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Minimally Invasive Procedures, Perioperative Telemedicine, and Decreased Hospital Stays Following Covid-19 Surgical Restrictions: Spinal Surgery

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Abstract

The 2019 severe acute respiratory syndrome coronavirus 2 pandemic had devastating impacts on healthcare system operations. Disruption of this delicate system led to international healthcare challenges with new policy changes that affected all specialties, including the global spine surgery community. The pandemic disrupted normal spine surgery proceedings, restricting, and postponing elective procedures, which comprise a large proportion of spine surgeries. This disruption may have contributed to significant economic losses for providers and resulted in the prolonged impairment of patients who were forced to postpone their procedures. However, response to the pandemic precipitated new procedural guidelines and practices that prioritize health outcomes and satisfaction. These new changes and innovations are positioned to provide lasting economic and procedural impacts in favor of both providers and patients. Thus, the objective of our review is to explore how spinal surgical practices and post-op recovery changed following COVID-19 and highlight some lasting impacts the pandemic created for future patients.

Keywords

covid implications; surgical management; telemedicine; improved outcomes

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Introduction

Spinal surgery is indicated for a multitude of serious ailments including but not limited to chronic pain, numbness, paresthesia, and loss of motor function. The need for surgical intervention can be classified as immediate, urgent, expedited, or elective depending on the level of patient injury or impairment[1, 2]. Elective procedures are most frequently performed, meaning the procedure can be planned in the future without serious disease progression[2]. Minimally invasive procedures allow the surgeon to limit patient discomfort by minimizing trauma to the patient's natural anatomy, showing major benefits over open surgery[3–5]. During the COVID-19 pandemic, elective surgeries were restricted to conserve hospital resources like beds and personal protective equipment (PPE) for healthcare workers and individuals infected with COVID-19[1, 6]. Restrictions on surgery and hospital visits led to the increased adoption of telemedicine, which allowed limited patient care to continue during the pandemic.

Covid and Declining Cases

The transition to minimally invasive surgery has proven to be save costs, reduce blood loss, shorten hospital stay, decrease postoperative pain, and expediate recovery in comparison to open surgical techniques[3, 5]. The COVID-19 pandemic had a detrimental impact on elective spinal surgery, where most cases had been canceled or postponed, with the aim of conserving resources and sparing hospital systems and providers from being overwhelmed[6]. For example, during the initial lockdown in Europe, the total number of spinal procedures decreased by 50% in comparison to the previous year in both French and Italian tertiary spinal centers[6]. Minimally invasive procedures were preferential during this time to limit the potential need for ICU beds and reduce operating time[6]. One study was able to illustrate an overall decline of cases for elective cervical spine surgery by 21.6% in the second quarter of 2020 compared to 2019[7].

During the midst of the pandemic, patients undergoing elective surgery had higher comorbidity risk, leading to increased complication and mortality rate[7]. While delaying and postponing elective procedures may reduce infection rates and overall mortality in surgical candidates, it also may result in progression of symptoms and hindered improvement after their surgery[8].

Fear of infection

Following the reopening of elective surgeries during phase I of the pandemic, a study of Medicare patients in June 2020 showed that surgical volume for spine surgeries was less than half that of expected, despite a 3-month backlog of canceled cases in addition to new cases[9, 10]. One study by Norris et al. illustrated how half of the patients scheduled prior to the pandemic deferred rescheduling well after the mandate was lifted, showing reluctance likely due to concern of COVID-19 exposure[9]. Literature revealed that the rate of postoperative infections was nearly the same as previous years despite the worry of COVID-19 accelerating potential for infection. Furthermore, Norris et al. showed 0 positive

post-surgical COVID-19 infections following rescheduled elective surgeries supporting the safety spine surgery despite the pandemic[9, 11, 12].

Postoperative pain

A study by Bronheim et al. illustrated the impact of COVID-19 on postoperative pain following elective spine surgery for conditions including cervical and lumbar disc degeneration and stenosis. These patients were categorized into pre- and post-COVID periods corresponding to before and after March 2020. It is important to note that out of 431 patients who filled out an initial preoperative survey, only 296 patients filled out the survey postoperatively, with 83 of them being greater than 24-months postoperative. It was found that patients post March 2020 had significantly worse outcomes regarding back and leg pain, physical function, fatigue, and functioning within social roles[13]. Increased postoperative pain has been associated with greater healthcare costs, greater depression rate, and increased risk of complications from prolonged use of NSAIDs and opioid medications[14]. It is probable that, given the pandemic's restrictions on non-essential activities, walking and similar activities were curtailed among these patients. It has been found that walking earlier after surgery may optimize patient reported outcomes[15]. It may be implicated that COVID-19 has not only delayed the postoperative recovery of patients undergoing spine surgery, but also delayed surgical treatment. Such delay in treatment may have contributed to worsened preoperative conditions, leading to poorer surgical outcomes.

Impact of COVID-19 on Physicians

COVID-19 affected physicians and patients alike in a multitude of ways. Cancellation of elective procedures during the COVID-19 pandemic resulted in estimated losses upwards of \$17 billion per month in reimbursement and \$5 billion per month in net income to the US hospital system[16]. In addition to a financial burden, there was a significant psychological burden on physicians as well, with one study surveying 902 spine surgeons globally, illustrating the stressors of family health concern and moderately high anxiety levels due to COVID-19[16, 17].

In addition to established spine surgeons, training surgeons saw significant decline of more than 50% for elective procedures, leaving fellowship directors concerned with the preparedness of their fellows due to less surgical exposure during the pandemic[18]. This hiccup in training may equate to hindered surgeon ability by decreasing the sheer volume of cases experienced during peak training periods.

Postponed vs Emergent Surgery

The majority of spine surgical cases; including spinal fusion, microdiscectomy, laminectomy, microdiscectomy, kyphoplasty, and artificial disc replacement; are elective rather than emergent[19]. Spinal cases may be categorized as elective or emergent much like other surgical procedures, prioritizing life or organ saving procedures first. The National Confidential Enquiry into Patient Outcome and Death (NCEPOD) lists four categories of surgical intervention: immediate, urgent, expedited, and elective[2]. Procedures are

considered immediate if they are life, limb, or organ saving and are usually performed minutes after a patient presents to the emergency room, often with acute trauma. Urgent procedures involve potentially life-threatening conditions where the surgeon usually has a few hours to decide whether to operate. Expedited procedures require earlier rather than later treatment with the decision to operate restricted to a few days. Finally, elective surgeries are those procedures that are planned on routine admission to the hospital, considering the availability of physicians and staff[2]. Most spine cases are elective; scheduled in advance after patients present with neck, back, or leg pain and the spinal disorder or defect is identified on imaging[19]. However, occasionally patients do present with symptoms of worsening weakness, numbness, paresthesia, loss of bowel or bladder control, or even paralysis. The presence of any of these motor, sensory, or autonomic deficits would immediately elevate the operative classification from elective to expedited, urgent, or immediate. The precise level of urgency would depend on the severity and acuity of those neurological symptoms. Thus, it is the extent of neurological compromise that determines the urgency of surgical intervention in the field of spine surgery[1]. Neurological compromise can occur due to epidural abscess or spinal cord compression secondary to fracture, infection, tumor, or disc herniation. Following the identification and appraisal of neurological compromise, the surgeon would set a timeline for operating. Of note, cases of postoperative wound infections near the spine, spinal instability at risk of causing neurologic injury from any cause, and any acute traumatic spinal cord injury specifically warrant immediate surgical intervention[1].

At the start of the COVID-19 pandemic, the focus of all fields of surgery, spine included, shifted to prioritize public safety[1, 20]. The consideration of what surgeries would be performed, and which would be postponed came into question. At the peak of the pandemic from March to June in 2020, several countries and even some American states like Texas issued executive orders to postpone all elective surgeries in the hopes of conserving resources (e.g., masks, gloves, gowns, ventilators, filters for ventilators, ICU/hospital beds) and slowing the spread of the highly infectious virus[1]. On April 22, 2020 the North American Spine Society (NASS) released an official document that recommended all elective cases be postponed for the time being[20–22].

The NASS guidelines organized spine cases into tiers of elective, urgent, and emergent cases in a similar fashion to the NCEPOD guidelines. Spinal cases where pain and dysfunction could be reasonably managed without procedural intervention were designated as elective[1]. However, this categorization may have been slightly misleading as these patients still had serious disorders with painful symptoms. These elective cases included patients with scoliosis and/or kyphosis, symptomatic hardware or pseudoarthrosis chronic conditions, degenerative spinal disorders such as degenerative disc disease, some disc herniations, and spinal stenosis or spondylolisthesis without significant neurologic deficit[1]. The halting of elective spinal surgeries across the globe raised many concerns about patient outcomes, healthcare costs, and backlog of surgical cases[23]. Patients with elective cases had no choice but to endure their pain until the pandemic concluded or newer, less stringent surgical guidelines were enforced[23]. This had drastic repercussions on the overall health of those patients. Earlier surgical intervention in spinal cases is well documented to correlate with improved clinical outcomes[24]. As surgical intervention was postponed, the severe

myelopathy, radiculopathy, and chronic pain persisted. Patients developed increasingly poorer clinical outcomes with higher complication rates, leading to more operations and admissions, which ultimately also drove up healthcare costs[1, 23].

Urgent cases are more severe than elective ones. Patients who had significant neurologic deficits, cervical or thoracic myelopathy with recent progression, spinal conditions causing intractable pain that result in ED presentation, severe functional limitations and/or excessive opioid use despite attempted non-procedural treatments were considered urgent[1]. With urgent cases, surgeons were advised to proceed with the procedure if the local policies and medical resources could handle it. Depending on the healthcare facility and the projected positive COVID-19 cases in the region, in-patient stays were limited, and the availability of staff and PPE were also being rationed for patients with COVID-19. In line with NASS recommendations, Rizkalla et al. recommended that urgent procedures be performed at an ambulatory surgery center (ASC) or facility with minimal COVID-19 cases. If urgent cases presented to larger hospitals treating COVID-19 patients, surgeons were still recommended to operate if extra precautions were taken to isolate them from the COVID-19 units, and visitors were limited [1]. Finally, the criteria for emergent cases remained largely unchanged throughout the COVID-19 pandemic. Emergent surgery in patients with traumatic spinal cord injury, postoperative wound infection, or severe spinal instability and cases with progressive or severe neurologic deficit from any cause continued to be recommended for immediate surgery to preserve life and/or organ function[1].

Benefits of telemedicine

The increased availability of communications technology has led to a rapid expansion of telemedicine (TM). This advancement has proven to be an effective medium of decreasing economic burden and potential health risks compared to traditional spinal surgery clinic visits[25]. The financial and temporal benefits of TM are derived from decreased travel time and time off work for patients while retaining similar clinical outcomes as an office visit[26, 27]. Thankar et al. carried out a cost analysis of TM visits in comparison with in-person visits among spine/neurosurgery patients and concluded that TM visits were nearly one-third the cost of traditional visits. They found that savings were most sensitive to factors including the distance patients had to travel for appointments and patient volume[28]. Recent literature has demonstrated that TM is particularly effective in preoperative and postoperative care. In a study of 174 patients undergoing elective spine surgery, telemedicine was delivered via a mobile app providing preoperative instructions. For their analysis, Stewart et. al concluded this intervention decreased surgical cancelation rates due to noncompliance in comparison to the control group[29]. In a second study of 60 patients undergoing lumbar discectomy, TM was demonstrated to be an effective method of postoperative patient monitoring which reduced hospitalization time while maintaining high patient satisfaction[30] TM has had a steady trajectory of advancement which was recently accelerated by the COVID-19 pandemic.

During the health crisis, TM was used to triage patients, thereby limiting unnecessary exposures to, and spread of the virus[31, 32]. This was readily accomplished in the setting of non-urgent and elective care where TM provided an opportunity for remote consultations

and identification of patients who required escalated care. In doing so, it reduced person-to-person contact and resource consumption in an overburdened health system[33–37]. Such advancements in patient care necessitated by the pandemic are poised to continue in the future as a medium to improve economic efficiency and increase patient satisfaction while upholding high clinical outcomes, especially in fields such as non-invasive spine surgery.

Negatives of telemedicine

Despite the clear benefits of telemedicine in spinal surgery, it also has potential drawbacks to be overcome. These include the medium being a possible hindrance to the physician-patient relationship, prohibitive upfront economic costs, and the preclusion of a physical exam. Traditionally, preoperative visits are used to consult the patient and establish rapport. However, avenue of establishing a relationship is at risk of being lost in TM. The medium has been cited to cause patients feelings of depersonalization when consulting their physicians, an effect compounded by the lack of formal physician training in telemedical equipment[38]. Furthermore, patients who suffer from impaired vision or hearing are especially at risk of compromised understanding and recognition during a video consultation compared to in person visits, a significant barrier to patient care. However, L. Alimandi et al. demonstrated this concern could be partially overcome in the future through the use of technical aids[39]. Additionally, while TM has been shown to be a possible economic boon to spinal surgery practices, the initial premium for TM software and infrastructure may weigh heavily upon a new or small group. This is especially of note to spine surgeons in private practices as those operating at a tertiary health center may benefit from economies of scale[40]. Therefore, while large or hospital-based groups may be more insulated from this drawback, the up-front investment may dissuade smaller practices from offering telemedicine. While the above factors are concerning, the most salient constraint of telemedicine in spine surgery is the inability to conduct a physical examination. Currently, literature in other fields has suggested possible solutions in the form of remote physical evaluations using smartphone sensors to gauge physical findings such as range of motion, gait, and tremors[41, 42]. However, it remains to be seen how effective these adjuncts to care can be in replacing the physical exam. Should no clear solution be found, advancement in TM may decrease in the field as the impetus of the COVID-19 pandemic fades.

Patient recovery post-op

During the COVID-19 pandemic, some countries limited surgery to all but the most urgent cases[20]. The North American Spine Society guidelines extended this criterion to patients with progressive or severe neurological compression or general pathological deterioration, a standard supported by members of the community[1, 21, 22]. Furthermore, early surgical intervention with acute injury is the gold-standard for acute spine injuries and continued to be so during the pandemic[24, 43, 44]. COVID-19 infection mitigation during preoperative, perioperative, and postoperative care of spinal surgery patients was a significant concern throughout this time. Current standards for preoperative care recommended patients be screened for COVID-19 prior to surgery[1, 45]. This screening includes patients reporting a negative COVID-19 tested prior to surgery, patients responding negatively to possible exposures, and patient being assessed for COVID-19 symptoms the day of surgery where

possible[1, 45]. In instances of perioperative care with patients known or suspected to be COVID-19 positive, Zou et al recommends minimally invasive surgery, limited operation time, and the utilization of necessary personal protective equipment[45].

Concerning postoperative care, especially regarding long hospital stays, patients are at risk of urinary tract infections, pneumonia, and thrombosis due to prolonged immobilization. These factors alone may heighten their susceptibility to COVID-19 infections[46, 47]. To minimize risk of postoperative infection, patients were less inclined to be active after surgery, which may have led to increased complication rates as well. Consequently, different methods of minimizing patients risk of infection postoperatively were explored. Options such as an ambulatory surgical center (ASC) setting where patients were found to likely have a decreased risk of COVID-19 compared to their counterparts at larger hospitals or remote monitoring through telemedicine were considered as alternatives to traditional postoperative hospitalization when possible[44, 48–50].

Case Report

A noteworthy outcome or silver lining that resulted from the COVID-19 pandemic was the consideration towards and subsequent development of a triaging system to organize spinal surgery cases in terms of urgency. The North American Spine Society (NASS) was not the only entity to create and release triage scoring guidelines as similar 3 or 4 tiered systems were created by the French Spine Surgery Society, Saudi Spine Society, and New York's North ell Health[51–53]. Other scoring systems used more precise measurements to measure a patient's level of impairment and progression, scored on a –19 to 91 scale[54]. While similar systems of prioritizing surgeries had already been described for the broader field of general surgery, like in the case of the The National Confidential Enquiry into Patient Outcome and Death (NCEPOD), nothing resembling the sort had been done for spine surgery.

The following case report detailed by Archer and Gardner illustrates some of the challenges that were faced prior to adopting a priority triage for spine procedures during COVID-19[55]. Archer and Gardner describe a 76-year-old patient who presented to the ER via EMS after a motor vehicle accident. The patient rear-ended another vehicle and had a double roll over. At the ER, the patient complained of neck and left shoulder pain. A cervical CT showed an acute fracture of the antero-superior osteophyte on the body of C7 and an opening of the cervical facet at C6/7 but no fractures or obvious misalignment were noted. An x-ray of the patient's left shoulder was also performed and returned normal. Following imaging, the patient was discharged home to minimize risk for infection. Two weeks following discharge, the patient's shoulder pain worsened, now accompanied by numbness and weakness in her left arm. She could barely move her neck. The patient would not have returned to the hospital had her general practitioner not assessed her at home and urged her to return for care. Upon her return, a cervical MRI was obtained, demonstrating an anterior subluxation of the C6 vertebrae and significant misalignment between spinous processes C6 and C7. A cervical discectomy and fusion at C6/7 was performed and the patient made a full recovery[55]. As summarized by Archer and Gardner, this case signifies a missed unstable cervical spinal injury, which could have been avoided had

distinct guidelines for urgency been followed. Under the NASS recommended guidelines, this patient would have been classified as emergent due to the unstable cervical spinal injury and would have been operated on much sooner, if not immediately. Granted, the gravity of the case was dependent on the results of the MRI, which were not obtained during the patient's initial ER visit. It is likely that concerns over possible COVID-19 infection led to this patient's premature discharge. The emergency and orthopedic team were likely blinded by the international push to conserve resources, minimize hospital stay, and treat patients non-operatively, which almost left this patient paralyzed. This case signifies the importance of developing systems and following them, especially in times of unprecedented public health crises. An easy to follow and detailed triage system for determining priority and need for surgery can better guide clinicians to make systematic, informed decisions in times of distress.

Conclusions

The COVID-19 pandemic led to strict limitations of elective surgical procedures, further exacerbating symptoms and complications of patients forced to put their surgeries on hold. After awaiting their turn in the operating room, patient outcomes were seriously impacted, leading to increased complications rates, costs, and duration of care. The practice of minimally invasive spinal procedures helped alleviate congestion of hospital beds by showing decreased surgical time, hospital stay, complication rates, and need for PPE. The implementation of telemedicine for perioperative visits showed improvements in patient compliance, cost-effectiveness, and overall satisfaction but may be accompanied with increased risk in cases if serious complications were to arise. Minimally invasive spinal surgery in conjunction with perioperative telemedicine visits showed to significantly improve overall outcomes for patients, surgeons, and hospital economists alike.

More research is needed to investigate certain indications for patient concern while being seen virtually by their surgeons postoperatively. Although spinal surgery patients during the pandemic were met with a great deal of discomfort and complications, their sacrifice may lead to improved guidelines for spinal surgeons to follow for years to come.

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