Preliminary Communication

The barrier effect of laminae: laminotomy *versus* laminectomy

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Study design: An experimental study to investigate whether replacement of the laminae (laminotomy) after subluminal procedures can prevent the invasion of scar tissue towards the dura.

Setting: Izmir, Turkey.

Methods: Laminectomy and laminotomy were performed at different levels on seven rats. Their spinal columns were investigated histopathologically after a period of 3 months.

Results: The histopathological evaluation revealed that the dura and spinal cord were involved by scar tissue at laminectomy area. However, this invasion was not observed at laminotomy levels. This study showed the barrier effect of laminae against fibroblastic activity.

Conclusion: The barrier effect of lamina may affect the surgical outcome related to epidural fibrosis.

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Introduction

Post-operative scarring has been implicated as an important cause of clinical problems after spinal surgery^{1–3} and prevention of scarring has been attempted using some medications.^{4–9} LaRocca¹⁰ reported that the extent of the peridural fibrosis was directly proportional to the size of the laminectomy defect and showed a decrease in perineural scar formation with physical barriers and various materials that have a mechanical barrier effect.^{2,4,8,9,11–17} In this study, the barrier efficacy of lamina in prevention of scar formation was investigated in rats. A laminotomy was defined as replacement of lamina after subluminal surgery, whereas laminectomy was defined as permanent resection of lamina.

Materials and methods

Seven male *Rattus Norvegicus* rats, aged 6 months, weighing an average of 300 g, were used in the experimental study. The surgical procedure was performed under intraperitoneal anaesthesia [Cethalar, di 2-(0-clorophenil)-2-(methyl amino) cyclohecsanon hydrochloride, 8 mg/100 g]. The animal was fixed on a small table and a midline incision was made along the spinous processes of the lumbar area. The fascia

and thoraco-columbar muscle were opened bilaterally, and total laminectomies of the L2 and L5 were performed with a seizer. The L5 lamina was reattached and fixed by suture. The incision was closed after a careful homeostasis. The rats were housed in a temperature-controlled room with a 12 h light:dark cycle and they were followed-up for 3 months. After this period of time the rats were sacrificed and spinal columns were excised *en bloc*. The specimens were fixed and decalcified with bone acid for 12 h. Four-micron sections were examined after staining with haematoxylen and eosin. The objective criteria of adhesion was graded according to the following classification:⁶

- Grade 0 = when the dura mater was free of the scar tissue
- Grade 1 = when only thin fibrous band(s) between the scar tissue and dura mater were observed
- Grade 2 = when continuous adherence was observed but was less than two-thirds of laminectomy defect
- Grade 3 = when scar tissue adherence was large, more than two-thirds of the laminectomy defect, and/or extended to the nerve roots.

These gradings were compared using Fisher's exact test.

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Results

None of the rats showed paresis in their lower extremities or evidence of any stress reactions to the surgery. The histologic observation showed adhesion of the dura mater and spinal cord by scar tissue (Figures 1 and 2) at laminectomy areas. However, no invasion was observed at laminotomy levels (Figure 3). The slides were graded for the presence or absence of scar tissue, and there was significant difference (by Fischer's exact test) between laminectomy and laminotomy areas ($P < 0.001$) (Table 1).

Discussion

Epidural fibrosis has been considered as a cause of recurrent symptoms after spinal surgery¹⁻³ and still

forms an important cause of reexploration after spinal surgery. Numerous materials have been used for prophylaxis of epidural fibrosis. This study investigated the barrier effect of lamina to minimize epidural fibrosis. Although some authors emphasized the possible role of lamina in the prevention of epidural fibrosis,^{18,19} it was not accepted by others²⁰ and remained controversial. This study is the first experimental study focusing on the barrier effect of lamina against epidural fibrosis.

The review of the literature reveals the presence of many hypotheses and treatment attempts regarding epidural fibrosis. For many years some authors considered that inflammation plays a role in the occurrence of scar tissue^{6,7,14} and reported a significant decrease in the amount of fibrotic tissue using steroids or nonsteroidal anti-inflammatory drugs.^{6,7} On the other hand, Jacobs *et al*⁸ reported that anti-inflammatory drugs delayed tissue healing and frequently resulted in abscess formation, and eventually filling of the defect by scar tissue.

The concept of interposing a membrane to prevent the formation of scar tissue was investigated in 1974, on the basis of animal studies with a Gelfoam membrane.¹⁰ However, consequently studies showed no evidence that Gelfoam prevented the ingrowth of scar tissue.^{2,8,13,15} The new foamy materials such as viscous (1.9%) Na hyaluronate solution,⁹ absorbable gel matrix comprising absorbable gelatine and carbohydrate polymer (ADCON-L)^{5,21} reduced peridural scar tissue in the animal model. Later studies showed that autogenous free fat graft was more effective in preventing scar tissue.^{8,14,15} However, some cases were reported with symptomatic compres-

Figure 1 Dura and spinal cord were involved by scar tissue after laminectomy (arrow) (grade 3)

Figure 2 The adherence on laminectomy defect (arrow) (grade 2)

Figure 3 Spinal neural elements were prevented after laminotomy (arrow) (grade 1)

Table 1 Histopathological grading of scar tissue

	Laminotomy (L5)	Laminectomy (L2)
Grade 0	3	—
Grade 1	4	—
Grade 2	—	5
Grade 3	—	2

sion of nerve root by a free fat graft that presumably was displaced by contraction of the paraspinal muscles.^{22,23} Cook *et al*¹² reported that free fat graft was an effective barrier to scar formation at early time periods. However, progressive fat degradation with some increase in scarring was observed at long-term periods. Abitbol *et al*⁴ and MacKay *et al*² also reported ineffectivities of free fat grafts. Gill *et al*¹³ offered good results using pedicled fat grafts in dogs, and they performed this method in 92 patients who had various spinal pathologies.²⁴ However, other studies have indicated scar formation in a number of specimens even when fat graft was used. Barbera *et al*¹¹ performed an experimental study in dogs using various barrier materials and found good results with bone and methyl methacrylate. Polylactic acid membrane,¹⁶ polyactive membrane sheets,¹² and polyethylene oxide/polybutylene terephthalate copolymer¹⁷ have been used successfully for mechanic barrier effects to prevent scar tissue.

This short review of the literature highlights the lack of consensus regarding aetiology and treatment of epidural fibrosis.

Laminotomies, with increasing popularity in spine surgery, offer additional advantages over laminectomies especially in children and young adults.^{7,25–29} The main advantages of laminotomy over laminectomy include restoration of normal bony anatomy, contribution to the spinal biomechanics to prevent spinal deformities particularly in paediatric cases, and prevention of epidural fibrosis.^{28,30–32}

On the basis of results presented here, it is concluded that the use of laminotomy procedure for spinal pathologies reduces the amount of postoperative epidural fibrosis and may contribute to the postoperative outcome.

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