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Arachnoiditis from Myelography and Laminectomy in Experimental Animals

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Clinical reports have suggested that myelography and laminectomy may produce more arachnoiditis than myelography alone. The effect of experimental lumbar myelography and laminectomy on arachnoiditis in monkeys was studied. Arachnoiditis was as severe after myelography alone as after myelography and laminectomy. Minimal arachnoiditis was found myelographically and histologically after myelography with metrizamide 300 mg I/ml, and severe arachnoiditis was found after myelography with iophendylate whether or not laminectomy was performed. Laminectomy alone produced insignificant arachnoid changes. Experimental myelography preceding laminectomy did not increase the risk of arachnoiditis.

The frequency of adhesive arachnoiditis is reportedly higher after myelography and laminectomy than after myelography alone [1-5]. Whether myelography before laminectomy increases the risk of arachnoiditis has not been studied experimentally. We performed experimental myelography and laminectomy in primates to detect a possible synergistic effect between them in causing arachnoiditis.

Materials and Methods

Twenty-six monkeys of the species *Macaca radiata* (bonnet macaque) and *Macaca fascicularis* (cynomolgus macaque) that had passed routine health examinations and quarantine were used for the study. The animals were divided into five groups (table 1). Six animals in group 1 underwent lumbar myelography with metrizamide (Amipaque). Six animals in group 2 underwent lumbar laminectomy and surgical exploration of the spinal canal that simulated a clinical laminectomy. In group 3, eight animals underwent laminectomy after myelography with metrizamide. Four of these animals were operated 2 days after myelography, and four 3 days after myelography. Three animals in group 4 underwent lumbar myelography with iophendylate (Pantopaque). In group 5, three animals underwent L4 laminectomy 5 days after myelography with iophendylate.

The myelographic procedure was the same for each animal. The animal was fasted overnight and premedicated and sedated with ketamine hydrochloride, acepromazine maleate, and atropine sulfate. After the animal's back was shaved and prepped with iodine tincture, the monkey was placed in the prone position. With sterile precautions, a lumbar puncture was done at the L3-L4 level with a 20 gauge disposable spinal needle. The animals were tipped about 45° from horizontal with the head up, and 1 ml of cerebrospinal fluid was allowed to drip out before metrizamide 300 mg I/ml or iophendylate was injected through the needle. The volumes of metrizamide injected were 2.4 ml in the bonnets and 1.2 ml in the cynomolgus; the volume of iophendylate injected in the bonnets was 0.6 ml, and none of it was removed. Frontal and lateral films were taken, and the animal was then kept overnight in a sitting position in a primate restraint chair.

Laminectomy was performed by a surgeon (C. R. B.) without knowledge of whether myelography had been done. After the same preparations as for myelography, a midline incision was made from L3 to L7, and the paraspinal muscles were elevated. The spinous process of L4, L5, or L6 was removed with rongeurs, and, after freeing the ligamentum flavum, the lamina of the same vertebra was also removed. The dura, disk space, neural

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TABLE 1: Arachnoiditis in Monkeys after Myelography, Laminectomy, or Myelography and Laminectomy

Group No., Procedure: Contrast Medium	Species of Macaque Monkey	Animal No.; Weight (kg)	Arachnoiditis Scores		
			Myelographic	Histologic	
				Fibrosis	Inflammation
1, Myelography:					
Metrizamide (2.4 ml, 300 mg I/ml)	Bonnet	368; 4.5	4	4	2
		369; 4.0	3	3	0
Metrizamide (1.2 ml, 300 mg I/ml)	Cynomolgus	443; 1.3	0	1	2
		446; 1.9	2	2	0
		447; 2.1	2	2	0
		448; 1.9	1	0	0
2, Laminectomy:					
.....	Bonnet	370; 4.2	3	3	0
		371; 3.5	4	6	7
		374; 4.6	2	2	1
		375; 3.3	6	1	1
.....	Cynomolgus	441; 1.8	6	1	0
		442; 2.0	3	1	0
3, Laminectomy after myelography:					
Metrizamide (2.4 ml, 300 mg I/ml)	Bonnet	372; 4.8	*	7	5
		373; 4.1	4	1	2
		376; 3.4	7	10	4
		377; 3.5	2	4	1
Metrizamide (1.2 ml, 300 mg I/ml)	Cynomolgus	437; 1.6	†	1	2
		438; 2.2	6	2	0
		439; 2.0	2	0	2
		440; 1.7	1	4	1
4, Myelography:					
Iophendylate (0.6 ml)	Bonnet	395; 3.3	ND	22	13
		396; 3.2	ND	12	9
		397; 3.4	ND	4	1
5, Laminectomy after myelography:					
Iophendylate (0.6 ml)	Bonnet	386; 3.6	ND	4	10
		389; 3.3	ND	16	16
		392; 2.9	ND	16	15

Note.—ND = control myelography not done. Arachnoiditis scale is from 0 to 36. Below 5 was considered normal.

* Epidural injection.

† Subtotal block at laminectomy level.

foramina, and nerve roots were inspected carefully, and the wound was then closed. Electrocautery, suction on the dura, and drains were avoided (see [6] for a more detailed description).

Twelve weeks later, the animals were killed by overdose of phenobarbital. The animals in groups 1–3 underwent myelography with 1.2 ml of metrizamide, 170 mg I/ml, immediately before sacrifice. The lumbar dural sac and its contents were removed and prepared for microscopic sections. Signs of adhesive arachnoiditis at the L5, L6, and L7 levels were assessed myelographically and histologically. Independently and without reference to the animal's previous treatment, the neuropathologist (K. C. H.) studied the histologic sections, and a neuroradiologist (J. G. J.) studied the myelographic changes. The scoring system, which has been reported [7], has a maximum possible score of 36, either for histologic or myelographic evidence of arachnoiditis. Scores below 5 were considered normal, since scores up to 8 have been observed in control animals. The Kruskal-Wallis analysis of variance by ranks [8] was used to test the significance of the differences between the groups.

Results

There were no seizures or morbidity after myelography. Except for an epidural injection of contrast medium in one control animal (no. 372), all injections were subarachnoid.

After surgery, there were no signs of wound infection or neurologic deficit. Each animal developed a mild to moderate kyphosis, which caused little obstruction to the flow of contrast medium, except in one animal (no. 437) with subtotal block at the laminectomy level.

The results of the myelographic and histologic studies correlated well with each other (table 1). Most animals having metrizamide myelography alone (group 1) or myelography followed by laminectomy (group 3) had a normal-appearing arachnoid at myelography and histologic examination; a few animals had evidence of mild arachnoiditis. Animals having laminectomy alone (group 2) were similar. The differences in scores between these groups were not statistically significant. The myelographic scores for arachnoiditis were 0–7 ($p < 0.95$). The histologic scores for fibrosis and inflammation were 0–10 ($p < 0.95$) and 0–7 ($p < 0.1$), respectively. Animals having iophendylate myelography alone (group 4) or followed by laminectomy (group 5) had evidence of severe postprocedural arachnoiditis on histologic examination. The scores were 1–22. The scores in groups 4 and 5 differed insignificantly from each other ($p < 0.95$), but differed significantly from those in groups 1 and 3 ($p < 0.005$).

Arachnoiditis was not limited to the laminectomy level in

any animal. Although contrast-medium flow was obstructed in one animal at the laminectomy level, there was no histologic evidence that arachnoiditis caused obstruction. In fact, arachnoiditis was less severe at the laminectomy level than at the caudal end of the sac.

Discussion

Failure of laminectomy to relieve low-back symptoms is relatively common [9] and a major health problem [10]. The question arises whether postmyelographic arachnoiditis contributes to failed back surgery or continued pain after disk removal. Myelographic evidence of adhesive arachnoiditis is reportedly more common in patients who have had previous myelography and laminectomy than in patients who had previous myelography only, whether the contrast medium was methiodal, meglumine iocarmate, or iophendylate [1-5]. Reviewing repeat myelograms in patients with low back pain, one investigator observed a definite risk of adhesive arachnoiditis when patients had been operated on between the two examinations [2].

We studied experimentally the role of contrast medium and laminectomy in producing arachnoiditis. We used the two commercially available contrast media, metrizamide and iophendylate. We chose to use metrizamide in a high concentration and in a volume (per unit of body weight) that exceeds customary clinical practice because mild arachnoiditis is produced [7]. Iophendylate is known to produce more severe arachnoiditis if not removed from the thecal sac after myelography [6, 11].

We selected an interval of about 3 days between myelography and laminectomy since cerebrospinal fluid cell count and protein is maximal 3 days after myelography with a water-soluble contrast medium (V. M. Haughton, unpublished data). Although some investigators suggested that arachnoiditis was likely to be more severe if the interval between operation and laminectomy was short [4, 12], the evidence is not consistent [2]. Since iophendylate is not absorbed, we assumed that the interval between myelography and laminectomy was of little importance if this contrast medium were used.

We found no evidence, at least in the time intervals and with the types of contrast media used, that myelography potentiates the risk of arachnoiditis from laminectomy. The degree of arachnoiditis that resulted from metrizamide and iophendylate in these studies was similar to results from previous studies [6, 7]. The lack of arachnoiditis after laminectomy contrasts with previously reported studies. Our experimental operation included retraction of the dura and careful exploration of the canal and neural foramina. The operations, all performed by a surgeon (C. R. B.) with previous operative experience in macaque monkeys, produced epidural adhesions. A lack of correlation between extradural adhesions and adhesive arachnoiditis diagnosed myelographically has been reported [2, 13], but arachnoiditis after spinal surgery, even though the dura is not opened, has been documented [14]. Even retraction of the dura to visualize a ruptured intervertebral disk is believed to initiate arachnoiditis [14],

perhaps because of circulatory changes, bleeding, or thrombosis of small meningeal vessels. In experimental studies, injury to the pia-arachnoid is more significant than injury to the dura in producing arachnoiditis [15].

Experimental laminectomy in our animals compared closely with clinical practice of laminectomy except that disk disease, spinal stenosis, nerve compression, etc. were not present. Whether disk excision would produce more arachnoiditis than laminectomy or whether disk disease itself produces arachnoiditis is not answered by this study and should be analyzed in future experiments. Arachnoiditis has been reported to complicate lumbar disk disease [16, 17]. Until experimental studies of disk herniation, laminectomy, and myelography together are performed, the experimental results give no support to the clinical suspicion that myelography may potentiate the effect of laminectomy in producing arachnoiditis.

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