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ORIGINAL ARTICLE

Comparison of anterior cervical decompression fusion versus anterior cervical corpectomy with paramesh in central cord syndrome patients.

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ABSTRACT… Objective: To compare ACDF and ACCP in terms of neurological recovery and postoperative pain among CCS patients presenting at a tertiary care hospital, Karachi, Pakistan. **Study Design:** Prospective Cohort study. **Setting:** Department of Orthopedics, Dr. Ziauddin Hospital, Karachi. **Period:** February 2021 to March 2023. **Methods:** Patients diagnosed with CCS, presenting within 6 weeks of the index injury of age 45 to 60 years of either gender were included in the study. Group 1 included patients who underwent ACDF and Group 2 included patients who underwent ACCP. Patients in both groups were followed up to 2 years post-surgery. Outcomes were neurological outcome and pain. Data was analyzed using SPSS version 23. **Results:** There were no significant baseline differences between groups in terms of age, gender, hypertension, or diabetes. Neurological improvement was observed in 68% of the ACCP group compared to 32% in the ACDF group (p=0.025). However, 59.2% of ACDF patients reported significant pain relief, compared to 40.8% of ACCP patients (p=0.011). There were no significant readmissions or morbidity in either group. **Conclusion:** ACCP offers superior long-term neurological outcomes, while ACDF provides better postoperative pain relief. The choice of procedure should be based on individual patient needs, balancing neurological recovery and pain management considerations. Further multicentre studies are needed to generalize these findings.

Key words: Corpectomy, Central Cord Syndrome, Cervical Spine, Clinical Outcome Paramesh, Decompression Fusion.

INTRODUCTION

Central cord syndrome (CCS) is a neurological condition characterized by specific patterns of sensory and motor dysfunction resulting from damage to the central portion of the spinal cord.[1,2] First described by Schneider et al. in 1954, CCS typically presents with disproportionate impairment of motor function in the upper extremities compared to the lower extremities, along with variable sensory deficits.[3,4] This syndrome is commonly associated with traumatic spinal cord injuries (SCI), particularly hyperextension injuries of the cervical spine, although non-traumatic etiologies such as spinal stenosis or vascular compromise can also lead to its manifestation.[1,5]

The pathophysiology of CCS involves injury to the central gray matter and surrounding white matter tracts within the spinal cord. Mechanisms contributing to this injury may include direct mechanical compression, vascular compromise leading to ischemia, and secondary inflammatory processes.[1] The resulting damage disrupts ascending and descending pathways responsible for relaying sensory information and controlling motor function, leading to the characteristic clinical presentation of CCS.[6]

Diagnosing CCS is primarily based on detailed neurological assessments, supplemented by neuroimaging studies such as magnetic resonance imaging (MRI) to visualize spinal cord anatomy and identify the extent of injury.[6] Treatment strategies for CCS encompass a multidisciplinary approach, including acute stabilization of spinal injuries, pharmacological interventions to manage pain and spasticity,

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as well as rehabilitative therapies aimed at maximizing functional recovery.[7]

Anterior Cervical Decompression Fusion (ACDF) offers direct decompression and is particularly beneficial for patients with anterior column instability, restoring intervertebral height and correcting cervical alignment through the use of either standalone cages or an Anterior cervical corpectomy with paramesh (ACCP).[8-10] This study aims to evaluate the efficacy of ACDF compared to ACCP in treating CCS, with a focus on optimizing clinical outcomes and informing decision-making in patient care.

METHODS

It was a prospective cohort study conducted at the department of orthopedics, Dr. Ziauddin Hospital, Karachi from from February 2021 to March 2023. Sample size of 30 in each group was estimated using Open Epi Sample Size Calculator, by taking statistics of neck disability index as 11.88 ± 2.57 in ACDF[8], by considering 15% in ACCP group, power of test as 80% and 95% confidence level. By inflating the sample size by 10% in each group for potential losses, 33 patients were included in both groups. Patients diagnosed with CCS, presenting within 6 weeks of the index injury of age 45 to 60 years of either gender were included in the study. Patients with prior cervical surgery, and those deemed unfit for general anaesthesia due to ASA grades 3-4 were excluded from the study. Non-probability consecutive sampling technique was employed.

Ethical approval was obtained from ethical review committee (ERC 09-05/21) of Dr. Ziauddin Hospital. Informed consent was obtained from eligible participants. Group 1 included patients who underwent ACDF and Group 2 included patients who underwent ACCP. In the ACDF group, the surgical procedure involved the removal of a herniated or degenerative disc that was compressing neural tissues. This was accomplished through an incision made in the anterior (front) region of the neck. After exposing the affected area, the problematic disc was carefully removed. Subsequently, a graft was inserted between the vertebrae where the disc had been removed. This graft served to promote bone growth and fusion of the adjacent vertebrae, stabilizing the spine. For the ACCP group, the procedure was similar to the ACDF but involved a more extensive surgical approach. This included a larger and more vertically oriented incision to provide greater exposure of the cervical spine. This additional exposure was necessary for cases where the entire vertebra (or a significant portion thereof) needed to be removed due to extensive degeneration or compression. In some cases where both the disc and adjacent bony structures were impinging on the spinal cord, a combination of discectomy (removal of the disc) and corpectomy (removal of the vertebra) was performed. Following the removal of these structures, the gap was bridged with a graft, and spinal fusion was carried out. The fusion process, often likened to welding, involved the joining of the adjacent vertebrae to form a single, solid unit, thereby ensuring long-term stability and alignment of the cervical spine. Patients in both groups were followed up to 2 years post-surgery. Outcomes were neurological outcome and pain. The neurological status was measured by the ASIA (American Spinal Injury Association Impairment Scale and grade E was considered as good outcome. For pain, Visual Analogue Scale (VAS score) was used and score of less than considered as good outcome. Data regarding age, gender, comobids i.e. hypertension and diabetes were also collected. All collected data was kept secured in passcode protected file.

Data was analyzed using SPSS version 23. Mean and SD for age were computed. Frequency and percentage were computed for gender, hypertension, diabetes, improvement in neurological outcomes and pain. Comparison between both groups for age was done using independent samples t-test and for gender, hypertension, diabetes, improvement in neurological outcomes and pain was done using chi-square test. A p-value of less than 0.05 was considered as statistically significant.

RESULTS

Table-I compares the baseline characteristics between two groups (ACDF and ACCP), with 33 patients in each group. The average age in the

ACDF group was 52.67 years, while in the ACCP group, it was 53.09 years. In the ACDF group, 41.9% of patients were female, while in the ACCP group, 58.1% were female. About 57.9% of the patients in the ACDF group had hypertension compared to 42.1% in the ACCP group, while, 43.8% of the patients in the ACDF group had diabetes compared to 56.3% in the ACCP group. There are no significant differences in baseline characteristics (age, gender, hypertension, or diabetes) between the two groups, making them comparable ($p>0.05$).

In the ACDF group, three patients were lost to follow-up after 1 year. Meanwhile, in the ACCP group, 1 patient died after 6 months, and 1 patient was lost to follow-up after 1 year.

Figure-1 shows the distribution of ASIA impairment grades between the ACDF and ACCP groups. About 32% of the patients in ACDF group and 68% of the patients in ACCP group showed significant improvement in neurological outcomes ($p=0.025$).

Figure-2 shows the improvement in pain between the ACDF and ACCP groups. About 59.2% patients in the ACDF group reported significant improvement in pain, compared to 40.8% in the ACCP group.

There were no cases of readmission and morbidity among both the groups.

Variables	ACDF (n=33)	ACCP (n=33)	P-Value
Age (years)	52.67±1.02	53.09±8.61	0.816
Gender			
Female	13 (41.9%)	18 (58.1%)	0.301
Male	20 (57.1%)	15 (42.9%)	
Hypertension			
Yes	11 (57.9%)	8 (42.1%)	0.766
No	22 (46.8%)	25 (53.2%)	
Diabetes			
Yes	7 (43.8%)	9 (56.3%)	0.599
No	23 (52.3%)	21 (47.7%)	

Table-I. Baseline characteristics between both groups (n=66)

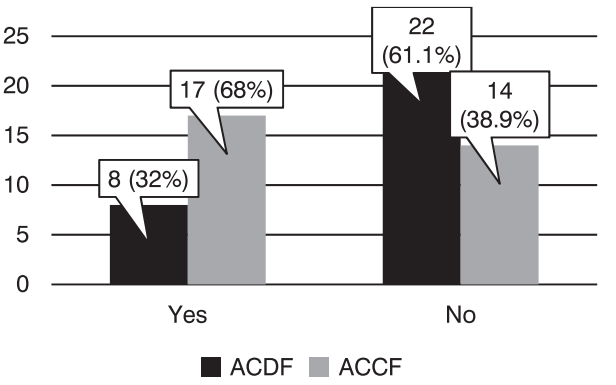

Figure-1. Comparison improvement in neurological outcomes at 2 years between groups

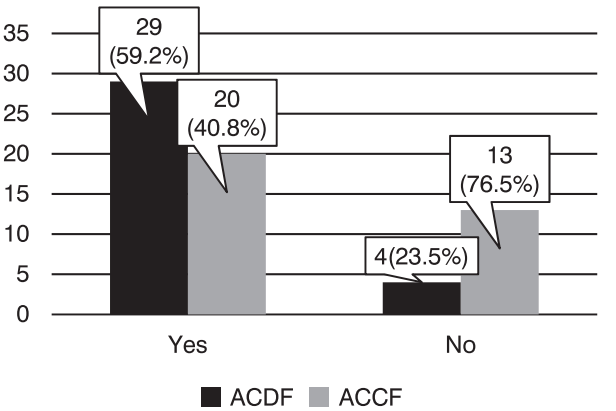

Figure-2. Comparison of improvement in pain at 2 years between groups

DISCUSSION

CCS is a type of incomplete spinal cord injury that primarily affects motor and sensory functions in the upper limbs more than the lower limbs. It is most commonly associated with hyperextension injuries of the cervical spine.[11-15] Two surgical approaches commonly used to treat CCS are **ACDF** and **ACCP**. ACDF is a less invasive procedure with shorter hospital stays, while ACCP is considered more extensive, often leading to better long-term neurological outcomes.[16,17] Despite the widespread use of these techniques, there is no consensus on which approach yields superior results, especially regarding neurological recovery, functional status, and pain management.[16-19] This study aimed to compare the outcomes of these two surgical techniques in CCS patients over two years post-surgery.

The current study showed that patients who

underwent ACCP had better neurological outcomes at the two-year follow-up compared to those who had ACDF (68% vs. 32%, p=0.025), indicating that ACCP is more effective in improving neurological function in the long term. Regarding pain outcomes, ACDF patients had better pain relief, with 59.2% of patients reporting significant improvement compared to 40.8% in the ACCP group (p=0.011). This suggests that while ACCP offers better neurological recovery, ACDF may be preferable for managing postoperative pain.

International studies, such as those conducted by Wang et al., also report that ACCP generally leads to better neurological outcomes due to the more extensive decompression it provides.[20] The current study supports these findings by showing a greater percentage of ACCP patients achieving better ASIA grades compared to ACDF patients. However, the difference in outcomes was more pronounced in this study, possibly due to differences in patient selection and surgical expertise.

In contrast to neurological outcomes, the pain relief observed in the ACDF group was better, which is supported by studies like those by Song et al., who reported that ACDF is associated with shorter recovery times and reduced immediate postoperative discomfort.[8] The current study extends this observation by showing that this benefit persists over the two-year follow-up period.

A key strength of the study is the two-year follow-up period, which allows for a comprehensive assessment of both immediate and long-term surgical outcomes. Many studies focus on shorter follow-up durations. The study directly compares two widely used surgical techniques for CCS, providing valuable insights into their relative merits in different outcome domains (neurological recovery vs. pain). Being conducted in a single center limits the generalizability of the findings. Outcomes may differ in other settings due to variations in surgical expertise, patient demographics, and perioperative care. Although the sample size of 66 patients is adequate for detecting significant differences, larger studies are needed to confirm these findings. A larger sample could also help detect potential differences in subgroups (e.g., older vs. younger patients).

The findings of this study suggest several important directions for future research and clinical practice. The choice between ACDF and ACCP should be tailored to the individual patient's condition. Patients with a priority for pain management and shorter recovery times may benefit more from ACDF, while those with a higher emphasis on neurological recovery may be better suited for ACCP. Future studies should involve multiple centers to increase the generalizability of the results. This would help account for variability in surgical techniques and postoperative care, offering a more comprehensive picture of the outcomes of ACDF and ACCP. Given the lack of randomized controlled trials comparing ACDF and ACCP, future research should focus on conducting such studies to provide high-quality evidence on which surgical technique offers the best overall outcomes for CCS patients. The potential of hybrid procedures, such as combining single-level corpectomy with discectomy, should be explored as they may offer a balance between the neurological benefits of ACCP and the pain management benefits of ACDF.

CONCLUSION

This study demonstrated that ACCP provides better neurological outcomes in patients with central cord syndrome, whereas ACDF is more effective in reducing postoperative pain. The choice of procedure should be based on the patient's clinical presentation, surgeon expertise, and specific treatment goals.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Zahra Salahuddin:** Data collection.
2	**Minahil Hashmi:** Data collection.
3	**Athar Muniruddin Siddiqui:** Data interpretation.
4	**Naseem Munshi:** Data interpretation.
5	**Arham Azizi:** Data collection, ethical issues.
6	**Muhammad Salman Masroor:** Data collection.