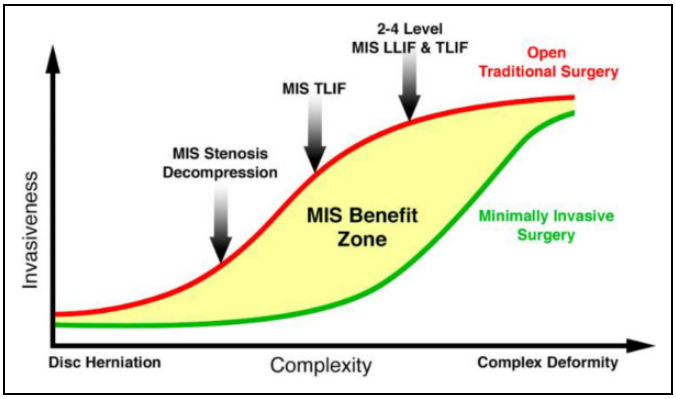

Figure 1. The "benefit zone" for MISS includes procedures in the mid zone of complexity, for example, MIS stenosis decompression, MIS-TLIF, or 2- to 4-level MIS LLIF and TLIF.
Abbreviations: MISS, minimally invasive spine surgery; MIS, minimally invasive surgery; TLIF, transforaminal lumbar interbody fusion; LLIF, lateral lumbar interbody fusion.

Ibrahim Hussain and colleagues, Chau Diep Quoc Vo and colleagues, Barbara Carl and colleagues, Mohamed Albana and colleagues, and Jonathan M. Parish and colleagues.

Technique

Surgical skills and techniques are influenced by the surgeon's operative background, mentorship, training, and operative experience in MISS. The key techniques in MISS include the unilateral approach for bilateral (over the top) decompression via tubular retractors or the endoscope and anterior, lateral, or oblique interbody cage placement and fusion for indirect decompression and deformity correction in the lumbar spine. In this issue, techniques are addressed with the contributions by Jason Ilias Liounakos and colleagues and Angela M. Carrascosa-Granada and colleagues highlighting endoscopic techniques. A contribution by Ori Barzilai and colleagues highlighting the role of minimal access surgery in the treatment of spinal metastatic tumors within the thoracic spine is also included. Finally, we have contributions by Christoph Wipplinger and colleagues, Winward Choy and colleagues, and Jakub Godzik and colleagues highlighting the tandem microscopic slalom technique, OLIF (oblique lateral interbody fusion) with stereotactic navigation, a systematic review of indirect decompression failures after lateral lumbar interbody fusion, and MIS anterior column realignment, respectively, for the lumbar spine.

Training

As MISS becomes more prominent in spine surgery, trainees are receiving earlier and more frequent exposure of MISS techniques, allowing them to graduate with a greater proficiency in these techniques. However, as MISS continues to evolve, it is crucial for MISS-trained surgeons to keep up with these developments and reach the peak of their ability. Teaching yourself and others is the best way to attain proficiency. In this issue, we address the AOSpine consensus paper on nomenclature by Christoph Hofstetter and colleagues, the development of a curriculum for MISS by Franziska A. Schmidt and colleagues, and the best teaching and learning strategies for MISS by Asdrubal Falavigna and colleagues.

Testing

Data provided by research and continuous outcome tracking provide numerous advantages to the field of MISS including improvements in novice surgeon training, surgical decision making, knowledge for optimal technological investments, and patient counseling. In this issue, we address this with the contributions by Derek Guo Ju and colleagues, Norman J. Marcus and colleagues, Chi Heon Kim and colleagues, and Sara Lener and colleagues highlighting a review on intervertebral disc repair, muscle as a primary source of pain and dysfunction, a comparison between MIS (minimally invasive surgery) versus open TLIF (transforaminal lumbar interbody fusion), and a systematic review on MIS TLIF techniques and technologies, respectively.

Talent

When assessing innate and acquired surgical skills, there are several factors including preexisting nonsurgical competence and environmental support. Several nonsurgical skills have been proposed as precursors of surgical talent, for example, innate handiness, playing musical instruments, playing computer games, regular use of chopsticks, and so on.[9-15] The environment can significantly improve surgical skills from a preexisting skill level through adequate teaching and training. Carolin Melcher and colleagues address this in the article highlighting metrics development for minimal invasive unilateral laminotomy for bilateral decompression of lumbar spinal stenosis.

We have to keep in mind that our patients expect and deserve the best possible long-term outcomes—the question of how to get there is secondary. Therefore, we need to critically evaluate the many new and fascinating developments, especially in the area of MISS, navigation, robotics, and so forth. We need to effectively separate the worthwhile and meaningful advances from the glitter of potentially misguided technology. Hopefully, this special issue will be helpful in advancing this goal.

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References

1. AOSpine. MISS: curriculum framework. https://aospine.aofoundation.org/education/curriculum/miss-curriculum. Accessed February 20, 2020.

2. McAfee PC, Phillips FM, Andersson G, et al. Minimally invasive spine surgery. *Spine (Phila Pa 1976)*. 2010;35(26 suppl): S271-S273.
3. Del Castillo-Calcáneo J, Navarro-Ramirez R, Gimenez-Gigon M, et al. Principles and fundamentals of minimally invasive spine surgery. *World Neurosurg*. 2018;119:465-471.
4. Hasan S, Hartl R, Hofstetter CP. The benefit zone of full-endoscopic spine surgery. *J Spine Surg*. 2019;5(suppl 1): S41-S56.
5. Boukebir MA, Berlin CD, Navarro-Ramirez R, et al. Ten-step minimally invasive spine lumbar decompression and dural repair through tubular retractors. *Oper Neurosurg (Hagerstown)*. 2017; 13:232-245.
6. Lian X, Navarro-Ramirez R, Berlin C, et al. Total 3D Airo® navigation for minimally invasive transforaminal lumbar interbody fusion. *Biomed Res Int*. 2016;2016:5027340.
7. Navarro-Ramirez R, Lang G, Lian X, et al. Total navigation in spine surgery; a concise guide to eliminate fluoroscopy using a portable intraoperative computed tomography 3-dimensional navigation system. *World Neurosurg*. 2017;100:325-335.
8. Carl B, Bopp M, Saß B, Voellger B, Nimsky C. Implementation of augmented reality support in spine surgery. *Eur Spine J*. 2019; 28:1697-1711.
9. Buckley CE, Kavanagh DO, Gallagher TK, Conroy RM, Traynor OJ, Neary PC. Does aptitude influence the rate at which proficiency is achieved for laparoscopic appendectomy? *J Am Coll Surg*. 2013;217:1020-1027.
10. Grantcharov TP, Bardram L, Funch-Jensen P, Rosenberg J. Impact of hand dominance, gender, and experience with computer games on performance in virtual reality laparoscopy. *Surg Endosc*. 2003;17:1082-1085.
11. Boyd T, Jung I, Van Sickle K, Schwesinger W, Michalek J, Bingener J. Music experience influences laparoscopic skills performance. *JSLS*. 2008;12:292-294.
12. Donnon T, DesCôteaux JG, Violato C. Impact of cognitive imaging and sex differences on the development of laparoscopic suturing skills. *Can J Surg*. 2005;48:387-393.
13. White MT, Welch K. Does gender predict performance of novices undergoing Fundamentals of Laparoscopic Surgery (FLS) training? *Am J Surg*. 2012;203:397-400.
14. Thorson CM, Kelly JP, Forse RA, Turaga KK. Can we continue to ignore gender differences in performance on simulation trainers? *J Laparoendosc Adv Surg Tech A*. 2011;21:329-333.
15. Rosser JC Jr, Lynch PJ, Cuddihy L, Gentile DA, Klonsky J, Merrell R. The impact of video games on training surgeons in the 21st century. *Arch Surg*. 2007;142:181-186.