



Review Article

Review/Perspective: Operations for Cauda Equina Syndromes - “The Sooner the Better”

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ABSTRACT

Background: Although most studies recommended that early surgery for cauda equina syndromes (CES) be performed within <48 h., the largest and most comprehensive Nationwide Inpatient Sample Database (NISC) series, involving over 25,000 CES patients recommended that time be shortened to 0–<24 h. In short, CES surgery performed “the sooner the better,” was best.

Methods: The 2 major variants of CES include; incomplete/partial ICES, and those with urinary retention/bowel incontinence (RCES). Those with ICES often exhibit varying combinations of motor weakness, sensory loss (i.e. including perineal numbness), and urinary dysfunction, while RCES patients typically exhibit more severe paraparesis, sensory loss including saddle anesthesia, and urinary/bowel incontinence. The pathology responsible for ICES/RCES syndromes may include; acute disc herniations/stenosis, trauma (i.e. including iatrogenic/surgical hematomas etc.), infections, abscesses, and other pathology. Surgery for either ICES/RCES may include decompressions to multilevel laminectomies/fusions.

Results: Following early surgery, most studies showed that ICES and RCES patients exhibited improvement in motor weakness and sensory loss. However, recovery of sphincter function was more variable, being poorer for RCES patients with preoperative urinary retention/bowel incontinence.

Conclusions: Although early CES surgery was defined in most studies as <48 h., two large NISC series involving over 25, 000 CES patients showed that CES surgery performed within 0 -< 24 h resulted in the best outcomes.

Keywords: Cauda Equina Syndrome, Early Diagnosis, Optimal Timing, Surgery, “The Sooner the Better” Surgery

INTRODUCTION

Surgery performed “the sooner the better” for patients with cauda equina syndromes (CES) was best [Table 1].^[1,3-18] Early surgery for CES was typically defined as within <48 h. after the onset of symptoms/signs; however, the two largest Nationwide Inpatient Sample Database (NISC) series recommend that CES surgery be completed within 0–<24 h. to achieve the best outcomes [Table 1].^[1,4-6,9,10,14,16-18] CES syndromes are divided into incomplete/partial CES (ICES) versus complete/retention/incontinence CES (RCES) syndromes based upon the respective lesser or greater severity of preoperative motor, sensory, and/or sphincteric deficits.^[9,16,17] ICES/RCES syndromes were largely attributed to; acute disc herniations/stenosis, iatrogenic-surgical trauma, trauma/fractures, infections/abscesses, and other factors.^[1-18] Early surgery, predominantly

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Table 1: Literature on optimal timing of surgery of Cauda Equina syndromes.

Author [Ref] Year	Patient Population	Design of Study/ Optimal Timing	MR Myelo-CT	Preop Surgery Symptoms	Timing of Surgery Outcome
Ahn <i>et al.</i> ^[1] Spine 2000	Time Onset CES vs. Outcome with Surgery Meta-analysis	5 Times to Surgery<24 h 24-48 h 2-10 d 11 d-1 mo>1 mo	Poor Prognostic Factors: Urinary-Fecal Incontinence Older Age	Same Outcomes<24 vs. 24-<48	Better Outcomes Sensory/Motor Sphincter Fx with Surgery<48 h vs. > 48 h (Worse)
Gleave and MacFarlane ^[7] Br J Neurosurg 2002	Role Urgent Surgery Dec CES LDH-Central	Outcome of Urgent or Emergent Surgery for CES	Impact on Sphincter Fx Long-Term	Increased Risks of Emergency Surgery Large Central LDH	CESR-Urinary Incontinence with Overflow Not Benefit Urgent Dec
DeLong <i>et al.</i> ^[6] J Neurosurg Spine 2008	16 Studies Met-analysis CES/ICES vs. CESR From LDH	Outcomes with/ without Urinary Retention	Surgical Times<12 h<24 h<36 h<48 h<72 h	Urinary Outcome Normal Fair Poor 4 Largest Studies<24 vs. <48 h Results	More likely Fair/Poor Outcome with Later Surgery All Groups Higher Fair/Poor Results for CESR
Daniels <i>et al.</i> ^[5] Orthopedics 2012	Review Medicolegal Cases with CES - Assess AO	CES-True Emergency Improved Outcomes Surgery<48 h	26.7% Patients Presented Preop with Sphincter Dysfunction	Recovery Sphincter Function Not Always Occur	Worse Outcomes Surgery>48 After Onset Symptoms
Chau <i>et al.</i> ^[4] World Neurosurg 2014	CES Rare Emergency	Level Neuro Dysfunction Preop Determines Prognosis	Onset Duration Surgical Time Major Impact on Outcome	Early Surgery<48 h Rule	Earlier Surgery More Benefit for Compressed Nerves/Acute Compromise
Todd ^[18] Bone Joint J 2015	Review Medicolegal -Acute Neuro Deterioration	Deficit: B Rad ICES RCES Cont Prog Deficits	MR Study of Choice	Time to Surgery<12 h<24 h<48 h<72 h	Emergency Surgery Decompress ASAP Urgent Emergent Day or Night
Srikandarajah <i>et al.</i> ^[16] Br J Neurosurg 2015	How Does Surgery Dec 200 CES Pts<24, 48, or 72 h Impact Bladder Fx Outcome Average Follow 96 d	61 RCES 139 ICES 36 ICES<24 h 32/36 NL BL Fx 103 ICES>24 h NL BL 55/103	64 ICES<48 h 54 Normal BL Fx 75 ICESI>48 h 33 Normal BL	35 RCES Surgery<24, 48, 72 h No Diff in BL Fx Result No Difference in RCES BL Fx	Concluded Surgery<24 h Onset CES Better Outcomes if No Preop BL Loss
Thakur <i>et al.</i> ^[17] Spine J 2017	NISD 2005-2011 CES Does Early Surgery Dec Result in Better Outcomes CESI/CESR	4066 Adult CES Dec Outcomes Mortality (Inpatient), LOS Hospital Charges	Timing CES Surgery<24 h (1846) 24-48 h (1080) >48 h (1130) Avg Age 50.19 41% F	Surgery<24 h vs. >48 h<Mortality<LOS<Hosp Charges<Unfavor Discharges	ICES Surgery>48 h >Unfavor Discharges>LOS>Hosp >Charges Concluded Early Surgery Better Outcomes: Both CESI/CESR But More Improvement CESI vs. RCESI

(Contd...)

Table 1: (Continued).

Author [Ref] Year	Patient Population	Design of Study/ Optimal Timing	MR Myelo-CT	Preop Surgery Symptoms	Timing of Surgery Outcome
Heyes <i>et al.</i> ^[9] J Orthop 2018	Outcome 136 Pts CES Surgery Followed 2 yrs Impact Surgery<24 h	Timing of Surgery British Assoc of Spine Surgeons 2008–2014	45 CESS (Suspect) 22 CESI (Incomplete) 69 CESR (Urine Retention) Better Outcomes CESS- Postop LBP Saddle Pares	Better Sensory+Motor Outcomes with Early Surgery<24 h	No Sig Diff in Autonomic Outcomes (BL, BO) With early Surgery (<24 h)
Hogan <i>et al.</i> ^[10] World Neurosurg 2019	Timing Dec for CES 2000–2014 Trends	NISD 20,924 Pts Early<48 h vs. Delayed>48 h Surgery	Early Surgery<48 h (80.2% to 76.2% Over Early vs. Late yrs of Study) Percentage Unchanged Despite Evidence Better Outcomes Early Surgery	Delayed CES Surgery Higher Inpatient Mortality (Stat Sig)	Dec 0–1 day Improved Outcomes Lower Comp Less Mort
Hazelwood <i>et al.</i> ^[8] Acta Neurochir (Wien) 2019	46 Survey Long-Term BL+BO Sphincter Fx Outcomes CES Surgery	ICESI Incomplete RCES Urine Retention Avg Age 45 (21–83) Followed Avg 43 mos	Dysfunction BL 76% BO 13% Sexual 39% Physical 48%	RCES Pts Sig Worse Outcomes in BL and BO and Sexual Fx vs. ICES	High Prevalence Long-Term BL, Sexual and Physical Dys in CES patients RCES Poorer Outcomes
Medress <i>et al.</i> ^[14] Neurosurg Focus 2020	CES Including Medical Malpractice Time to Surgery Sig Associated with Plaintiff Verdict	CES Emergency Causes LDH Tumor Hematoma Abscess Fracture	Symptoms Paraparesis Saddle Anesthesia BO and BL Incontinence	US Mean Award \$1.57 Million 1983-2010 73.3% Present No Original Sphincter Dys	83.3% Favor Plaintiff Dec Surgery<48 h Critical Prognosis Surgery<48 h Sphincter Incont surgery Less vs. >48 h Delayed surgery High risk BL Incontinence and Worse Motor deficits+Sexual dys
Long <i>et al.</i> ^[13] Am J Emerg Med 2020	How to Diagnose and Manage CES LBP Often Due to LDH	Red Flags BSciatica, Reduced Perineal Sensation BL Dys-Urine Retention	Loss Anal tone Loss Sexual Fx	MR Diagnostic Study Choice Bladder Scans	Spine Consult Surgery Dec
Lam <i>et al.</i> ^[12] Top Spinal Cord Inj Rehabil 2020	71 Pts Survey BL, BO, Sexual Dys After CES Surgery for LDH	High Prevalence Long-Term BL, BO, Sexual Dys After CES Surgery	42 Males 29 Females	Compared Preop to Postop Status	CES Requires Emergency Dec to Prevent Sphincter Dys BL, BO, Sexual

(Contd...)

Table 1: (Continued).

Author [Ref] Year	Patient Population	Design of Study/ Optimal Timing	MR Myelo-CT	Preop Surgery Symptoms	Timing of Surgery Outcome
Askar <i>et al.</i> ^[2] Br J Neurosurg 2020	Case Report Tisseel Causing CES Fibrin Sealant	Incidental Durotomy 65 yo M Revision Lumbar Dec	Postop CES Urine Retention BSciatica Perianal Numb Postop Day 3	Urgent Surgical Removal Tisseel Fully Recovered	Case of CES due to Tisseel/Fibrin Glue Augment Closure For Incidental Durotomy
Barker <i>et al.</i> ^[3] Bone Joint J 2021	61 Pts CES Survey Chronic LBP Autonomic Disfunction (BL/BO Dys)	Surgical Dec Acute CES Massive LDH Followed Avg 58.2 mos	ICES RCES Avg Age 43 33% BL Dys	10% Foley 38% BO Dys 47% Perineal Numb 67% LBP	Avg Follow up 5 yrs Persistent LBP Autonomic Dys
Kuris <i>et al.</i> ^[11] Am J Med 2021	Critical Timely Diagnosis Treatment	Optimal Outcomes Avoid Medicolegal Suits	Varying Degrees Sensory Loss Motor Weakness BO/BL Dys	MR Study of Choice or Myelo-CT	Emergency Surgery Dec Early Surgery Best Prognosis Neuro Recovery
Seidel <i>et al.</i> ^[15] Spine J 2021	2362 pts 5 yr NICD Followed CES Comp Emergency	Study Timing Surgery Dec BL Dys	Compared to 9448 Non-CES Controls Spinal Dec	5 yr Postop CES 10–12% BL Dys 0.7–0.9% Surgery BL Dys	High Risk BL Dys After CES Surgery and Need for Urological Surgery

Ref: References, Preop: Preoperative, Myelo-CT: Myelogram/CT Findings, MR: Magnetic Resonance Imaging, CES: Cauda Equina Syndrome, AO: Adverse Outcomes, Assoc: Association, Surg: Surgical, Emerg: Emergency, Fx: Function, S: Sensory, M: Motor, Sph: Sphincter (Urinary Rectal) Function Inc: Incontinence, d: Days, h: hour (s), mos: Months, yr (s): Years, ML: Medicolegal, B: Bilateral, ICES: Incomplete CES, RCES: Retention Urine with CES, Cont: Continuous, Prog: Progressive, Neuro: Neurological, Det: Deterioration, ASAP: As Soon As Possible, LAM: Laminectomy, Pts: Patients, Dec: Decompression, RCES, BL: Bladder, NL: Normal, Diff: Difference, CESS: Suspicious CES, CESI: Incomplete CES, CESR: Painless Urinary Retention (painless), BO: Bowel, Sig: Significant., LBP: Low Back Pain, Pares: Paresthesias, LDH: Lumbar Disc Herniation, Avg: Average, Dys: Dysfunction, Preop: -Preoperative, Postop: Postoperative, BSciatica: Bilateral Sciatica, Neuro: Neurological, Sx: Symptoms, Incont: Incontinence, VAS: Visual Analog Scale, ODI: Oswestry Disability Index, NISD: Nationwide Inpatient Sample Database (International Classification of Disease 9th Edition), Stat Sig: Statistically Significant, Mort: Mortality, Comp: Complication, NICD: National Insurance Claims Database, LOS: Length of stay, Unfavor: Unfavorable, Hosp: Hospital, vs.: Versus

including laminectomy to multilevel decompressions with/without fusions, increased the probability of better outcomes for both ICES and RCES populations.^[1,4-6,9,10,14,16-18]

DIFFERENT COMBINATIONS OF PREOPERATIVE SYMPTOMS AND SIGNS OF ICES AND RCES

Multiple studies confirmed that the red flags for CES (i.e. including ICES and RCES syndromes) included; varying severities of sciatica, motor weakness, sensory loss with reduced perineal sensation, bladder/bowel dysfunction/urinary retention, and loss of sexual function [Table 1].^[1,4-6,9,10,13,14,16-18] ICES patients usually exhibited varying motor weakness, sensory deficits (i.e. perineal numbness), and urinary dysfunction, while RCES patients more typically had paresis/paralysis, more severe sensory loss including saddle anesthesia, and urinary/bowel retention/incontinence.^[3,8,13] Preoperative symptoms in Barker *et al.* 61 ICES/RCES patients with acute lumbar

disc herniations exhibited; low back pain (67%), perineal numbness (47%), bladder (33% with 10% of these requiring a Foley), and bowel dysfunction (38%).^[3] Postoperatively, Hazelwood *et al.* (2019) 46 ICES/RCES patients exhibited residual/long-term loss of physical (48% motor/sensory), bladder (76%), bowel (13%), and sexual function (39%), with the worst outcomes seen in RCES patients.^[8]

SURGERY FOR ICES AND RCES SYNDROMES: "THE SOONER THE BETTER" IS BEST

Most smaller studies recommended early surgery for CES (ICES/RCES) within <48 h. [Table 1].^[1,4,6,10,16-18] However, two of the largest and highest quality NISC series documented that surgery performed from 0-<24 h after the onset of symptoms or performed "the sooner the better", resulted in the best outcomes [Table 1].^[1,4,6,10,16,18] In 2017, Thakur *et al.*, using the NISC (2005–2011) database involving 4066 adults with CES, determined that surgery in ICES patients performed in <24 h. resulted in better outcomes with lower mortality rates,

shorter lengths of stay, lesser hospital charges, and a reduced rate of unfavorable discharges versus surgery performed after 48 h [Table 1].^[17] Hogan *et al.* (2019), based on a National Inpatient Sample Database of 20,924 CES patients, additionally confirmed that early CES surgery (i.e. performed within 0–<24 h.) resulted in lower complication and mortality rates.^[10] The operations performed in most studies included decompressive laminectomies with occasional decompressions/fusions [Table 1].^[3,7,10,12,13,15,17,18]

LONG-TERM POSTOPERATIVE SPHINCTER DYSFUNCTION FOR BOTH ICES AND RCES PATIENTS

Several studies observed greater residual long-term bladder or bowel dysfunction after surgery in both ICES and RCES patients [Table 1].^[7,9,12,15] Gleave *et al.* (2002) concluded there was no benefit for RCES patients to undergo early emergent surgery as it did not improve the extent of postoperative recovery of sphincter function.^[7] When Heyes *et al.* (2018) evaluated 45 CESS (suspicious/incomplete), 22 ICES (incomplete), and 69 RCES (urinary retention) patients, those undergoing early surgery (i.e. <24 h) had better sensory/motor outcomes, but early surgery did not favorably impact recovery of sphincter function.^[9] In Lam *et al.* (2020) they found that for 71 patients with CES undergoing early/emergent surgery, patients exhibited greater postoperative improvement in motor/sensory function. However, they still experienced a "... high prevalence of long-term bowel, bladder, and sexual dysfunction post-CES (surgery)."^[12] Further, at 5 postoperative years in Seidel *et al.* (2021) 2362 patients with CES versus 9448 matched controls (i.e. from the National Insurance Claims Database), 10–12% of CES patients exhibited residual bladder dysfunction, and required a 0.7–0.9% incidence of additional urological procedures versus control patients.^[15]

MEDICOLEGAL VIEW OF SURGICAL TIMING FOR CES

The medicolegal literature acknowledges that CES surgery performed "the sooner the better" is best [Table 1].^[5,11,14] Daniels *et al.* (2012) emphasized that CES remains one of the "true surgical emergencies" that should be addressed <48 h. after the onset of symptoms.^[5] Their evaluation of CES court cases showed a "...positive association between time to surgery >48 h and adverse decisions." In 2020, Medress *et al.* noted that the failure to timely diagnose and treat CES was one of the major causes of medical negligence; they recommended early/emergent CES surgery (i.e. <48 h.) to avoid permanent neurological injury.^[14] Kuris *et al.* (2021) similarly emphasized that MR and/or Myelo-CT studies and decompressive surgery be performed "the sooner the better" in CES patients to improve outcomes.^[11]

CONCLUSION

Although many studies stated that CES surgery should be performed within <48 h. after symptom onset, two of the largest NISC series (i.e. involving 20,924,^[10] and 4066 patients respectively^[17]) documented that CES surgery performed "the sooner the better" (i.e. 0–<24 h) was best [Table 1].^[1,2-18]

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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