Original Research Article

Factor Affecting Recovery of Cauda Equina Syndrome in Patients With Prolapsed Lumbar Intervertebral Disc

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Abstract

Introduction: Cauda equina syndrome is a neurological condition characterized by severe low back-pain, saddle anaesthesia, bowel and bladder dysfunction, sexual dysfunction and neurological deficit in lower limb. **Aims and objective:** To study the clinico-pathogenesis, Factors affecting the outcome and To assess the impact of early and delayed decompression of prolapsed lumbar intervertebral disc on the recovery of caudaequina syndrome. **Materials and method:** A prospective study was carried out on patients presenting with clinical features of caudaequina syndrome. Patients presenting with clinical feature of caudaequina syndrome and giving consent for surgery will be admitted in Department of Neurosurgery, J.A. group of hospitals, G.R. Medical College, Gwalior (M.P.), over a period of 24 month (from December 2017 to November 2019). **Results & Conclusion:**. Cauda Equina Syndrome is a serious surgical condition, Early diagnosis and surgical decompression within 48 hours of onset of bladder dysfunction in CES-I can prevent further neurological damage to bladder dysfunction and also prevent deterioration to complete CES.

Keywords: Cauda Equina Syndrome, Lumbar spine surgery, spine decompression

Introduction

The term ¨caudaequina" was first described by a French anatomist, Lazarius in 1600. Caudaequina syndrome secondary to intervertebral disc herniation was first reported by Dandy in 1929.In1934 Mixter and Barr first describe the caudaequina syndrome is a severe neurological syndrome[1-3]

Caudaequina consists of nerve root distal to the conusmedullaris, these nerve roots have both a ventral and dorsal root. The dorsal root consists of afferent fibers for transmission of sensation, and the ventral root provides motor fibres for the efferent pathway. The nerves in caudaequina region include the lower lumber and all the sacral nerve roots, and these nerves provides sensory innervation to the saddle area, voluntary control of the external anal and urinary sphincters and sensory and motor fibres to the lower limb. Caudaequina syndrome is characterized by the compression of the distal lumbar, sacral and coccygeal nerve roots distal to conusmedullaris at the level of L1 and L2 vertebral level[4]. Caudaequina syndrome is a neurological condition characterized by severe low back-pain, saddle anaesthesia, bowel and bladder dysfunction, sexual dysfunction and neurological deficit in lower limb (motor/ sensory loss or reflex changes)[5]Caudaequina syndrome has low incidence in the population, ranging from 1 in 33,000 to 1 in 100,000·Most frequently, it occurs between the ages of 31-50**.**Lumbar disc herniation is most common cause of caudaequinasyndrome, about 45% cases of caudaequina syndrome are caused by lumbar disc herniation.It is most commonly due to the L4-L5 lumbar disc herniation[6]

Materials and method

This prospective study was carried out at the Department of Neurosurgery, J.A. Group of Hospitals, G.R. Medical College, Gwalior, and M.P.

32 cases of caudaequina syndrome due to lumbar intervertebral disc herniation was included in study. During two years (December 2017 to November 2019). 2 patients were lost during study.

Inclusion Criteria

Patients of all age group irrespective of sex those who presented with symptoms and signs of caudaequina syndrome due to prolapsed lumbar intervertebral disc. Recurrent cases of caudaequina syndrome due to prolapsed lumbar intervertebral disc are also included in this study.

Exclusion Criteria

- Patient not giving consent for study or not willing for surgery.
- Patients who had been previously operated for lumbar spine surgery for any other cause.
- Patients having caudaequina syndrome cause, other than prolapsed lumbar intervertebral disc.

Methods

A prospective study was carried out on patients presenting with clinical features of caudaequina syndrome. Patients presenting with clinical feature of caudaequina syndrome and giving consent for surgery will be admitted in Department of Neurosurgery, J.A. group of hospitals, G.R. Medical College, Gwalior (M.P.) and included in the study. We defined caudaequina compression as a complex of low back ache, sciatica (pain extending down the lower limb in a dermatomal pattern), saddle anaesthesia, and motor weakness in the lower extremities in association with either bladder or bowel dysfunction. Not all criteria were required for the diagnosis of caudaequina syndrome. Patients were included in the study on the basis that they had symptoms of urinary dysfunction and saddle anaesthesia, with varying degrees of motor and sensory loss in either of the extremities. Patients were categorized into complete (CES-R) and incomplete (CES-I) before surgical decompression of caudaequina. Complete caudaequina syndrome (CES-R) is defined as painless urinary retention or overflow incontinence or faecal

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incontinence with or without complete perianal sensory loss. All CES-R cases had a urinary catheter inserted. Incomplete CES-I is defined as altered urinary sensation (urinary frequency, urgency, or urinary straining) and decrease perianal sensory loss with or without lower back pain, unilateral/bilateral sciatica, and lower limb motor or sensory signs.

Patients were divided into three groups with regard to onset of symptoms in accordance with Tandon and Sankaren[12]. Group I, in which the symptoms arose suddenly without previous history of backache, group II in which there was an acute onset of bladder dysfunction following a long history of low back pain and group III, in which CES arose gradually from a background of chronic low back pain and sciatica.

Diagnosis of caudaequina syndrome was made on the basis of history and clinical signs supplemented with magnetic resonance imaging (MRI) of spine, on MRI imaging if the cause of caudaequina syndrome found to be prolapsed lumbar intervertebral disc then these patients was included in study.

We defined early decompression as surgical decompression within 48 hrs of the development of the caudaequina syndrome and delayed decompression any time following this. The patients were divided into three groups on the basis of time interval between onset of symptoms of caudaequina syndrome and surgical intervention as <24 hrs, 24-48hrs and >48hrs.

Pre-operative assessment

a) Clinical examination of patients
b) X-ray lumbosacral spine lateral-flexion-extension and anterior-posterior view
c) MRI-Lumbosacral spine
d) Types of Surgical procedure

Surgical options: All patients underwent surgery via a standard posterior approach

1. Standard wide laminectomy with discectomy
2. Microdiscectomy

Patients were allowed to walk on the 2nd post operative day along with isometric abdominal and lower extremity exercises. The patients were advised to use a lumbosacral belt, and avoid forward bending, sitting for prolonged periods, straining and lifting heavy weight.

Follow-up

All patients were clinically assessed and followed for a minimum of 6 months at the neurosurgery OPD. Post-void residual urinary volume was measured at 1month and at 6 months. Post void residual volume was measured with Foley's catheterization or by bladder USG.

Outcome of caudaequina syndrome

Bladder outcome was defined as, excellent outcome (normal bladder function), good outcome (definite improvement) and poor outcome (no improvement) based on clinical assessment and post-void residual urinary volume. We defined bladder recovery as 'excellent outcome' if the patients did not exhibit any residual bladder symptoms, 'good outcome' if the patients required to stain but did not require intermittent catheterization and had residual urine volume <100ml and poor outcome, those who required intermittent catheterization and had a residual urine volume >100ml.

Overall surgical outcome (recovery) of caudaequina syndrome were evaluated as good outcome (who had complete recovery of bowel bladder function, saddle anaesthesia and sciatica, sensory and motor power), fair (recovery) outcome (who had complete recovery of sciatica, saddle anaesthesia, and defecation dysfunction and had some difficulty during micturition but did not require intermittent catheterization) and poor (recovery) outcome (low back pain and sciatica recovered in most of the patients and some recovery of saddle anaesthesia and bowel and bladder dysfunction and required intermittent catheterization.

Statistical Analysis Method: The McNemar test was used to determine the differences on a categorical dependent variable between two related groups. P-value <0.05 was considered statistically significant. All analysis was done using SPSS software, version 24.0.

Observation and Results

Table 1: Distribution of patients according to gender

Gender	No. of patients (n=30)	Percentage (%)
Male	26	86.7
Female	4	13.3

In our study, total number of patients was 30. Out of which 26 (86.7%) were male and 4 (13.3%) were female.

Table 2: Distribution of patients according to age

Age (years)	No. of patients (n=30)	Percentage (%)
21-30	5	16.7
31-40	14	46.7
41-50	9	30.0
51-60	1	3.3
61-70	1	3.3

The Mean ± SD age of the patients in our study was 39.1±9.2 years (Range: 20 - 65 years) Majority of the patients in our study were in age group of 31-40 years (46.7)

Table 3: Distribution of patients according to symptoms

Symptoms	No. of patients (n=30)	Percentage (%)
Back pain	27	90.0
Unilateral sciatica (right or left)	15	50.0
Bilateral sciatica	15	50.0
Urinary difficulty*	17	56.7
Urinary retention	13	43.3
Defecation dysfunction	25	83.3
Leg or foot paraesthesia	21	70.0
Sexual dysfunction (Male only)	19	63.3

Urinary difficulty* (frequency, urgency or straining)

In our study, urinary symptoms were most common, present in all patients.

Table 4: Distribution of patients according to neurological signs

Neurological sign	No. of patients (n=30)	Percentage (%)
Saddle hypoesthesia	27	90.0
Perianal sensation present	14	46.7
Perianal sensation decrease	10	33.3
Perianal sensation absent	6	20.0
Decrease anal tone	6	20.0
Absent anal reflex	19	63.3
Absent bulbocavernous reflex	17	56.7
Foot drop	8	26.7
Weak EHL	17	56.7
Absent ankle jerk	22	73.3

Most common neurological sign observed was saddle anaesthesia in 27 (90.0%) patients.

Table 5: Distribution of patients according to bowel and bladder dysfunction

Bowel or bladder dysfunction	No. of patients (n=30)	Percentage (%)
Urinary dysfunction*	17	56.7
Urinary retention	13	43.3
Faecal incontinence	4	13.3
Constipation	21	70.0

*(frequency, urgency or straining)

Most common Bowel or bladder dysfunction was Constipation in 21 (70.0%) patients.

Table 6: Distribution of patients according to onset of caudaequina syndrome

Onset of caudaequina syndrome	No. of patients (n=30)	Percentage (%)
Sudden onset (Type 1)	12	40.0
Acute onset (Type 2)	13	43.3
Chronic onset (Type 3)	5	16.7

Most common type of onset of caudaequina syndrome was acute in 13 (43.3%) patients followed by sudden in 12 (40.0%) patients and chronic onset in 5 (16.7%) patients.

Table 7: Distribution of patients according to types of caudaequina syndrome

Type of caudaequina syndrome	No. of patients (n=30)	Percentage (%)
CES-I	15	50.0
CES-R	15	50.0

Patients were equally distributed in CES - I and CES - R type of cauda equine syndrome.

Table 8: Distribution of patients according to level of lumbar intervertebral disc

Level of disc	No. of patients (n=30)	Percentage (%)
L2 - L3	1	3.3
L3 - L4	4	13.3
L4 - L5	21	70.0
L5 - S1	4	13.3

Most common level of disc involvement was L4-L5 in 21 (70.0%) patients and 1 (3.3%) patient of L2-L3 level. patients followed by L3-L4 in 4 (13.3%) patients, L5-S1 in 4 (13.3%)

Table 9: Distribution of patients according to time interval between onset of caudaequina Syndrome and surgery

Time interval between onset of CES and surgery	No. of patients (n=30)	Percentage (%)
<24 hrs	2	6.6
24-48 hrs	8	26.7
>48 hrs	20	66.7

The delay in surgery from the onset of caudaequina syndrome was ranged from 1to 25 days and mean was 5.8 days. Out of 30 cases, 2 (6.6%) cases were operated within 24 hours of onset of symptoms, 8 (26.7%) cases within 24-48 hours and remaining 20 (66.7%) cases after 48 hours (mean duration 8days) of onset of symptoms

Table 10: Distribution of patients according to type of surgical procedure

Type of surgical procedure	No. of patients (n=30)	Percentage (%)
Laminectomy with discectomy	26	86.7
Microdiscectomy*	4	13.3

*Microdiscectomy includes: Fenestration or hemilaminectomy.

Out of 30 patients, laminectomy with discectomy was done in 26 (86.7%) patients and Microdiscectomy was done in 4 (13.3%) patients

Table 11: Correlation between type of onset of caudaequina syndrome and outcome of CES

Type of onset of CES	Outcome of CES at 6 months				p- value
	Good	Fair	Poor	Total	
Sudden (Type 1)	0 (0.0%)	9(75.0%)	3 (25.0%)	12 (100%)	0.099
Acute (Type 2)	3 (23.1%)	4 (30.7%)	6 (46.2%)	13 (100%)	
Chronic (Type 3)	0 (0%)	4 (80.0%)	1 (20.0%)	5 (100%)	

*p-value < 0.05, statistically significant

There was no significant association observed between poor outcome of CES at 6 months with type of onset of CES (p= 0.099). Nine (7.5%) patients out of 12 sudden onset patients and 4 (80.0%) patients out of 5 chronic onset patients had fair outcome of CES at 6 months whereas 3 (23.1%) and 4 (30.7%) patients out of 13 acute onset had good and fair outcome of CES at 6 months respectively.

Table 12: Correlation between types of cauda equina syndrome and outcome of CES at 6 months

Types of CES	Outcome of CES at 6months				p-value
	Good	Fair	Poor	Total	
CES-I	1 (6.7%)	11 (73.3%)	3 (20.0%)	15	0.048
CES-R	2 (13.3%)	6 (40.0%)	7 (46.7%)	15	

Good, fair and poor outcome of CES at 6months were 2 (13.3%), 6 (40.0%) and 7 (46.7%) in CES-R patients whereas 1 (6.7%), 11 (73.3%) and 3 (20.0%) in CES-I patients respectively. Outcome was significantly better in CES-I as compared to CES-R (p=0.048).

Table 13: Recovery of CES-R in early v/s delayed decompression at 1 month

Timing of surgery	Recovery of CES-R at 1 month				p-value
	Good	Fair	Poor	Total	
<24 hrs	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0.094
24-48 hrs	0 (0%)	0 (0%)	3 (100%)	3 (100%)	
>48 hrs	2 (18.2%)	1 (9.1%)	8 (72.7%)	11 (100%)	

Early surgery within 48 hrs was not associated with better recovery of CES-R at 1 month (p= 0.094).

Table 14: Recovery of CES-I in early v/s delayed decompression at 1 month

Timing of surgery	Recovery of CES-I at 1 month				p-value
	Good	Fair	Poor	Total	
<24 hrs	1 (100%)	0 (0%)	0 (0%)	1 (100%)	0.0021
24-48 hrs	0 (0%)	4 (80%)	1 (20%)	5 (100%)	
>48 hrs	0 (0%)	4 (44.4%)	5 (55.6%)	9 (100%)	

Early surgery within 48 hrs was significantly associated with better recovery of CES-I at 1 month (p= 0.0021

Table 15: Recovery of CES-R in early v/s delayed decompression at 6 month

Timing of surgery	Recovery of CES-R at 6 month				p-value
	Good	Fair	Poor	Total	
<24 hrs	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0.658
24-48 hrs	0 (0%)	1(33.3%)	2 (66.7%)	3 (100%)	
>48 hrs	2 (18.2%)	4 (36.4%)	5 (45.5%)	11 (100%)	

Out of 15 patients having complete type of CES-R, one out of 3 (33.3%) patients who had operated within 24-48 hours were reported with fair recovery of CES-R at 6 month.

Table 16: Recovery of CES-I in early v/s delayed decompression at 6 month

Timing of surgery	Recovery of CES-I at 6 months				p-value
	Good	Fair	Poor	Total	
<24 hrs	1 (100%)	0 (0%)	0 (0%)	1 (100%)	0.002
24-48 hrs	0 (0%)	5 (100%)	0 (0%)	5 (100%)	
>48 hrs	0 (0%)	6 (66.7%)	3 (33.3%)	9 (100%)	

Out of 15 patients having incomplete type of CES, only one patient, who had been operated within 24 hours, was reported with good recovery of CES-I at 6 month

Table 17: Outcome at the end of follow up compared to preoperative status in the CES-I group

CES – I	Pre-Operative (n=15)	Post-Operative at 6 Months	p-value
Low back pain	13 (86.7%)	2 (13.3%)	0.001*
Sciatica	15 (100%)	2 (13.3%)	0.001*
Motor Weakness	7 (46.7%)	1 (6.7%)	0.031*
Defecation dysfunction	12 (80%)	2 (13.3%)	0.001
Sexual dysfunction	11 (73.3%)	6 (40%)	0.277

In our study, low back pain was present in 13 patients (86.7%) preoperatively whereas post operatively after 6 months only 2 patients had low back pain.

Table 18: Outcome at the end of follow up compared to preoperative status in the CES-R

CES – R	Pre-Operative (n=15)	Post-Operative at 6 Months	p-value
Low back pain	14 (93.3%)	6 (40%)	0.002*
Sciatica	15 (100%)	4 (26.7%)	-
Motor Weakness	10 (66.7%)	7 (46.7%)	0.277
Defecation dysfunction	13 (86.7%)	4 (26.7%)	0.001
Sexual dysfunction	8 (53.3%)	5 (33.3%)	0.277

In our study, low back pain was present in 14 patients (93.3%) whereas postoperatively after 6 months only 6 patients (40%) had low back pain.

Discussion

Caudaequina syndrome is an uncommon condition, accounting for 2-6% of all lumbar disc herniation [7]. It is characterised by a diverse spectrum of symptoms and signs caused by compression of caudaequina nerve roots[8]. It is a neurological emergency, because it is associated with sphincter disorders and incontinence of urine and stool in the patients along with other local and paralytic symptoms, in case of continued pressure on the caudaequina roots. Pathogenesis of CES remains unclear. Mechanical compression and ischemia of caudaequina are the two main hypotheses for development of caudaequina syndrome[9]. Clinician must focus on urinary retention because it provides the classification of caudaequina syndrome which is CES-R (complete urinary retention) and CES-I (frequency, urgency, limited urinary sensation and loss of ability to void).

Demographic feature

Gender wise distribution

In our study total number of patients was 32; two patients were lost to follow up and excluded from the study. There was a male predominance in our study with 26 (86.7%) males and 4 (13.3%) females, male to female ratio being 6.5:1. Our study correlates with Dinning et al[10],, who had found male in 71.8% cases and female in 28.2% cases. Radulovic et al also had similar findings, male (76.6%) and female (23.4%)[11]

Age wise distribution

In our study, Majority of the patients belonged to the age group of 31 - 40 years (46.7%), second most common age group was 41-50 years (30.0%), followed by 21-30 years (16.7%). Most of the patients in our study were middle aged males which correlates with results of Beculic et al[12]. Our study correlated with the Kostuik et al, Hussain et al[14], Radulovic D et al[11] and Olivero WC et al[13-15]

Clinical feature

In our study the most common clinical features were bladder dysfunction in association with sciatica, saddle anesthesia and defecation dysfunction. Bladder dysfunction was present in all patients, followed by back pain and saddle anaesthesia in 27(90.0%) patients each. Half of the patients had incomplete bladder dysfunction and other half had complete bladder dysfunction. Our study correlated with the study of Kennedy JG et al and Heyes G et al[16,17]

Radiological feature

Level of lumbar intervertebral disc

Caudaequina syndrome may appear following disc herniation at any level below L1-L2, but majority of patients present with disc herniation at the lowest levels, that is mainly L4-L5 and L5-S1. In our study, most common level of disc involvement was L4-L5 being found in 21 patients (70.0%) followed by L3-L4 in 4 patients (13.3%), and L5-S1 in 4 patients (13.3%). Our study is accordance with Shapiro S et al[6], Bharuka A.D et[18], Beculic et al[19], Kennedy J.G et al[16], McCarthy et al[20] and Delgado- Lopez P.D et al[21].

Correlation between onset of caudaequina syndrome and outcome of CES

In our study, onset of caudaequina symptoms varied from sudden onset of bladder to gradual progression over several weeks. Out of 30 patients those who had a poor outcome, three were type I onset, six type II onset and one type III onset. In our study we could not find poor correlation between onset of bladder dysfunction and outcome of caudaequina syndrome at 6 months. Our study is in accordance with Kennedy et al[16], McCarthy et al[20]

Correlation between type of caudaequina syndrome and outcome of caudaequina syndrome.

Caudaequina syndrome has diverse phenotypes; the most common symptom is difficulty in urination, followed by bowel dysfunction, and sexual dysfunction[21]. Bladder symptoms can either be complete (CES-R) or incomplete (CES-I) depending upon severity of urinary sphincter involvement[23]. CES-R patients are those with complete loss of voluntary bladder control along with either acute retention or overflow incontinence. CES-I patients present with vague symptoms such as sensation of incomplete voiding, urgency, poor urinary stream, and urinary straining. In our study, 3 patients (20%) out of 15 patients with CES-I had poor outcome, whereas 7 patients (46.7%) out of 15 patients with CES-R had poor outcome of cauda equina syndromeat 6 months. In our study, we found that cauda equina syndrome recovery was significantly better in CES-I compared to CES-R.Our study is in accordance with Hazelwood et al, Delgado-Lopez et al, Gleaveand Mcfarlane[21-23]

Correlation between level of disc and outcome of CES

In our study, out of 21 patients with L4-L5 disc level, 10 patients (47.6%) had a good outcome, 3 patients (14.3%) had an excellent outcome and 8 patients (38.1%) had a poor outcome of caudaequina syndrome in follow up period (after 6 months). Two patients out of 4 patients with L5-S1 had a good outcome of caudaequina syndrome. All four patients of L3-L4 disc and one patients of L2-L3 disc had a good outcome. In our study, no statistical correlation was found between level of disc and outcome of caudaequina syndrome. Our study correlated with Kennedy et al[16] who had also found no statistical correlation between level of disc and outcome of caudaequina syndrome.

Impact of timing of surgery on recovery of cauda equina syndrome

At one month of follow-up: The role of early surgery in improving the bladder outcome of patients with caudaequina syndrome following lumbar disc herniation remains controversial. In our study, at one month of follow-up, one patient who had been operated within 24hr, had fair recovery ofCES-R and all the 3 patients operated within 24-48 hrs had poor recovery of CES-R. The ones who had been operated after 48 hrs (11 patients), 2 had good recovery and one had fair recovery of CES-R.

But in CES-I only one patient operated within 24 hr had good recovery and four out of five patients who had been operated within 24-48 hrs had fair recovery of CES-I at one month of follow-up. Those who had been operated after 48 hrs (9 patients) showed fair and poor recovery of CES in 4 & 5 patients respectively. At one month of follow up there was significant better recovery of CES-I as compared to CES-R.

At six months of follow-up: In our study we observed that surgical outcome of CES-Rrecoveryhad no correlation with timing of surgery. There was good recovery in all the patients with incomplete caudaequina syndrome (CES-I), those who had been operated within 24 hrs or within 24-48 hrs of onset of symptoms at 6 months of follow up. But delay in surgical decompression after 48 hrs in nine patients (60.0%) with CES-I had poorer recovery of CES at 6 months of

follow up. There was no statistically significant difference (p=0.658) in bladder outcome between the patients operated within 48 hrs and those operated after 48 hrs in CES-R.CES recovery increased with duration of time in both complete and incomplete CES, but the overall recovery of CES was better in incomplete CES as compared to complete CES. Our study is in accordance with Bharukaet al, Ahn's meta-analysis[24], Delgado-Lopez PD et al, Srikandarajahet al, Gleave and Macfarlane[18,24,21,25,23]

Correlation between timing of surgery and outcome of saddle anaesthesia in CES-I and CES-R

This study also assesses the effect of timing of surgery on post operative outcome of saddle anaesthesia. In our study at the end of follow up, saddle anaesthesia was improved in 7 cases out of 12 cases of CES-I. In CES-R at end of follow up, saddle anaesthesia was improved in 7 cases out of 15 cases. There was no statistical significant correlation found between timing of surgery and outcome of saddle anaesthesia in CES-R and CES-I. Heyes et al[26] also found no effect of timing of surgery on outcome of saddle anaesthesia in CES-R and CES-I.

Conclusion

Cauda Equina Syndrome is a serious surgical condition with devastating effect on quality of life and significant economical burden. Early diagnosis and surgical decompression within 48 hours of onset of bladder dysfunction in CES-I can prevent further neurological damage to bladder dysfunction and also prevent deterioration to complete CES. Although in complete CES the recovery was not time dependent to same extent as the incomplete CES. However most authors advocate that early decompression may be helpful in recovery of CES-R. Clinician must give priority to bowel &bladder dysfunction because it helps in classification of CES into complete and incomplete, so that prognosis can be evaluated and discussed with the patient to expect for a realistic outcome.

References

1. Lazarius A. Historiaanatomica humanicorporis. Frankfurt Germany: Becker, 1600:178.
2. Dandy WE. Loose cartilage from intervertebral disk simulating tumor of the spinal cord. Arch Surg. 1989;9:660-672.
3. Gitleman A, Hishmeh S, Moreli B, Joseph S, Casden A, Kulflik P, Neuwirth M, Stephen M. Cauda equina Syndrome; A comprehensive Review. The American Journal of Orthopaedics. 2008;37(11):556-562.
4. Cohen MS, Wall EJ, Kerber CW, Abitbol JJ, Garfin SR. The anatomy of the caudaequina on CT scans and MRI. J Bone Joint Surg Am. 1991;73(3):381-384.
5. Fraser S, Roberts L, Murphy E. Caudaequina syndrome: a literature review of its definition and clinical presentation. Arch Phys Med Rehabil. 2009;90(11):1964-1968.
6. Shapiro S. Medical realities of caudaequina syndrome secondary to lumbar disc herniation. Spine. 200;25:348-351.
7. Henriques T, Olerued C, Peter̈n-Mallmin M et al. Caudaequina syndrome as a postoperative complication in five patients operated for lumbar disc herniation. Spine. 2001;26:293-297.
8. Todd NV, Dickson RA. Standards of care in caudaequina syndrome. British Journal of Neurosurgery. 2016;30(5):518-522.
9. Spector LR, Madigan L, Rhyne A, Darden B 2nd, Kim D. Caudaequina syndrome. J Am Acad Orthop Surg. 2008;16:471-479.
10. Dinning T, Schaeffer H. Discogenic compression of the caudaequina: A surgical emergency. Aust NZJ Surg. 1993;63(12):927-934.
11. Radulović D, Tasić G, Joković M, Nikolić I. The role of surgical decompression of caudaequina in lumbar disc herniation and recovery of bladder function.Med Pregl. 2004;57(7-8):327-30.
12. Beculic H, Skomorac R, Jusic A et al. Impact of timing on surgical outcome in patients with caudaequina syndrome caused by lumbar disc herniation. Med Glas (Zenica). 2016;13:136-41.
13. Kostuik JP, Harrington I, Alexander D, Rand W, Evans D. Caudaequina syndrome and lumbar disc herniation. J Bone Joint Surg Am. 1986;68:386-391.
14. Hussain SA, Gullan RW, Chitnavis BP. Caudaequina syndrome: outcome and implications for management. Br J Neurosurg. 2003;17(2):164-167.
15. Olivero WC, Wang H, Hanigan WC, Henderson JP, Tracy PT, Elwood PW, Lister JR, Lyle L. Caudaequina syndrome (CES) from lumbar disc herniations. J Spinal Disord Tech. 2009;22:202-206.
16. Kennedy JG, Soffe KE, McGrath A, Stephens MM, Walsh MG, McManus F. Predictors of outcome in caudaequina syndrome. Eur Spine J. 1999;8(4):317-322
17. Heyes G, Jones M, Verzin E. Influence of timing of surgery on Caudaequina syndrome: Outcomes at a national spinal centre. Journal of Orthopaedics. 2018;15:210-215.
18. Bharuka AD, Phunde R, Patel HB. Evaluation of relationship between timing of surgery and functional outcome considering the extent of neurological deficit in patients with caudaequina syndrome secondary to lumbar disc herniation. Int J Res Orthop. 2017;3(5):998-1003.
19. Beculic H, Skomorac R, Jusic A et al. Impact of timing on surgical outcome in patients with caudaequina syndrome caused by lumbar disc herniation. Med Glas (Zenica). 2016;13:136-41.
20. McCarthy MJ, Aylott CE, Grevitt MP, Hegarty J. Caudaequina syndrome: factors affecting long-term functional and sphincteric outcome. Spine. 2007;32(2):207-216.
21. Delgado-Lopez PD, Martin-Alonso J, Martin-Velasco V. Caudaequina syndrome due to disc herniation : Long term functional prognosis. Neurocirugia. 2010;30(6):278-287.
22. Hazelwood JE, Hoeritzauer I, Pronin S. An assessment of patient-reported long-term outcomes following surgery for caudaequina syndrome. Acta Neurochirurgica. 2019;161:1887–1894.
23. Gleave JRW, Macfarlane R. Prognosis for recovery of bladder function following lumbar central disc prolapse. Brit J Neurosurg. 1990;4:205-210.
24. Ahn UM, Ahn NU, Buchowski JM, Garrett ES, Sieber AN, Kostuik JP. Caudaequina syndrome secondary to lumbar disc herniation—a meta-analysis of surgical outcomes. Spine. 2000;25(12):1515-1522.
25. Srikandarajah N, Boissaud-Cooke MA, Clark S, Wilby MJ. Does early surgical decompression in caudaequina syndrome improve bladder outcome?. Spine. 2015;40(8):580-3.
26. Heyes G, Jones M, Verzin E. Influence of timing of surgery on Caudaequina syndrome: Outcomes at a national spinal centre. Journal of Orthopaedics. 2018;15:210-215.

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