Original Article

The impact of COVID-19 on spinal cord injuries and trauma at a tertiary referral centre in Sydney

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Background: The coronavirus disease 2019 (COVID-19) pandemic has yielded far-reaching consequences for individual health systems as well as society. Although several studies have investigated epidemiological trends due to the pandemic-associated restrictions in patients requiring surgery for general surgical, trauma and orthopaedic aetiologies, there has been no assessment of the impact on spinal trauma and surgery in Australia. Thus, the aim of this study was to examine these changes at an Australian level one tertiary referral spinal cord injury (SCI) centre.

Methods: We performed a retrospective cohort study of patients presenting to this institution with spinal injuries requiring surgery, from two time periods [one prior to the pandemic, and one during]. We analysed demographics, injury mechanism and characteristics, and surgical factors to identify significant differences between the cohorts.

Results: There were 7.3% fewer spinal operations performed in the COVID-19 affected period. Although patient demographics were unchanged, the total number of emergency operations performed for injuries sustained in a motor vehicle accident decreased by 44% compared to the pre-COVID cohort (P=0.049). The median number of spinal levels affected by injury decreased, and there was a 30% decrease in American Spinal Injury Association (ASIA) type A injuries during the pandemic (P=0.006), with a corresponding increase in ASIA B injuries (P=0.032).

Conclusions: The pandemic (and its associated social restrictions) has influenced the patterns of spinal injuries treated at this tertiary level institute during this time. We observed an overall reduction in the volume of emergency procedures performed during the pandemic. There was no change in the proportion of spinal cord injuries when compared to the pre-pandemic period; however, the severity of spinal cord injuries was diminished during the pandemic.

Keywords: Coronavirus disease 2019 (COVID-19); spinal cord injury (SCI); trauma

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Introduction

The onset of the coronavirus disease 2019 (COVID-19) pandemic in March 2020 has resulted in a number of health and economic consequences worldwide (1). Australia recorded its first case in February 2020, and subsequent increases in caseload led to the introduction of public health measures aiming to mitigate the spread of disease and decrease the impact of the virus on local health system resources and personnel numbers (1,2). These measures included widespread social and travel restrictions; provision of dedicated testing and treatment facilities; surveillance and quarantine procedures; and the limitation of elective surgery to preserve hospital bed and staffing capacity (3). The institution assessed in this study ceased elective operations during the pandemic for all but urgent categories (surgery required in less than 30 days) from 25 March 2020. This persisted until May 2020, after which a very gradual return to elective operating was initiated over several months, with several further cessations as subsequent outbreaks of the virus emerged over 2020 and 2021. Throughout the pandemic, emergency surgery continued without restriction; however, strict peri-operative procedures were implemented to reduce the risk of viral transmission.

During the periods of social restriction in Australia, presentations to emergency departments decreased by 38% (4). A similar drop has been demonstrated in Australian general orthopaedic and hand surgery trauma presentations (5-7). This domestic experience has also been reflected internationally (8). However, there has been no assessment of the changes seen in spinal trauma and surgery in Australia during this time, and the international literature is limited (9-12). Currently, more than 20,000 Australians live with a spinal cord injury (SCI). The combined cost to individuals and government is $3.7 billion annually, without taking into consideration the substantial physical and psychological burden on injured patients and their families over a lifetime living with disability (13). For those sustaining a SCI during the pandemic, the burden was likely heightened, due to hospital visitor restrictions limiting family support, difficulty in accessing home environment modifications, fear of contracting COVID whilst an inpatient, and uncertainty about the future.

The aim of this study was to examine the change in volume and nature of presentations of spinal trauma requiring surgery at a tertiary-level Australian hospital during the periods of social restriction in 2020 and 2021, compared to an equivalent pre-pandemic period in 2018 and 2019, in order to compare this to patterns of other orthopaedic trauma both locally and overseas. We also assessed changes in non-traumatic, but still urgent, spinal surgery (due to tumours or other pathology). We hypothesised that the volume of traumatic injuries would decrease, with alterations in the mechanism of injury reflective of changes in social activity. For non-traumatic spinal surgery, we posited that the presentations would be unchanged between the time periods studied, as these presentations are unrelated to social activity and movement. This information allows comparison to previous reports on the impact of the pandemic both within Australia and overseas, and informs relevant stakeholders in order to optimize the provision of services in future disasters. We present the following article in accordance with the STROBE reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-22-46/rc).

Methods

This study was performed in a retrospective cohort fashion. It was carried out at a tertiary referral SCI and trauma centre that covers both metropolitan and rural areas, and is one of only two acute SCI centres in New South Wales (NSW), Australia. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013), with approval granted by the Northern Sydney Local Health District Human Research Ethics Committee (No. EC00112), and individual consent for this retrospective analysis was waived. Data was obtained from the PowerChart electronic medical record system (Cerner, North Kansas City, MO, USA) for all patients requiring emergency spinal surgery for the periods 16 March 2020 to 26 February 2021 [during the COVID-19 public health restrictions; "COVID cohort"] and 16 March 2018 to 26 February 2019 [the control period; "pre-COVID cohort"]. This duration was chosen as it encompassed the period where the greatest restrictions were implemented on operating theatres, in combination with periods of social restriction. Operations were performed by one of five fellowship-trained spine surgeons, hailing from either an orthopaedic or neurosurgical background, dependent on the on-call roster.

Medical records were reviewed to ascertain basic demographic data, as well as injury details, such as

Table 1 Patient and injury demographics

Characteristics	Pre-COVID cohort (N=218)	COVID cohort (N=202)	P value
Male, n (%)	137 (62.8)	135 (66.8)	0.393
Median age (years)	56	57	0.352
Traumatic injury, n (%)	108 (49.5)	97 (48.0)	0.755
Tumour, n (%)	20 (9.2)	24 (11.9)	0.365
Soft tissue /disc pathology, n (%)	67 (30.7)	58 (28.7)	0.651
Neurological deficit, n (%)	84 (38.5)	76 (37.6)	0.872
Spinal cord injury, n (%)	35 (16.1)	38 (18.8)	0.833
Median ISS score, n [IQR]	22 [16, 30]	21.50 [14.5, 29]	0.634

ISS, injury severity score. COVID, coronavirus disease; IQR, interquartile range.

mechanism, region of spine involved, American Spinal Injury Association (ASIA) score, and Injury Severity Score (ISS). Operative data was also examined, including the procedure performed, number of levels instrumented, members of surgical team scrubbed and operative duration. Comparisons were made between the two cohorts to detect any differences.

Statistical analyses

Statistical analyses were performed using R 4.1.0 (R Core Team, 2021). Continuous variables were expressed as mean and standard deviation for normally distributed data and analysed using the Student's two-tailed unpaired *t*-test. If they were not normally distributed, values were expressed as median and interquartile range (IQR) and a Mann-Whitney U test was used instead. Categorical variables were expressed as counts and percentages and analysed using the chi-square test. If one or more expected values were less than 5, Fisher's exact test was used instead. A P value less than 0.05 was considered statistically significant.

Results

In total, 202 emergency spinal operations were performed during the COVID period, compared to 218 in the period prior to the pandemic, a decrease of 7.3%. The median age of the pre-COVID cohort was 56 (IQR, 36–72) years, compared with 57 (IQR, 42–73) years for the COVID Cohort. In both cohorts, most presentations were males (62.8% and 66.8% respectively) (*Table 1*).

Presentation characteristics

There were no statistically significant differences between the cohorts for fracture configuration, neurological deficit, SCI and ISS score. There was also no significant difference in pathological diagnoses between cohorts (*Table 1*).

When considering mechanism of injury, a significant reduction of 44% in the proportion of injuries resulting from motor vehicle accidents was noted in the COVID cohort as compared to the pre-COVID cohort, from 13.3% (29/218 cases) down to 7.4% (15/202 cases) (P=0.049). Home and hobby-related injuries also declined during the pandemic, accounting for 31.2% (68/218) pre-COVID, and 20.8% (42/202) of injuries during COVID (P=0.015). The number of cycling-related presentations increased between the two cohorts, from 4/218 pre-COVID, to 10/202 during COVID, although this did not reach statistical significance (P=0.076). There was no difference in high-energy, work-related, or substance-use and mental health-related injuries (*Table 2*).

A significant decrease in the proportion of patients who had multiple regions of the spine involved was noted, from 22.9% (50/218) pre-COVID to 7.0% (14/202) in COVID (P<0.001). This was also reflected with a decrease in the median total number of spinal column levels involved, from 2 levels in the pre-COVID cohort, to 1 level in the COVID cohort (P<0.001). No significant differences were noted when assessing patient distributions for individual anatomical spinal regions.

With respect to neurologic injury, a significant decrease was noted in the proportion of patients with an ASIA score of A, from 48.6% (17/35) in the pre-COVID

Table 2 Mechanism of injury

Mechanism	Pre-COVID cohort, n (%)	COVID cohort, n (%)	P value
Road trauma	29 (13.3)	15 (7.4)	0.049*
Cycling	4 (1.8)	10 (5.0)	0.076
Pedestrian	1 (0.5)	0 (0.0)	1
Recreation	17 (7.8)	9 (4.5)	0.156
Fall from height	32 (14.7)	26 (12.9)	0.592
Fall from standing	24 (11.0)	32 (15.8)	0.145
Infection	17 (7.8)	21 (10.4)	0.354
Degenerative	22 (10.1)	11 (5.4)	0.077
Disc protrusion	47 (21.6)	49 (24.3)	0.511
Tumour	20 (9.2)	24 (11.9)	0.365
Home and hobby	68 (31.2)	42 (20.8)	0.015*
Work related	9 (4.1)	12 (5.9)	0.395
Substance use	14 (6.4)	17 (8.4)	0.435
Mental health	9 (4.1)	4 (2.0)	0.204
Other	5 (2.3)	5 (2.5)	1

*, significant finding. COVID, coronavirus disease.

cohort to 18.4% (7/38) in the COVID cohort (P=0.006). A corresponding increase in the proportion of patients with an ASIA score of B was seen, from 5.7% (2/35) pre-COVID to 23.7% (9/38) in COVID (P=0.032). No significant differences were detected between the cohorts for patients with ASIA scores of C and D (*Table 3*).

Surgical statistics

There were no significant differences between the cohorts for all procedure characteristic variables. A significant difference was identified in the proportion of surgeries performed after hours, with an increase from 47.2% (103/218) in the pre-COVID cohort to 56.9% (115/202) in the COVID cohort (P=0.047) (*Table 4*). Additionally, there was a significant increase in time inside the operating room, from a total of 197 minutes per case in the pre-COVID cohort to 219.5 minutes per case in the COVID cohort (P=0.034). There were no other significant differences noted.

Discussion

The COVID-19 pandemic has presented unprecedented

Table 3 Spinal injury characteristics

Characteristics	Pre-COVID cohort, n (%)	COVID cohort, n (%)	P value
Fracture classification	n=108	n=97	
Crush	10 (9.3)	8 (8.2)	0.826
Burst	35 (32.4)	26 (26.8)	0.425
Chance	15 (13.9)	13 (13.4)	0.955
Dislocation	26 (24.1)	34 (35.1)	0.074
Median number of spine regions involved	2	1	<0.001*
Multiple regions of spine involved	50 (22.9)	14 (7.0)	<0.001*
Region of spine involved			
Cervical	67 (30.7)	74 (36.6)	0.201
Thoracic	38 (17.4)	51 (25.2)	0.050
Lumbar	63 (28.9)	61 (30.2)	0.771
Sacral	0 (0.0)	2 (1.0)	0.231
Total spinal cord injuries	35 (16.1)	38 (18.8)	0.833
ASIA A	17 (48.6)	7 (18.4)	0.006*
ASIA B	2 (5.7)	9 (23.7)	0.032*
ASIA C	10 (28.6)	8 (21.1)	0.457
ASIA D	6 (17.1)	14 (36.8)	0.059

*, significant finding. ASIA, American Spinal Injury Association impairment scale. COVID, coronavirus disease.

Table 4 Surgical logistics

Variables	Pre-COVID Cohort	COVID cohort	P value
Procedure, n (%)			
Decompression	68 (31.2)	76 (37.6)	0.165
Fusion +/– Decompression	140 (64.2)	118 (58.4)	0.222
Debridement	4 (1.8)	1 (0.5)	0.374
Other	6 (2.8)	7 (3.5)	0.673
Approach, n (%)			0.955
Anterior	32 (14.7)	31 (15.4)	0.848
Posterior	181 (83.0)	165 (81.7)	0.718
Combined	2 (0.9)	2 (1.0)	1
Other	3 (1.4)	4 (2.0)	0.715
Instrumentation, n (%)	142 (65.1)	128 (63.4)	0.705
Levels instrumented, median [IQR]	3 [2, 5]	4 [2, 5]	0.592
Time from triage to surgery [hours], median [IQR]	21.6 [9.1, 60.8]	24.6 [11.0, 62.1]	0.372
Number of surgical team scrubbed, median [IQR]	2 [2, 3]	2 [2, 3]	0.263
Surgery performed after hours, n (%)	103 (47.2)	115 (56.9)	0.047*
Consultant primary surgeon, n (%)	194 (89.0)	171 (84.7)	0.188
Anaesthetic time [min], median [IQR]	231 [174.3, 299.8]	252 [182.8, 302]	0.231
Surgical time [min], median [IQR]	134 [92, 184.8]	150 [100.3, 200]	0.104
Time in room [min], median [IQR]	197 [144.3, 260.8]	219.5 [160.3, 281]	0.034*

*, significant finding. COVID, coronavirus disease; IQR, interquartile range.

challenges to the Australian healthcare system and delivery of surgical services. Rising case numbers across Australia, particularly in the states of NSW and Victoria, led to the implementation of social restrictions as a measure to combat the virus. These measures have been effective, with hospitals in NSW able to deliver emergency trauma and semi-urgent elective procedures, with a gradual increase in routine elective surgery as community transmission of the virus declined.

Many centres [both locally and overseas] have found that presentations of general trauma patients decreased during the pandemic, by up to 56.8% (8,9,14). The institution in this study recorded a 30.8% decrease in general orthopaedic trauma admissions during the first wave of the virus in early 2020 (7), while another trauma centre in Sydney recorded a decrease in presentations of 23% to 34% (15). Global trends in spinal trauma, however, have been variable. Ahuja *et al.* reported a 46% reduction in referrals to a tertiary spinal unit in the United Kingdom in the first three months of the pandemic compared to the same period a year earlier (10). A 26% reduction in spinal trauma procedures was also noted across multiple centres in Italy for the month of March in 2020 when compared to preceding years. Our study findings were consistent with these centres but lower in magnitude, with a 7.3% absolute decrease in spinal procedures performed following implementations of COVID health restrictions. However, not all centres had the same experience. Bajunaid *et al.* found that despite overall neurosurgical procedures falling by 44% across multiple centres in Saudi Arabia during the pandemic, the emergency spinal trauma load remained the same (11). Similarly, a single centre in the Republic of Korea found the overall number of spinal trauma procedures performed for patients was comparable to previous years (12).

The reduced rates of road trauma found in our study are possibly due to the public health orders limiting social movement and travel. These findings are consistent with a reduction in motor vehicle-related spinal trauma seen

both locally and internationally. A UK acute spinal injury unit found a shift from high energy to low energy related trauma during the pandemic (9). The authors postulated that this change was due to increased home activities and do-it-yourself jobs. Westmead Hospital in Sydney, Australia, reported a 40% to 52% decrease in road trauma in 2020 when compared to the preceding period (15). The institution in the current study recorded similar trends in general orthopaedic and hand trauma from motor vehicle accidents in the same period (6,7). The increased proportion of cycling-related trauma is likely multifactorial, with the Sydney City Council reporting a monthly increase in rates of cycling traffic up to 50% in certain areas of Greater Sydney in April 2020, despite a reduction in overall people movement of 87% (16).

Despite the reduction in road traffic-related spinal injuries, there was no significant difference in the ISS scores between the two periods in this study. Similarly, Jacob *et al.* reported no difference in the median ISS score for trauma presentations in the pre-COVID and COVID period (15). The rates of any SCI in this study remained similar between cohorts. However, rates of ASIA A SCI (designating a complete SCI) were significantly reduced. Rates of ASIA B SCI (indicating an incomplete SCI) increased between periods. An increased proportion of low energy mechanisms (although not statistically significant) and fewer road accidents (which are typically high energy in nature) might explain the differences in cord injury severity seen between the cohorts.

The pandemic has also dramatically affected internal hospital policies regarding peri-operative care for suspected infective individuals. Such changes include the redistribution of theatre staff, dedicated COVID operating theatres, strict personal protective equipment requirements and changes in anaesthetic practice regarding airway management due to the high risk of aerosolising viral particles. At the institution in this study, all patients are screened for COVID-19 preoperatively, with reverse transcriptase polymerase chain reaction (RT-PCR) viral swabs obtained for those patients at increased risk of infection. Given the emergent nature of patients with neurological compromise in spinal injury, RT-PCR swab results may not have returned prior to surgery commencement, and therefore COVID-19 protocols must be adhered to. This study showed that neither time to theatre nor mean surgical time was significantly increased between the two cohorts [consistent with the prior literature]; however, time inside the operating theatre was significantly increased, which is most likely due to time required to implement the risk reduction strategies for aerosolising procedures (17,18). Interestingly, these findings are not consistent with operative intervention in general orthopaedic and hand trauma from the same institute, with total surgical time decreasing in both respective pandemic cohorts (6,7).

Given fewer road trauma related injuries were observed in this study, we would expect fewer time-sensitive cases requiring operations performed after hours; however, this was not the case with after-hours surgery increasing from 103 to 115 operations between periods. This may be explained by limited dedicated COVID-19 operating theatres and increased time spent in room, as well as delays waiting for COVID tests for patients causing a resultant increase in cases commenced after hours. Future investigation into the optimisation of peri-operative protocols when triaging suspected COVID-19 positive patients for emergent surgery would be beneficial.

This study has a number of limitations. It is retrospective in nature, leading to potential selection and recall bias. The time period chosen for the 'COVID group' did not have uniform social restrictions throughout, resulting in potential confounding. However, it was necessary to choose a period of long enough duration to adequately capture patterns of injury, given the relatively low frequency of SCI.

This is the first study to provide insight into the implications of COVID and its subsequent limitation of social movement on the patterns of spinal injury and trauma surgery at an acute spinal injury unit in NSW. Further investigation into the social drivers contributing to SCI in Australia may aid in generation of public health strategies to prevent these injuries. Ongoing analysis of peri-operative protocols may help to deliver efficient care for those patients requiring urgent spinal surgery, as well as help rationalize resources in future pandemics or disasters.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-22-46/rc

Data Sharing Statement: Available at https://jss.amegroups.com/article/view/10.21037/jss-22-46/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jss.amegroups.com/article/view/10.21037/jss-22-46/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Northern Sydney Local Health District Human Research Ethics Committee (No. EC00112), and individual consent for this retrospective analysis was waived.

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