Review Article

Trends in outpatient minimally invasive spine surgery

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Contributions: (I) Conception and design: All authors; (II) Administrative support: None; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Abstract: There has been a definite upward trend in outpatient minimally invasive spine (MIS) surgery over the past decade. This increasing prevalence has been driven by several factors including advanced MIS techniques, improvements in perioperative pain management, and economic necessity. There is now a myriad of different spine surgery procedures which can be effectively employed in the outpatient setting, and the concept of awake, endoscopic fusion surgery represents a notable advance in the field. Additionally, the use of multi-modality analgesic agents has shown significant promise in this arena and has become increasingly important in states where legislation affecting narcotic prescriptions have been enacted. Finally, with an aging population, the need for outpatient spine surgery has become imperative from an economic standpoint.

Keywords: Outpatient spine surgery; minimally invasive spine (MIS) surgery; endoscopic spine surgery; Enhanced Recovery After Surgery (ERAS®)

Submitted Feb 08, 2019. Accepted for publication Apr 16, 2019.
doi: 10.21037/jss.2019.04.17
View this article at: http://dx.doi.org/10.21037/jss.2019.04.17

Introduction

Outpatient spine surgery has become increasingly prevalent over the past two decades (1,2). While this trend is likely due to a complex interplay between medical, social, and economic factors, it can be inferred that at least part of this change is due to the benefits offered by MIS surgery. Indeed, pain has classically been a major limitation for discharge in surgical patients (3). This is especially true in spine surgery patients, where muscle disruption, injury, and atrophy have been associated with substantial postoperative discomfort (4).

While the adoption of MIS approaches represents a significant advancement in the quest to reduce postoperative pain, many surgeons have realized the need for a more nuanced understanding of this problem (5). As a result, spine surgeons have now begun to embrace the Enhanced Recovery After Surgery (ERAS®) movement (5). This comprehensive, multi-disciplinary philosophy of patient care was first discussed in Denmark and has since spread throughout the world and across sub-specialties (6-8). Although the application of ERAS® to the world of spine surgery is still in its early stages, the concept of multi-modal pain management has already been adopted with good results (9-11). This approach has become especially critical given a shifting legal and political climate where the prescription of narcotic pain medications is increasingly regulated (12).

Beyond clinical considerations, there are also economic forces at play. Most notably, fundamental changes to the reimbursement system has resulted in introspection on behalf of both hospital administrators and practitioners. With limited resources and an aging population, spine surgeons find themselves tasked with treating a larger number of patients with a significant number of medical comorbidities (13). As a result, many have come to view outpatient spinal surgery as an integral part of the overall solution.

In this commentary, we will provide an overview of recent advances in outpatient MIS surgery, focusing not just on surgical techniques, but also the role of pain management and the economic implications of this shift.

Advances in MIS surgery

The development of novel MIS techniques has resulted in a new world of possibilities for both patients and surgeons. While early techniques centered around small, focused, decompressive procedures such as microdiscectomies, there are now a plethora of surgeries which can be performed in a minimally invasive fashion. We will provide a summary of the commonly performed outpatient MIS spine techniques for the purpose of this discussion.

With regards to non-instrumented procedures, the tubular microdiscectomy is now routinely performed as an outpatient surgery. Using only a small incision, a discectomy can be performed safely and with minimal postoperative discomfort resulting in shorter hospital stays and decreased pain medication requirements (14). One study comparing open to MIS microdiscectomy demonstrated a significant decrease in opiate pain requirements, with the MIS group consuming an average of 12.9 mg of IV morphine, 13.4 mg of hydrocodone, and 0 mg of oxycodone compared to 15.7 mg, 20.9 mg, and 11.7 mg respectively for the open group (14). Since pain is a major factor in early discharge, these reductions are not insignificant.

Endoscopic procedures have also become increasingly common. While the transforaminal endoscopic discectomy was first introduced in 1973, it has gained increasing popularity due to technological advances and an increased patient demand for minimally invasive procedures (15). These procedures offer the benefit of clear, direct visualization with an even smaller skin incision, and in many cases, avoidance of general anesthesia (15,16). This benefits of this approach are highlighted in a study by Lee *et al.* which found a decrease in hospital stay from 3.8 days in the open discectomy group to 0.9 days in the endoscopic group and a decrease in operative time from 73.8 min in the open group to 45.8 min in the endoscopic cohort (17). One could argue, however, that the benefits of MIS surgery in the outpatient setting are only modest and incremental in already minimally disruptive procedures such as laminectomies, laminotomies, and foraminotomies.

While spinal fusion was traditionally performed from a posterior approach, there are now a myriad of options for fusion including anterior, lateral, oblique, and posterolateral techniques. One of the most significant early advances in MIS spine surgery was the development of the MIS transforaminal lumbar interbody fusion (TLIF) (18). While the TLIF itself represented a significant advancement in fusion surgery, these procedures are now routinely being performed through an MIS approach which offers the same benefits of the open TLIF with decreased morbidity (19-21). Unfortunately, there is little data on the use of the MIS TLIF in the outpatient setting. There is, however, good evidence that the MIS approach results in decreased blood loss and a reduction in narcotic pain medication consumed when compared to the traditional open TLIF (22). The MIS technique also offers the benefit of preserving posterior musculature, which has been hypothesized to aid in maintaining physiologic lumbar stability, and therefore decreased adjacent level disease (23).

In our institution, we have also gained significant experience with the awake, endoscopic MIS TLIF (24,25). This procedure represents a culmination of all of the above techniques, utilizing long-acting local analgesics, endoscopic decompression and disk preparation, use of an expandable interbody device, and percutaneous screw placement (24,25). By performing these surgeries awake, we not only eliminate the risks associated with general anesthesia, but also mitigate the risk of nerve injury (24,25). This technique is extremely well-served to the ambulatory setting, as it combines the benefits of MIS techniques with advanced anesthesia practices. It is especially attractive in treating an aging population who would otherwise be dissuaded from fusion surgery due to the risks associated with general anesthesia.

We have worked in close consultation with our anesthesia colleagues to develop an awake fusion protocol, which we have previously outlined in detail (12,24). Communication between the surgeon and the anesthesiologist is critical throughout this procedure to ensure an optimal level of sedation—one in which the patient is comfortable but can still provide feedback which may indicate proximity to neural structures (24,25). Additionally, implementation of an awake fusion program is an iterative learning process, requiring constant process review and refinement. As an example, our anesthesiologists have added several additional medications to their preoperative regimen based upon our early experience, including adding a proton pump inhibitor to avoid emesis and an intranasal decongestant to avoid epistaxis (25). While seemingly minor, we believe these small corrective changes are critical to the success of any awake fusion program, and require close collaboration

between the surgical and anesthesia departments.

The anterior lumbar interbody fusion (ALIF), is another approach amenable to the outpatient setting. This approach was pioneered in the 1930s (26,27), and with recent technological advances now has multiple forms, including the "mini ALIF" and the endoscopic ALIF (28-30). While these procedures could theoretically be performed on an outpatient basis, we were unable to find any published data on this subject. One can hypothesize that the limitation in widespread adoption of the ALIF as an outpatient procedure may be the desire to monitor patients for postoperative ileus and possible vascular complications.

The development of the lateral transpsoas approach to the spine has also solidified its role as an outpatient spinal surgical procedure (31). First described by Ozgur *et al.* in 2001 and modernized in 2006, this approach allows the placement of an interbody graft through a small incision while avoiding the muscular disruption encountered in a posterior approach, and the risk of major vessel injury associated with the ALIF (32). There have been multiple iterations and versions of this approach since its inception and some have suggested a psoas splitting versus transpsoas approach as superior in the outpatient setting due to its reduced morbidity (33). The viability and efficacy of the lateral approach in the outpatient setting compared to the inpatient setting was compared in a retrospective review of 70 patients and demonstrated statistically significant reduction in operating room (OR) time, blood loss and disability as measured by Oswestry Disability Index (ODI) in the outpatient group compared to the inpatient cohort (31). While the reasons for these differences are complex, they speak to not only the viability of the lateral approach in the outpatient setting, but the actual benefits of performing this surgery on an outpatient basis.

Overall, there are numerous MIS spine surgical techniques that are well-suited to the outpatient setting. However, equally as important as the surgical approach is a multi-faceted understanding of the factors which will contribute to success in an outpatient setting.

Advances in pain management

The issue of pain management remains a difficult topic, and one that touches on many societal issues. The "opioid epidemic" has become a catch-phrase spoken across America, and there is no question that narcotic medication abuse poses a major challenge to surgeons (34). In Florida, where rampant prescription of narcotic pain medication has long been a known issue, new legislation explicitly limiting narcotic prescriptions went into effect July 1, 2018 (12).

While the intent of such legislation is appreciated, these changes have created a new barrier to outpatient spine surgery. It is undoubtedly true that opioids are linked to issues with abuse, dependency, and decreased pain thresholds (35). Nevertheless, narcotics have been a mainstay in the treatment of postoperative pain in spinal surgery patients due to a lack of alternative effective medications. Therefore, while new legislation has created a conundrum for practitioners in affected states, it has also resulted in a more urgent search for alternative means of analgesia.

Additionally, these legislative changes come at a time when practitioners are becoming increasingly aware of the need for a more holistic approach to patient care and pain management. This is evidenced by the proliferation of ERAS® programs across the country. These programs advocate for a systematic, multi-disciplinary approach to patient care and recovery with the goal of reducing pain, cost and length of stay while hastening recovery times (5-8). The ERAS® philosophy is well-suited to the outpatient setting, and its advocacy of multi-modality pain management techniques shows promise in the world of spine (9,10).

In our institution, one of the major advances in this regard has been with the adoption of liposomal bupivacaine (LB; Exparel, Pacira Pharmaceuticals Inc., Parsippany, NJ, USA). This is a long-acting local anesthetic which allows for an extended duration of action (36). Previous orthopedic research has indicated significant benefit with improved postoperative pain control and decreased overall opioid consumption (37). Additionally, early studies in spine have shown a significant reduction in the duration of intravenous (IV) narcotic use in patients who received Exparel (38). There is no doubt that this type of long-acting local analgesic will be a critical component of successful outpatient MIS surgery going forward.

Additionally, the use of non-narcotic pain medications, such as IV acetaminophen intraoperatively have shown good efficacy in managing pain (39). While some might argue that the benefits of such medications are limited to the immediate perioperative period, there is consensus that a multi-modality approach to pain management is needed (11,40). This approach includes not only IV acetaminophen and improved local anesthetics but also gabapentin and nonsteroidal antiinflammatory drugs (NSAIDs) when appropriate (11).

Overall, it is important for the spine surgeon to recognize the need for a robust pain management plan in order to facilitate an effective outpatient spinal surgery program.

Patient selection

As is the case with almost any surgical procedure, careful patient selection is paramount in outpatient MIS spine surgery. When considering which patients would be best suited to ambulatory spine surgery, one could reasonably use risk factors for readmission following spinal surgery as a proxy for success in the ambulatory setting.

One study examining readmissions after lumbar fusion found advanced age, American Society of Anesthesiologists (ASA) class, significant medical problems such as chronic obstructive pulmonary disease (COPD), weight loss, history of malignancy and prolonged operating room time as risk factors for readmission (41). There are undoubtedly other crucial factors as well including social support and intangible attributes such as patient resilience and pain tolerance which are not easily assessed.

Unfortunately, the realization of these risks does not yield a binary answer to the question of inpatient versus ambulatory surgery. Rather, they serve as guidelines which can help swing the pendulum towards or away from outpatient surgery. Often, the input of the anesthesiologist can be very helpful in making this decision in difficult patients, and any successful outpatient practice therefore requires a closely collaborative effort with anesthesia.

Finally, the decision regarding outpatient surgery must be viewed as a dynamic one. In other words, the physician must be committed to self-reflection throughout the surgical and immediate postoperative period. If, at any point, the surgeon's level of concern is raised, the option of inpatient hospitalization must always remain open.

Economic implications

With an ever increasing cost of healthcare in the United States (42) and limited economic resources there has been significant focus on reducing the cost of care. These pressures are not unique to spine surgery, and instead reflect a general concern regarding the long-term viability of our current healthcare model. In the realm of spine, however, this problem is complex, as the cost of surgery itself must be weighed against the astronomical societal cost of back pain (43). Indeed, there is a significant indirect cost associated with lower back pain (44), a concept that is reinforced by a large epidemiologic study which found lower back pain to be the number one global cause of disability (45). This affliction is most prevalent in the elderly—a fact that is especially relevant given the aging global population (45).

Hospitals themselves have also come under financial pressure as reimbursement models have shifted to value-based healthcare with bundled payments and Diagnosis Related Groups (DRGs). In this environment, hospitals are incentivized to reduce length of stay and inpatient hospitalization costs while maintaining the same standards of patient care. This has led to a realization that both quality and cost are integral parts of surgical decision-making (44). Reductions in length of stay would be self-defeating (not only economically, but also clinically) if they were to lead to increased complications and readmissions. Encouragingly, there is research to support the notion that early discharge, even after major surgery, is associated with decreased cost to the hospital, without a concordant increase in postoperative complications (46).

It is also critical to consider difference between hospital-based and free-standing ambulatory surgical centers. There seems little doubt that ambulatory surgical centers result in significant cost-savings when compared to hospital-based surgical centers (47). At the same time, there is concern regarding the potential conflict of interest associated with such physician-owned centers (47). The answer to this problem remains unclear but suggests the need for continued ongoing discussion.

As surgeons, therefore, we are faced with an onerous task: to balance our desire to treat patients with a clear understanding of the economic implications of our actions. It has been said that "necessity is the mother of all invention", and nowhere is this truer than in the world of spine. Indeed, the emergence of outpatient MIS spine surgery has not occurred in a bubble and has perhaps been equally driven by an awareness of patient outcomes and the general economic climate. There seems little doubt that these approaches will become increasingly important, as we strive to treat an aging population within the constraints of our current economic framework.

Conclusions

With the advent, and progressive refinement of MIS spine surgery, outpatient spine surgery has become a realistic option for many patients. As discussed above, this boom in outpatient surgery is partially due advances in MIS

surgical technique, partially due to increasingly effective pain management practices, and heavily influenced by social issues, legislative changes and economic trade winds. We believe that the implementation of ERAS® programs along with the development of awake, spinal fusion surgeries represent a significant advancement in this field, and we fully expect that outpatient surgery will only increase in the years ahead.

Nevertheless, we also believe some words of caution are in order. One could read this paper and be rightly convinced that an outpatient MIS spine surgery could be conceived for almost any patient. However, the practitioner must be careful in his/her selection of patients for ambulatory surgery. Undoubtedly, as the proverbial envelope is progressively pushed forward, the boundaries of what is "acceptable" for outpatient spine surgery will be challenged. While outpatient surgery may be an excellent option for some patients, it will result in suboptimal results for others.

Overall, we see clear benefit in the use of ambulatory MIS spine surgery in select populations. As MIS techniques are further refined, we have no doubt that these procedures will become all the more common. This belief is further strengthened with a global perspective: namely, our understanding of a growing global population with increasing longevity, limited healthcare resources, and a clear clinical need.

Acknowledgments

None.

Footnote

Conflicts of Interest: MY Wang serves as a consultant to Depuy-Synthes Spine, Aesculap Spine, JoiMax, and K2M; receives royalties from Children's Hospital of Los Angeles, Depuy-Synthes Spine, Springer Publishing, and Quality Medical Publishing; holds stock in Innovative Surgical Devices and Spinicity; and receives grants from the Department of Defense. GW Basil has no conflicts of interest to declare.

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Cite this article as: Basil GW, Wang MY. Trends in outpatient minimally invasive spine surgery. J Spine Surg 2019;5(Suppl 1):S108-S114. doi: 10.21037/jss.2019.04.17