

A Comparison of the Effectiveness of Waxed Paper and Gore-Tex on the Minimally Invasive Epidural Fibrosis Model

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Study Design: Experimental animal study.

Objective: The authors conducted a study to determine the effectiveness of waxed paper in preventing postlaminectomy epidural fibrosis in rats.

Summary of Background Data: Extensive epidural fibrosis after lumbar surgery may be the underlying cause in most cases of failed back surgery syndrome. Various materials have been used to prevent epidural fibrosis, but only moderate success has been shown.

Methods: Laminectomies were performed at the fourth lumbar vertebra (L-4) in 30 rats. Waxed paper or Gore-Tex was applied in a blinded fashion to the operative sites. In the control group, only the L-4 laminectomy was performed. The rats were killed 28 days after surgery.

Results: The extent of epidural fibrosis was evaluated by histologic analysis. There was a meaningful statistical difference among the waxed paper group and the Gore-Tex group compared with the control group, but there was no difference when the effectiveness of waxed paper was compared with that of Gore-Tex.

Conclusions: In this experimental model, the waxed paper applied locally effectively reduced epidural fibrosis, completely avoided dural adherence, and induced no side effects.

Key Words: laminectomy, epidural fibrosis, waxed paper, Gore-Tex

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Waxed paper, formed by a compound of cellulous plant fibers, is a water-proof waxed applied material. Because of its cost efficiency, waterproof nature, and nonadhesive characteristics,^{1–3} it is used in many

areas such as cooking and aviation. We considered that both the wax and the paper (contains cellulose) should be used as a physical barrier in epidural field.

This study aimed to compare the efficiency of waxed paper and Gore-Tex in the reduction of epidural fibrosis and the prevention of dural adhesions.

MATERIALS AND METHODS

Animal Population

The study included 30 female Sprague-Dawley rats (mean age: 7 mo; mean weight: 300 g). The approval of the Gazi University Ethics Committee was obtained for this purpose.

Surgical Procedure

After the lower back part of each rat was shaved, the surgical site was sterilized by povidone. L3-L5 laminae were exposed and a total laminectomy was performed at the L4 level. The rats were then randomly divided into 3 groups. Group 1 served as the control group. In group 2, the dura mater was covered with a 0.5 × 0.5 cm waxed paper after laminectomy. In group 3, the dura mater was covered with 0.5 × 0.5 cm Gore-Tex. The animals were killed on postoperative day 28.

Evaluation of Epidural Fibrosis

The bones of the lumbar area were removed en bloc in a manner to include paraspinal muscles. The specimen was immersed into 10% buffered formalin. The spine was further sawed axially through the upper L-3 to lower L-5 levels to isolate the laminectomy site. All specimens were sent for pathologic evaluation. Pathologic evaluation consisted of decalcification, dehydration, and preparations of paraffined blocks. Sections of 8 μm were obtained on the axial plane and stained with Masson trichrome and hematoxylin and eosin. All the laminectomy sections were evaluated by the same pathologist for density of fibrosis, both fibroblasts and inflammatory cell counts, arachnoidal involvement, and bone regeneration.

Epidural fibrosis was graded on the basis of the scheme devised by He et al.⁴ grade 0, dura mater is free of scar tissue; grade 1, only thin fibrous bands are observed between the scar tissue and dura mater; grade 2, continuous adherence is observed in less than two-thirds

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of the laminectomy defect; and grade 3, scar tissue adherence is large, affecting more than two-thirds of the laminectomy defect, or the adherence extended to the nerve roots.

Fibroblasts and inflammatory cell counts were evaluated in the light of the classification proposed by Warejcka et al⁵ as follows: grade 1, 100 or fewer cells in every region at 400 times magnification; grade 2, 100 to 150 cells in every region at 400 times magnification; and grade 3, 150 or more cells in every region at 400 times magnification. The presence of arachnoid involvement and bone regeneration was also noted.

Statistical Analysis

Epidural fibrosis, fibroblasts and inflammatory cell counts, arachnoid involvement, and bone regeneration were statistically analyzed using a standard χ^2 test, and a *P* value < 0.05 was accepted as statistically significant.

RESULTS

In axial sections stained with either hematoxylin and eosin or Masson trichrome, grade 3 epidural fibrosis was found in all control rats. The results of epidural fibrosis grades, both fibroblasts and inflammatory cell counts, and arachnoidal involvement indicated that the waxed paper group and the Gore-Tex group (Fig. 1) were not statistically significant (*P* value > 0.05). Conversely, there were significant differences in the epidural fibrosis grades, in both fibroblasts and inflammatory cell counts, and in the arachnoidal involvement among the experimental and control groups (*P* value < 0.05). The results of bone regeneration indicated that the results were not statistically significant (*P* value > 0.05) among the experimental and control groups.

DISCUSSION

Postlaminectomy epidural fibrosis after decompressive laminectomy and lumbar disc surgery procedures significantly increases the hazards of revision spine surgery and may contribute to the occurrence of “failed back syndrome”.⁶

Currently, there is no effective medical or surgical therapy for epidural fibrosis.

Previously, a film composed of carboxy methylcellulose and polyethylene oxide was shown to reduce peritoneal adhesions in a rabbit model.⁷ In our study, we observed that the waxed paper was not resorbed through 4 weeks. In epidural fibrosis, we showed that it reduces fibrosis by forming a good physical barrier.

Expanded polytetrafluoroethylene (Gore-Tex), a biocompatible material, has been used safely and effectively for many years in multiple clinical applications in several surgical areas, including vascular surgery,⁸⁻¹⁰ soft-tissue repair,¹¹ plastic surgery,¹² gynecology,¹³ cardiac surgery,¹⁴ and neurosurgery.¹⁵

In the current study, we tested the hypothesis that the use of waxed paper will be safe, will significantly

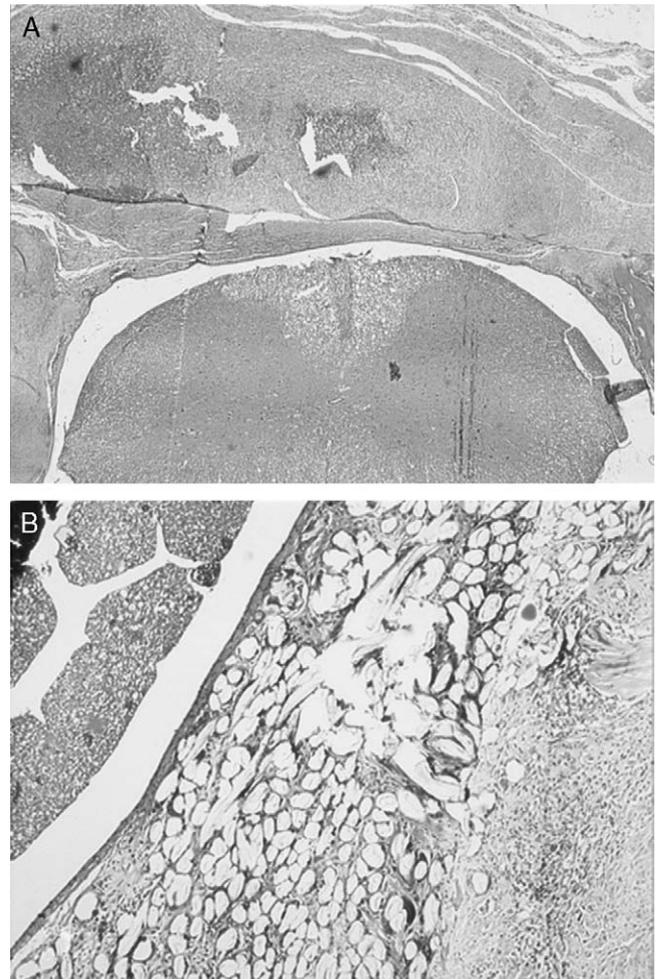


FIGURE 1. A, Grade 1 fibrosis demonstrated in a waxed paper group rat. There was no direct contact among the underlying dura mater and arachnoid with the scar tissue. Hematoxylin and eosin. Original magnification $\times 40$. B, Grade 1 fibrosis demonstrated in a Gore-Tex group rat. There was no direct contact among the underlying dura mater and arachnoid with the scar tissue. Masson trichrome. Original magnification $\times 40$.

reduce the extent of epidural fibrosis after laminectomy, and will prevent the consequent adhesion of this tissue to the dura mater. When the results of epidural fibrosis, fibroblast density, the inflammatory cell density, and arachnoid adhesion were assessed, we could not find any significant differences among the waxed paper group and the Gore-Tex group (*P* value < 0.05). It was remarkable that epidural fibrosis had lower rates in the waxed paper group compared with the control group. And this was found to be meaningful statistically.

The results presented in this paper were generated in animal experiments and may not be fully applicable to the clinical situation. Further study will help to clarify the relative advantages of waxed paper on the reduction of epidural fibrosis.

CONCLUSION

The prevention and treatment of epidural fibrosis, which is the most important cause of failed back syndrome, is still a problem. Although an efficient agent to prevent this complication has not been found, we have come to the conclusion that the use of waxed paper is minimally invasive, efficient, and easy.

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