Reduction of Extruding Intradural Lumbar Nerve Root in Dural Injury by Straight Leg Raising Maneuver: Experimental Cadaveric Study

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Background: *No data was reported that straight leg raise (SLR) manuever in prone position could stretch intradural nerve root and reduced it into dural sac. The finding of this condition could guide surgeon to repair dural sac easily during accidental durotomy.*

Objective: *To evaluate the displaced intradural nerve root could be reduced into durotomy site during SLR maneuver in prone position.*

Material and Method: *Fifteen unembalmed cadavers were used for this study. After dissection paraspinal muscle and laminectomy, one centimeters midline durotomy at L4-5 was performed. Nerve root at the durotomy site was picked up and pulled out 0.5 centimeter from durotomy site. SLR maneuver was done and the reduction of extruded nerve root was observed.*

Results: *All nerve roots came back into dural sac during three repeated SLR maneuver. No nerve root was incarcerated at durotomy site.*

Conclusion: *SLR maneuver in prone position could tighten intradural nerve root and reduced it back into dural sac at the level of L4-5.*

Keywords: *Intradural lumbar nerve root, Straight leg raise maneuver, Reduction, Dural tear*

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The incidence of dural injury in lumbar spine surgery varied from 1% to 17%[1-4] and generally resulted in poor long-term clinical outcomes. The neurologic sequelae of durotomy ranged from asymptomatic to pseudomeningocele, cerebrospinal fluid fistula and nerve root injury. Primary closure of dural defect was considered the gold standard of durotomy management to prevent the neurologic sequelae. Closure of the dural defect might be difficult to perform due to positive pressure of celebrospinal fluid (CSF) and nerve root extrusion at durotomy site. Procedure that reduced and kept nerve root in dural sac was important during primary repair. A number of investigators had attempted to document the displacement and strain of lumbosacral nerve roots during straight leg raise (SLR) in humans. Studies had demonstrated that the lumbosacral nerve roots move 2 to 8 mm during the SLR maneuver[5-11]. This displacement was evaluated extraforaminally, intraforaminally and was described to occur between 30 degrees and 70 degrees of hip flexion during SLR maneuver[5-11]. Smith et al[12] documented up to 5 mm of linear displacement and 2% to 4% strain of the lumbosacral nerve roots and associated dura during the SLR maneuver in unembalmed cadavers. They further described minimal L4-S2 nerve root displacement between 0 degree and 30 degrees of hip flexion during SLR maneuver, displacement parallel to the nerve root axis between 30 degrees and 60 degrees[12]. Kobayashi et al[13] intraoperatively assessed lumbar nerve root displacement in vivo, documenting limitations in nerve root displacement during SLR maneuver in patients with lumbar disc herniations, with up to 4 mm of root displacement during the same test after lumbar discectomy. No data was reported that SLR maneuver in prone position could stretch intradural nerve root and reduced it into dural sac. If this finding is approved, surgeon may repair dura mater during accidental durotomy easier.

The purpose of the current study was to

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evaluate the displacement of intradural nerve root and reduction it into durotomy site during SLR maneuver in prone position of unembalmed cadavers.

Material and Method

Fifthteen unembalmed cadavers were used for this study. Cadavers were excluded from the study if they had undergone lumbar spine surgery or had gross spinal deformity. In the prone position, we made a posterior midline skin incision from L4 to sacrum. Skin flaps raised on both sides. Paraspinal muscles and ligaments were detached, spinous process were removed and wide laminectomy from L4 to L5 carried out, thereby exposing dural sac. During preparation and assessments, specimens were kept hydrate using 0.9% normal saline gauze. One centimeter midline durotomy was performed. Nerve root at the durotomy site was picked up and pull out 0.5 centimeter from durotomy site. Then cadavers were move caudally so that their legs hung down from the table (Fig. 1). SLR maneuver was done with knee full extension and ninety degree ankle position. Hip flexion angle was recorded with digital goniometer (Wenzhou Sanhe Measuring Instruments Co., LTD) and the reduction of extruded nerve root was observed after completely back into dural sac. Observations were taken 3 times with 10 minutes between each observation. Continuous data were analyzed with mean and standard deviation.

Results

The cadavers consisted of 5 males and 10 female, with an age range of 30 to 59 years and mean age of 40±5.2 years. Cadaver height and weight ranged from 163 to 181 centimeters and 54 to 78 kilograms with means of 168±8 centimeters and 67±7 kilograms, respectively. Positions of hip flexion were 37.2±4 degree (35-40 degree) when the nerve roots were initially come back into dural sac. When hip flexions were 72.5±6 degree (range from 60-80 degree) nerve roots were reduced back to dural sac. (Fig. 2, 3 and Table 1). All nerve roots came back into dural sac during three repeated SLR maneuvers. No nerve root was entrapped and incarcerated at durotomy site.

Discussion

Lumbar nerve root movement and tension by SLR maneuver was due to the taking up of slack in the nerve root as a whole[12]. The nerve root was then stretched like a string over the bridge of a violin. The rate of movement was maximal at its commencement, and two-thirds of the excursion was completed by the time the angle had reached 60 degrees[14]. Beyond this point, further movement of the root was sluggish, and

Fig. 1 Cadaver legs hung down from the table when performed SLR maneuver.

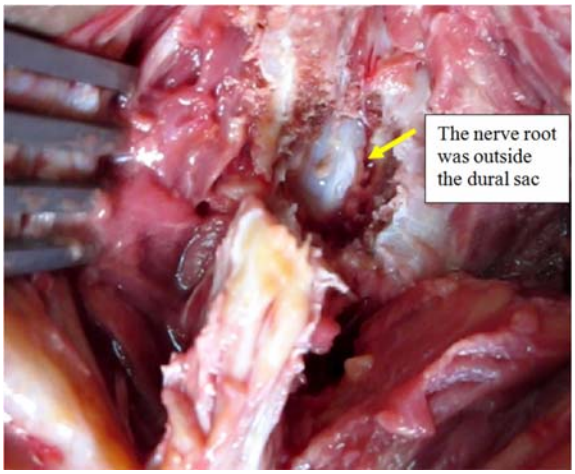

Fig. 2 Nerve root pick up outside durotomy site.

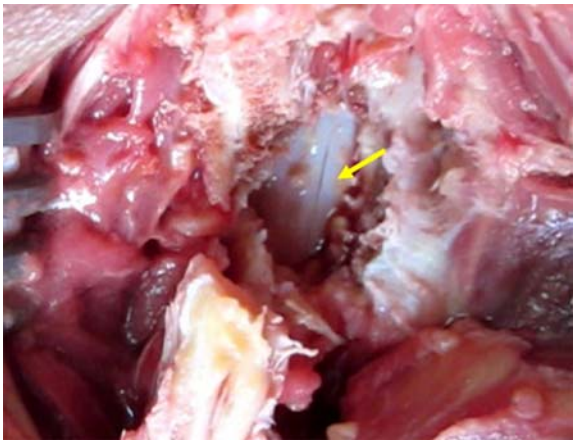

Fig. 3 Nerve root was reduced into dural sac.

Table 1. Dermographic data and hip flexion angle during SLR maneuver

Cadaver	Age (year)	Height (centimeters)	Weight (kilograms)	Hip flexion angle (initiation of nerve motion)	Hip flexion angle (all nerve was reduced)
1	35	171	56	35	73
2	53	168	62	35	70
3	40	170	68	40	69
4	30	178	75	38	60
5	57	163	54	35	72
6	32	163	58	40	66
7	45	165	70	36	79
8	40	179	78	38	69
9	44	166	69	37	72
10	59	178	74	40	62
11	48	175	70	39	80
12	55	164	55	35	65
13	58	181	78	37	70
14	34	165	55	36	64
15	59	166	56	39	77

by the time the leg had been raised to 90 degrees, the root will had been stationary for some time. In the present study, SLR maneuver was not only tighten the slack nerve root, but also reduced it back to dural sac at the level of L4 and L5. There was not any nerve root that entrapped at the durotomy site. This finding might be applied to clinical practice. During intraoperative incidental durotomy, CSF pressure push the nerve root out of the tear site. When the surgeon performed SLR, the nerve root came back into dural sac so primary dural repair might be easier. There were many limitations to apply for clinical practice. First, this finding was approved in unembalmed cadaver. Second, the durotomy was only 1 centimeter long and at the L4-5 level. In clinical practice, other factors that affected primary dural repair such as shape of dural injury, positive pressure of CSF and patient position during surgery. So further study in vivo must be proved.

Conclusion

SLR maneuver could reduce intradural nerve root back into dural sac. Clinical application in patient must be approved in the future.

What is already known on this topic?

Lumbar nerve root outside dural sac can move 5-8 millimeters during SLR maneuver.

What this study adds?

Lumbar nerve root in dural sac can be tighten and reduced back during SLR maneuver.

Acknowledgements

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Potential conflicts of interest

None.

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การคืนกลับของรากประสาทส่วนเอวเข้าสู่ถุงเยื่อดูราขณะทำการยกขาขึ้นตรง: การศึกษาทดลองในศพ

ยิ่งยง ต่ออุดม

วัตถุประสงค์: *เพื่อศึกษาการดึงกลับของรากประสาทส่วนเอวเข้าสู่ถุงเยื่อดูราขณะทำการยกขาขึ้นตรงในท่านอนคว่ำ*

วัสดุและวิธีการ: *เป็นการศึกษาในศพที่ไม่ได้ดองจำนวน 15 ราย สังเกตการคืนกลับของรากประสาทเข้าสู่ถุงดูราขณะทำการยกขาขึ้นตรงในท่านอนคว่ำ จดบันทึกมุมของข้อสะโพกที่งอขณะที่รากประสาทคืนกลับเข้าสู่ถุงดูรา ทำการทดสอบซ้ำจำนวน 3 ครั้งในแต่ละศพ*

ผลการศึกษา: *ศพมีอายุระหว่าง 30 ถึง 59 ปี และมีน้ำหนักระหว่าง 54 ถึง 78 กิโลกรัม รากประสาทคืนกลับเข้าสู่ถุงเยื่อดูราเมื่อสะโพกงอทำมุมเฉลี่ย 37.2±4 องศา (35 ถึง 42 องศา) รากประสาทคืนกลับเข้าสู่ถุงเยื่อดูราทุกครั้งโดยไม่มีการติดคา*

สรุป: *ผลที่ได้นี้อาจจะนำไปใช้ในกรณีที่เกิดการฉีกขาดของเนื้อเยื่อดูราขณะผ่าตัด น่าจะทำให้การเย็บซ่อมง่ายขึ้น แต่การนำผลนี้ไปใช้กับผู้ป่วยจริงอาจถูกรบกวนด้วยปัจจัยอื่น เช่น ขนาดและรูปร่างของดูราที่ฉีกขาดและระดับของกระดูกสันหลังบริเวณที่ดูราฉีกขาด ดังนั้นการศึกษาต่อไปในผู้ป่วยจริงจึงควรได้รับการติดตามและรายงาน*