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Outpatient minimally invasive spine surgeries during the COVID-19 pandemic – A retrospective analysis of 164 consecutive cases

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ABSTRACT

Objective: To share our surgical experiences of minimally invasive cervical and lumbar procedures for patients who suffered from non-fatal motor vehicle accidents (MVAs) in the ambulatory surgery centers (ASCs) during the coronavirus disease 2019 (COVID-19) pandemic.
Methods: Anterior cervical discectomy and fusion (ACDF), anterior lumbar interbody fusion (ALIF), minimally invasive laminotomy and discectomy (MILD), percutaneous endoscopic laser-assisted discectomy (PELD) and percutaneous kyphoplasty (PK) were performed on carefully selected patients.
Results: From January 2020 to December 2021, our group performed 164 cases on 153 patients involving 249 intervertebral disc (IVD) levels. Of these, 116 cases (70.73%) on 114 patients (74.51%) were cervical, 48 cases (29.27%) were lumbar (including 8 PK cases). Eight patients had both cervical and lumbar procedures in a single anesthetic session (SAS) and were discharged on the same day. One hundred and six ACDF cases (92.17%) were at the C4–C5 and C5–C6 levels, which comprised of 146 (76.04%) IVDs. Of the 40 non-PK lumbar cases, 38 (95.0%) were at L4 to S1 lumbar levels. Six of these cases (15.0%) involved 2 lumbar levels. In contrast, 6 out of 8 kyphoplasties (75.0%) involved lower thoracic/higher lumbar vertebral columns (T11 to L2) and 2 were at the lower lumbar L4 level.
Conclusions: We successfully and safely performed various cervical and lumbar spine surgeries in the ASCs amid COVID-19 pandemic and all patients achieved the same-day discharge (SDD). In the non-fatal MVAs, mid-lower cervical (C4 to C6) and lower lumbar (L4 to S1) IVDs were the most affected levels.

1. Introduction

Cervical and lumbar spine intervertebral disc (IVD) disease is one the most common causes for neck and back pain as well as for sensory and motor dysfunction in relevant dermatomes and/or myotomes in the upper and lower extremities. Of these, trauma-induced disc injury or herniation and age-related degenerative changes are among the most common mechanisms accounting for the disc disease.[1,2]

The management of the cervical and lumbar disc disease is highly individualized depending on mechanism of injury, spinal pathology, the severity of disease and patient's preferences and responses. The management consists of physical therapy, local or systemic anti-inflammatory and analgesic treatment, and the surgery being the last resort if all conservative measures failed to achieve expected outcome.[1,3]

For those that require surgical intervention for cervical and lumbar disc disease, minimally invasive approaches have evolved as a reliable and safe technique with non-inferior or favorable outcomes compared to the conventional open procedures.[4–6] The benefits are of numerous, including smaller surgical incision, reduced chances of surgical site infection, minimized intraoperative blood loss, less postoperative pain, shorter hospital stay, better postoperative healing, faster recovery and favorable cosmetic appearance.[4–6]

Traditionally, the neurological surgeries, including spine surgery for disc disease, were performed in the hospital setting, most of which was

Abbreviations: ACDF, Anterior cervical discectomy and fusion; ALIF, Anterior lumbar interbody fusion; ALL, Anterior longitudinal ligament; AP, Anteroposterior; ASCs, Ambulatory surgery centers; COVID-19, Coronavius disease 2019; IVD, Intervertebral disc; MAC, Monitored anesthesia care; MILD, Minimally invasive laminotomy and discectomy; MVA, Motor vehicle accident; PELD, Percutaneous endoscopic laser-assisted discectomy; PK, Percutaneous kyphoplasty; PLL, Posterior longitudinal ligament; ROM, Range of motion; SARS-CoV-2, Severe acute respiratory syndrome coronavirus-2; SAS, Single anesthetic session; SDD, Same day discharge; VCF, Vertebral compression fracture.

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equipped with neuro-critical care capacity. In the past decade, a variety of cervical and lumbar spine procedures have been increasingly performed in the outpatient setting with similar postoperative patient outcomes but significantly reduced costs,[7,8] including patients of either younger than[9] or older than[10,11] 65 years. In the past 2 years, however, the unexpected COVID-19 pandemic has drastically impacted the health care system overall[12] and adversely affected the surgical subspecialties, including elective surgeries.[13,14] The objective of this study is to share our surgical experiences of minimally invasive cervical and lumbar procedures for patients who suffered from non-fatal motor vehicle accidents (MVAs) in the ambulatory surgery centers (ASCs) during the COVID-19 pandemic.

2. Methods

2.1. Study design

This is a retrospective analysis of the surgical data of the elective cases from a single surgeon group utilizing the minimally invasive approach to perform the various cervical and lumbar procedures in several ambulatory surgery centers (ASCs) during the first 2 years of COVID-19 pandemic.

2.2. Ethics approval

Institutional Review Board exemption was granted for this study and informed consent was not required. The clinic visit consent form that the patent signed included the content that the patient may be involved in clinical research or teaching.

2.3. COVID-19 safety measures

Updated national, local and institutional coronavirus disease 2019 (COVID-19) safety guidelines were strictly followed during the indexed study period. Even though the patients were not required to be tested or vaccinated against SARS-CoV-2 prior to the procedures, the pre-procedure screening questionnaires were used to assess the exposure risks. Body temperature check was performed prior to entry of the facilities and the surgery would be postponed for any patient with fever. Universal masks were required to all patients and staff during the study period and social distancing was exercised. Same rules applied the surgeons and staff who worked at the facility. Additional procedure-specific protective measures (such as minimizing the operating room staff during the process of intubation; adequate personal protective equipment) were also exercised per individual surgery center's policy.

2.4. Preoperative patient selection and postoperative care

Prior to surgery, each patient was thoroughly evaluated in the clinic. The conservative or less invasive treatment modalities, such as pain management, physical therapy, local injections, were offered to the patient. After the patient failed these measures and a decision for surgical intervention was made, the patient underwent extensive medical evaluation. As with all surgeries, the signed consent was obtained from the patient. The surgery would not take place until the anesthesiologist and operating surgeon cleared the patient immediately before the procedure started. On occasion, the surgery had to be cancelled in the preoperative (PreOp) area because of uncontrolled hypertension or even in the operating room (OR) right before the timeout due to the suspected urinary tract infection noted after the Foley catheter was inserted.

To minimize the SARS-CoV-2 exposure, the nursing visit to patient's home on the 2nd or the 3rd day after the surgery was arranged for drain check/removal (if criteria met). The office followup would take place in 1–2 weeks, during which time the COVID-19 questionnaire was completed by the patient to assess the exposure and any signs or symptoms of COVID-19.

2.5. Anterior cervical discectomy and fusion (ACDF) procedure

For cervical surgery, single or multi-level ACDF was performed. Briefly, the patient was placed on supine position with the neck slightly extended. After timeout was completed an anterolateral transverse incision was made over the pre-marked line at the desired level approximating the closest skin crease. The dissection was taken down through skin, superficial facia, platysma muscle, deep cervical facia to the anterior longitudinal ligament (ALL). After the level of interest was confirmed by the C-arm fluoroscopic unit, under the microscopic magnification, the disc was removed with appropriate instruments and the endplates were prepared for fusion. For the majority of the cases, the posterior longitudinal ligament was resected for better decompression.[15,16] A standalone cervical cage of appropriate size (Spineart USA Inc, Laguna Hills, CA) filled with bone scaffold was placed under fluoroscopy and secured with screws. Similar steps were repeated if multi-level ACDF was performed. Somatosensory and motor evoked potentials were conducted throughout the operation. The whole procedure was completed with excellent hemostasis. The wound was closed in layers and the skin was sutured in a plastic surgery fashion.

2.6. Lumbar procedures

Two categories of lumbar procedures were performed, including lumbar decompression with or without fusion and kyphoplasty, for the treatment of either lumbar disc/spondylotic disease or vertebral compression fracture (VCF), respectively. For decompression group, three approaches were employed for appropriately selected patients based on clinical presentation, pathology, imaging and accessibility. The degree of "invasiveness" was based on a 2014 Cochrane Review[4] and more recently published data[5] and meta-analysis.[6] These procedures were briefly described as follows with the emphasis on the characteristics to define the techniques instead of the operative details. Of note, 8 patients underwent ACDF following single or multiple level lumbar decompression/fusion surgeries in a single anesthetic session (SAS).

2.6.1. Anterior lumbar interbody fusion (ALIF)

This procedure was a collaborative effort with a vascular surgeon who performed the abdominal opening and exposure of the IVD of the interested level with the protection of abdominal aorta, iliac arteries and other important vessels. The patient was positioned supine but the anterolateral retroperitoneal approach may be employed for obese patient.[17] After the disc of interest was identified and confirmed with C-arm fluoroscopy, it was removed similarly to ACDF and a standalone intervertebral cage (Spinart, USA Inc, Laguna Hills, CA) filled with morselized allograft bone was placed in the disc space and secured with fixation screws. The wound was irrigated and satisfactory hemostasis was ensured followed by layered closure by vascular surgeon.

2.6.2. Minimally invasive laminotomy and (micro)discectomy (MILD)

In this procedure, the transmuscular approach with a tubular dilator was employed. The correctly identified patient was positioned prone after satisfactory induction of general endotracheal anesthesia. Under the C-arm fluoroscopy, a series of sequential tubular dilators were used to access the target interspace through a small paraspinal incision with minimal disruption of the paraspinal musculatures. A 16–20 mm tubular retractor was docked over the desired level confirmed by fluoroscopy to create the operative field. Under the binocular vision of the operative microscope, the hemilaminotomy ± facetectomy was performed using a combination appropriate instruments such as Sonopet drill (Stryker Corporation, Kalamazoo, Michigan), Kerrison rongeurs, currettes, etc. After appropriate mobilization and adequate protection of the traversing nerve root, the targeted IVD was incised and the discectomy was performed until the nerve root was well decompressed. Intraoperative Valsalva maneuver was performed to ensure the absence of cerebrospinal fluid leakage.[18]

The procedure was completed with meticulous hemostasis followed by layered closure of the surgical wound.

2.6.3. Percutaneous endoscopic laser-assisted discectomy (PELD)

The procedure was adapted from Choy[19] and Gangi[20] via transforaminal approach. Patient was similarly positioned prone after adequate sedation or anesthesia. Under the C-arm fluoroscopy, an 18-gauge needle was introduced to the center of the target IVD through a triangular safe zone (immediately anterior to the superior articular process and superior to the transverse process). A dilator followed the needle to allow the passage of endoscope. An endoscopic forcep was used to remove the annulus fibrosus. The laser optic fiber was then inserted to the center of the disc and the Red Diode laser (Gigaa Optronics Technology Ct, Ltd, Wuhan, China) was delivered as 10 W of continuous energy up to 2000 J with concomitant saline irrigation. The residues of evaporated nucleus polposus were further removed with endoscopic forceps.

2.6.4. Percutaneous kyphoplasty (PK)

This minimally invasive procedure was performed with patient positioned prone and mostly under monitored anesthesia care (MAC). With anteroposterior (AP) and lateral fluoroscopies, the target vertebral body was identified. Based on literature review, we employed bilateral instead of unilateral transpedicular approach.[21–23] The procedure started with the transpedicular insertion of the Jamshidi needles bilaterally into the fractured vertebral body and then the balloon tamp augmentation was performed to create adequate disc void space. About 5–7 mL cement (polymethylmethacrylate [PMMA]) was injected into the vertebral cavity.[22,23]

3. Results

3.1. Summary of the patients and procedures

From January 2020 to December 2021, during the waves of COVID-19 pandemic nationwide, our single neurosurgeon group performed a total of 164 consecutive cases on 153 patients (Table 1) including a total of 249 IVD levels. All the patients achieved the same day discharge (SDD) from the surgery centers with no incidence of surgery-associated COVID-19 as assessed by clinical symtoms during the follow-up questionnaire. It is worth noting that there were 46 cases (21.9%) less than those in the immediate prepandemic 2 years (January 2018 to December 2019), during which we performed a total of 210 cervical and lumbar combined cases (unpublished data). Fig. 1 shows representative cervical and lumbar procedures.

Of the cervical and lumbar patients combined, the age range was 21–79 years old, with a median age of 50 and average age of 49.06. The majority of the patients were relatively at younger age with fewer medical comorbidities. The most common chronic conditions were obesity, hypertension and diabetes; the latter two were well-controlled perioperatively. Overall, 91 (59.48%) patients were female. Of these, 70 were in the cervical group accounting for 61.40% intra-group percentage and 27 were in the lumbar group comprising 56.25% of the lumbar patients (Table 1).

A total of 116 cervical cases (70.73% of total cases), predominantly the ACDF, were performed on 114 patients (74.51% of total patients; 3 patients had revision surgery and were counted as separate cases). Forty-eight (48) cases (29.27% of the total) were lumbar procedures (Table 1). Of the 153 total patients, nine (9) patients (5.88% of total patients; including 6 females) had both cervical and lumbar operations (considered as 2 cases; 10.98% of total cases) involving of 22 IVD levels. Notably, 8 out of these 9 patients had both single or multi-level cervical and lumbar procedures in a single anesthetic session (SAS) (Table 2).

There was 1 accidental dura tear occurring in the revision of the previous C4–C5 ACDF with no nerve damage. The durotomy was repaired with duroplasty and the patient had no neuro deficits during follow-up. There was no surgical site infection in any of the cervical and lumbar procedures (Table 1).

3.2. Direct causes of injury and main pathology

The majority of the injuries (95.69% in the cervical group and 91.67% in the lumbar group) were the result of non-fatal motor vehicle accident (MVA) as shown in Supplementary Table 1. The rest of either group was secondary to falls.

Interertebral disc (IVD) disease due to injury (such as annular tear) and herniation during MVA was the predominant pathology in both cervical (108 cases, 93.10%) and lumbar (33 cases, 68.75%) groups (Fig. 2 illustrates a severe case of lumbar disc extrusion that occurred

Table 1
The Demographics of the patients and summary of the cases/procedures.

	Overall	%	Cervical	%	Lumbar	%	Cervical and Lumbar	%
Sex								
Male	62	40.52 [a]	44	38.60 [a]	21	43.75 [a]	3	33.33 [a]
Female	91	59.48 [a]	70	61.40 [a]	27	56.25 [a]	6	66.67 [a]
Total/Subtotal	153		114	74.51 [b]	48	31.37 [b]	9	5.88 [b]
Age								
Max	79		79		73		57	
Min	21		21		22		37	
Median	50		50		53		56	
Average	49.06		49.19		48.83		50.11	
Complications	1	0.61%						
Durotomy			1 [c]		0			
Nerve damage			0		0			
SARS-CoV-2 infection			0		0			
Surgical site infection			0		0			
Total/subtotal cases [d]	164		116 [f]	70.73 [g]	48	29.27 [g]	18	10.98 [g]
Total levels of procedures [e]	249		195	78.31 [h]	54	21.69 [h]	22	8.84 [h]

[a] Intra-group percentage ("cervical", "lumbar", "cervical and lumbar").
[b] Percentage of the number of the total patients (153).
[c] Occurred during a revision of previous ACDF. No acute or chronic neurologic deficits.
[d] Cervical and/or lumbar procedures on the same patient performed on the same day or different days are considered 2 separate cases.
[e] Procedure levels can be intervertebral disc levels in the case of cervical or lumbar decompressions/discectomies or vertebral body levels in kyphoplasty.
[f] Including one (1) separate revision case of ACDF.
[g] Percentage of total cases (164).
[h] Percentage of total levels of the procedures (249).

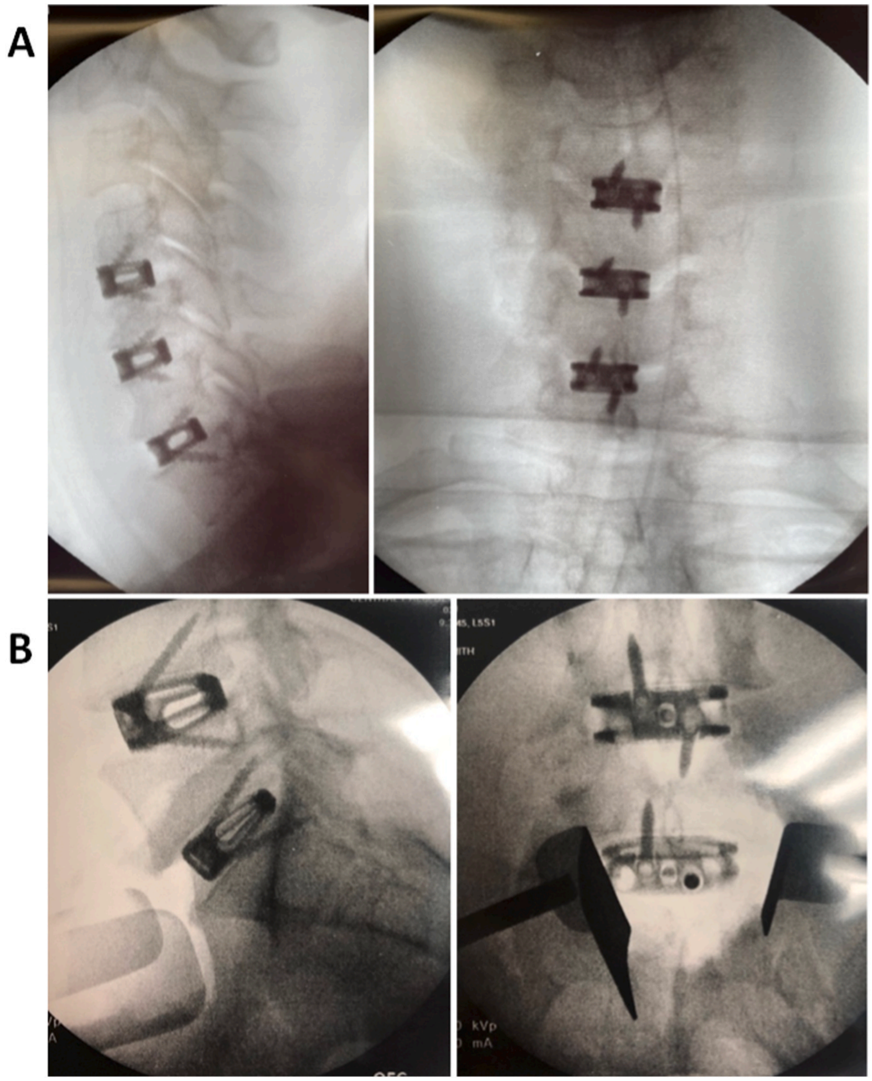

Fig. 1. Representative immediate post-operative X-ray images of cervical and lumbar cases. Panel (A) shows lateral (left) view and anteroposterior (AP) view (right) of a 3-level ACDF case at C4–C5, C5–C6 and C6–C7 levels. Panel (B) shows lateral (left) and AP (right) views of a case of 2-level ALIF at L4-L5 and L5-S1 levels.

Table 2
Patients with both cervical and lumbar surgeries.

Patient	Age	Sex	Cervical	Lumbar	Same day/SAS	Cervical Level(s)	Lumbar Level(s)	Total Level(s)
1	56	Female	ACDF C3–C4 + C4–C5	ALIF L4-L5	No	2	1	3
2	57	Female	ACDF C4–C5 + C5–C6	ALIF L4-L5	Yes	2	1	3
3	57	Female	ACDF C5–C6 + C6–C7	MILD L4-L5 (Left)	Yes	2	1	3
4	57	Male	ACDF C5–C6	MILD L5-S1 (Left)	Yes	1	1	2
5	41	Male	ACDF C5–C6	MILD L5-S1 (Left)	Yes	1	1	2
6	37	Female	ACDF C3–C4	PELD L5-S1	Yes	1	1	2
7	57	Female	ACDF C4–C5	PELD L5-S1	Yes	1	1	2
8	51	Male	ACDF C5–C6	PELD L5-S1	Yes	1	1	2
9	38	Female	ACDF C5–C6	PELD L4-L5 + L5-S1	Yes	1	2	3
Total								22

SAS: Single anesthetic session. ALIF, anterior lumbar interbody fusion; MILD, minimally invasive laminotomy and (micro)discectomy; PELD, percutaneous endoscopic laser-assisted discectomy.

during the rear-ending motor vehicle accident). In the cervical group, 8 younger patients (6.90%) with MVA were found to be unstable on flexion/extension cervical spine x-ray (data not shown). In lumbar disc disease group, 7 patients had stability issues which comprised 14.58% of the total lumbar cases. Unique to the lumbar patients, 8 of them (16.67%) had suffered from compression fracture at various thoraco-lumbar levels (Supplementary Table 1).

3.3. *Characteristics of the cervical and lumbar cases*

As detailed in Supplementary Table 2, a total of 116 cervical cases were performed, including 1 separate revision alone and 2 revisions along with ACDF (counted in ACDF as 1 case each, hence 115 ACDF cases and 1 revision case). The ACDF surgery involved from C3 to C7 IVDs, including 42 (36.52%) 1-level cases, 69 (60.00%) 2-level cases and

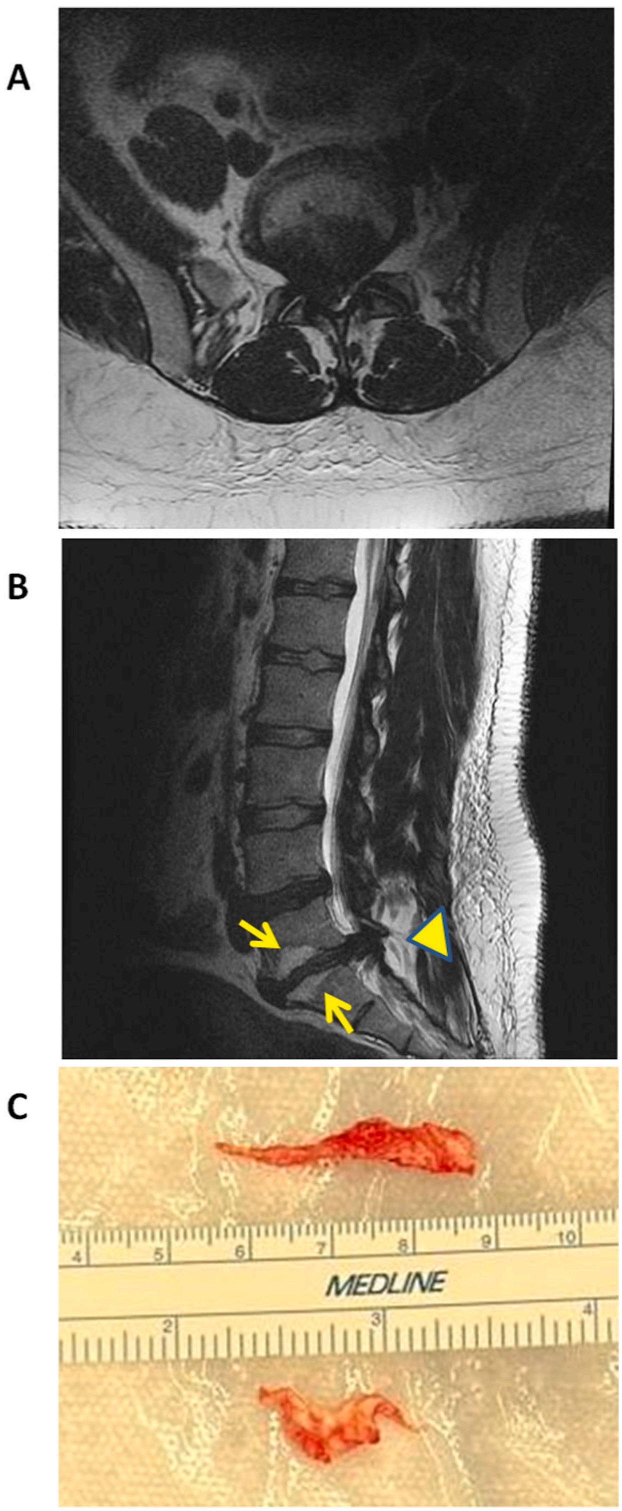

Fig. 2. Representation of a severe case of lumbar disc herniation and extrusion at the L5-S1 level during the motor vehicle accident. Axial (A) and right paramid saggital (B) T2 magnet resonance (MRI) images show severe spinal canal and neuroforaminal stenosis (particularly on the right). Also noted are the Modic type I endplate changes (arrows) and paraspinal muscle inflammation (arrow head). (C) Pieces of large herniated lumbar disc were removed during the surgery through minimally-invasive laminotomy and discectomy (MILD).

4 (3.48%) 3-level cases, comprising of 21.88%, 71.88% and 6.25% total IVD levels Supplementary Table 2. As a result, a total of 195 levels of cervical procedures were performed including 192 levels of ACDF and 3 levels of revisions (Supplementary Table 2).

With all the cervical injuries combined, the most affected IVDs were located at the C4–C5 and C5–C6 levels, which comprised 92.17% (106) of the total ACDF cases and 76.04% (146) of the total ACDF IVD levels (Supplementary Table 2). From C3 to C7, in either 1-level or 2-level ACDF procedure, there is a Bell-shape distribution in the frequency of the injured vertebral disc levels, where C4–C6 discs are at the dome of the bell (Fig. 3). In 3-level ACDF, either C3–C6 or C4–C7, all involved the C4–C6 levels. In addition, the 3 revisions were all within the C4–C6 levels (1 independently performed revision was at C4–C5 and 2 other revisions [C4–C5 and C5–C6] were performed along with ACDF [C5–C6 and C3–C4, respectively]).

Of the 48 lumbar surgeries, individualized procedures were performed based on different mechanisms of injury and the pathologies, including 19 cases (39.58%) of MILD, 11 cases (22.92%) of PELD, 10 cases (20.83%) of ALIF and 8 cases (16.67%) of PK (Supplementary Table 3). Of the 40 non-PK cases of decompression/fusion procedures combined, 38 (95.0%) were at lower lumbar levels (L4 to S1), 1 case was at L3-L4 and 1 case was at L2-L3 level. Six (6) cases (15.0%) involved 2 lumbar levels including L3-S1 IVDs. In sharp contrast, 6 of 8 kyphoplasties (75.0%) involved lower thoracic/higher lumbar vertebral columns (T11 to L2) and only 2 were at the lower lumbar L4 level (Supplementary Table 3 and Fig. 3).

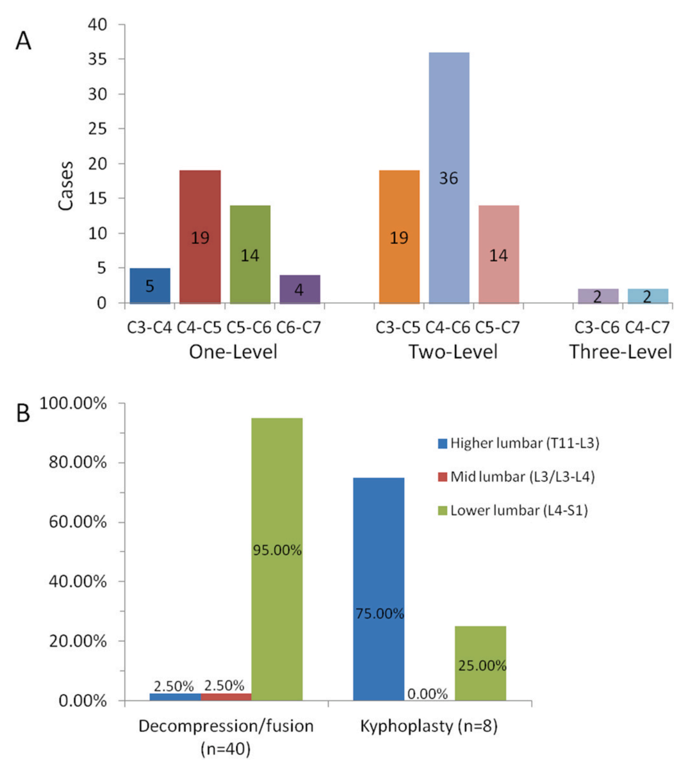

Fig. 3. Comparison and contrast of the skewed distribution of the IVD levels. (A) Cervical procedures (ACDF) (B) Lumbar procedures. In the "decompression/fusion" group, the procedures included MILD involving laminotomy plus/minus facetectomy, PELD and ALIF.

4. Discussion

Coronavirus disease 2019 (COVID-19) has been an unprecedented world-wide pandemic since the end of 2019. In the first 2 years, the whole world has seen several waves of deadly attacks with 285 million cases and 5.4 million deaths globally.[24] The United States is among one of the most hard hit countries with related death tolls over 800,000 by December 2021.[24] COVID-19 has drastic impact on all the industries, but healthcare as a forefront profession is inevitably affected the most.[12–14] Elective surgery amid COVID-19 pandemic has been particularly challenging.[13,14]

In comparison to the immediate preceding years of 2018 and 2019, we found 46 case reduction in our practice during the pandemic, which was thought to be results of direct and indirect impact of the pandemic. Despite these difficulties, we were able to perform a variety of spine surgeries safely with very low complication rate. With the appropriately heightened protective measures, there was no reported symptomatic surgery-associated SARS-CoV-2 infection during the study period. Moreover, there was only one (1) un-intended durotomy (0.61%) occurred in the cervical revision case and zero in primary ACDF or lumbar surgeries. As a comparison, one recent report by Grewal et al on 3361 patients showed the rate of dural tear was 1.4% in cervical spine, 7.8% in lumbar surgery, 13.5% in revision surgery compared with primary (average 4.8%).[25] While in a systemic review of lumbar surgery including 15,965 patients, up to 35% unintended durotomy rate was recorded.[26]

Outpatient neurosurgery, not only does it significantly reduce the cost, but also it may result in less complications and re-admission rates, as demonstrated in one study involving a cohort of 2492 Medicare patients.[11] ACDF is the most frequently performed outpatient procedures, including either 1–2 levels[9,10] or in some cases, 3 more levels.[11] It is worth to note that during the worst times of the pandemic, when the hospitals were overwhelmed with COVID-19 patients, the elective surgeries had to be suspended or postponed. In this case, the ambulatory centers served as a valuable supplemental resource for the care of the patients that needed surgery in order to improve the quality of life (alleviating the pain or improving the function).

In our practice, not only did we perform relatively uncomplicated procedures such as ACDF and MILD in the ambulatory surgery centers, but also we were able to accomplish more sophisticated surgeries safely and efficiently such as the multilevel cervical and lumbar procedures in a single anesthetic session (SAS). All these patients were discharged on the same day after careful postoperative assessment to ensure the discharge criteria were met.[9] Per literature search, we have not found any relevant reports on this “combined” cervical and lumbar surgical strategy in the outpatient setting. To prioritize, we always performed more complicated procedures in the early morning to allow sufficient time for patient’s recovery and same day discharge (SDD). The studies have shown that in both cervical[27] and lumbar[28] surgeries, late surgery start time (after 2 p.m.) was associated with increased complications and costs.[28]

One of the noteworthy findings in the retrospective analysis of our patients was the skewed levels of involvement of the vertebral columns/discs in the cervical and lumbar spine as a result of nonfatal MVAs or minor trauma (such as falls or injury by a falling object). As shown in Supplementary Table 2 and Fig. 3A, about 92% of the patients had injury at C4–C5 and C5–C6 requiring either single level or up to 3-level ACDF comprising a total of 146 IVD levels (76.04% of total ACDF levels) performed.

The relatively high incidence of the C4–C6 IVD injury is directly related to the anatomy and biomechanics of the mid-lower cervical spine. In nonfatal whiplash injury during the motor vehicle collision (especially rear-end crashes), the cervical spine suffers from initial forceful hyperextension followed by hyperflexion. Given its physiologic lordosis, the anterior and posterior longitudinal ligaments, which exert their function of protection and stabilization of the spinal columns and IVDs, are at the highest risks of injury at C3–C7 levels.[29] For the IVDs of aforementioned levels, during the whiplash injury, the non-physiologic stress is concentrated to the posterolateral aspect of the annulus fibrosus of the disc with the highest amount of strain in the C4–C5 and C5–C6 discs.[30]

During ACDF, the posterior longitudinal ligament (PLL) was carefully assessed and in many patients was resected with extra caution for it being felt beneficial for decompression. Although this step slightly increased the procedural complexity and the potential risk of dura injury, no complications were encountered in any of our patients. Despite one systemic review by Avila et al (2015) including literature as early as in the 1960s showing no significant clinical difference between the resected versus nonresected groups,[31] more recent studies[15,16] have demonstrated the benefits for improvement of radiculopathy postoperatively. Notably, a study by the Neurosurgery group at Johns Hopkins Hospital[16] on a total of 200 patients with a mean follow-up of 39 months showed that the excision of PLL during surgery led to 3.8 times greater odds of improvement in the symptoms, with no significant difference in the complication rate. In our experience, one case had consistently suppressed signals in the somatosensory and motor monitoring after the trial implant was placed without the resection of the PLL. The signals returned to baseline after the removal of PLL.

For lumbar decompression/fusion procedures (ALIF, MILD, PELD), the majority of the affected IVDs were in the lower lumbar (L4-S1) levels. Our finding is consistent with the hypothesis that these lower lumbar level IVDs are more prone to injury owing to its being more adjacent to the rigid sacrum[32] and the unique kinematic characteristics of the L5-S1 motion segment with greater range of motion (ROM) in extension and a smaller ROM in flexion compared with the upper lumbar spine.[33] In contrast, but being also consistent with the literature report,[34,35] our patients had remarkably high frequency of the vertebral column compression fracture at higher lumbar/lower thoracic levels (T11-L3), which was suggestive of decreased resistance to axial load during the accidents (falls, car clashes), especially with underlying conditions such as osteoporosis.

5. Conclusion

In summary, from January 2020 to December 2021 during the severe times of COVID-19 pandemic, with appropriate precautions and personal protective equipment, we performed various cervical and lumbar spine surgeries in the ambulatory surgical centers.

The surgeries included either less complex single level cervical or lumbar spine procedures or more sophisticated combined multi-level cervical and lumbar spine procedures in a SAS with no complications with patient being discharged on the same day. This experience could be a reference for the fellow neuro/orthopaedic spine surgeons to increase their level of comfort to perform more skill-demanding surgeries in outpatient surgery centers, thus reducing the cost in the today’s rising healthcare expenditures.

We also demonstrated that, for non-fatal injuries to the neck and back in the minor motor vehicle accidents, the most affected cervical levels were C4–C6 and lumbar levels were L4-S1 intervertebral discs. In contrast, the most vulnerable levels in vertebral compression fracture involved lower thoracic to higher lumbar spine, mainly T11-L2 levels. We reasoned that the skewed distribution may be related to the local anatomy, physiologic lordosis, sagittal angulation and the biomechanics of spinal motion segment as well as the mechanism of the injury. This may call for further research for appropriate protection in the motor vehicle to prevent related injury.

CRediT authorship contribution statement

Benjiang Ma: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Aaron Smith:** Resources, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.wnsx.2023.100229.

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