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Supraspinous and interspinous ligaments in dog, cat and baboon

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INTRODUCTION

In a recent paper the author (Heylings, 1978) gave an account of the supraspinous and interspinous ligaments of the human lumbar spine which was at variance with most textbook descriptions. In essence it was found that the human supraspinous ligament was purely collagenous, lying superficial to the lumbodorsal fascia and terminating at L4 or L5, below which it was replaced by decussating tendinous fibres of the erector spinae. The most superficial fibres of the ligament spanned three or four vertebrae, while the deepest ran between adjacent spines. The interspinous ligament was divisible into ventral, middle and dorsal parts. The ventral part extended dorsocranially from the ligamentum flavum and contained some elastic fibres. The middle part was the chief component and passed from the ventral half of the cranial border of one spinous process to the dorsal half of the caudal border of the next cranial spinous process: this part was purely collagenous. The dorsal part ran from the dorsal half of the cranial border of one spinous process to sweep cranially into either the supraspinous ligament or the erector spinae tendons: it was also purely collagenous.

In the present study these ligaments have been investigated in the dog, cat and baboon. Of special interest were: (1) the direction of the fibres in the interspinous ligaments, (2) the presence or absence of a supraspinous ligament, (3) the presence or absence of elastic fibres in the ligaments and (4) the correlation of structure with mode of locomotion.

MATERIAL AND METHODS

Three female and four male dogs between 4 months and 14 years old were used. Two were pure-bred greyhounds, one was a labrador and the others were mongrel labradors and collies. The three cats were between 18 months and 4 years old: one was pure Siamese, the others were mongrels. All these animals had been destroyed humanely by a veterinary surgeon in the course of his practice: they were not ill or deformed. The baboon specimens were obtained from animals destroyed at the end of studies in another department.

In the case of the dogs and cats the lower thoracic, all the lumbar and sacral vertebrae, and the first tail vertebrae were removed in one piece along with attached muscles and ligaments, special care being taken not to damage structures attached to the spinous processes. The baboon specimens consisted of blocks of three or four lumbar vertebrae with their attached soft parts, and their orientation and serial order was confirmed from the direction of the tips and the sizes of the transverse processes (Swindler & Wood, 1973).

Dissection was carried out with the aid of a hand lens and dissecting microscope,

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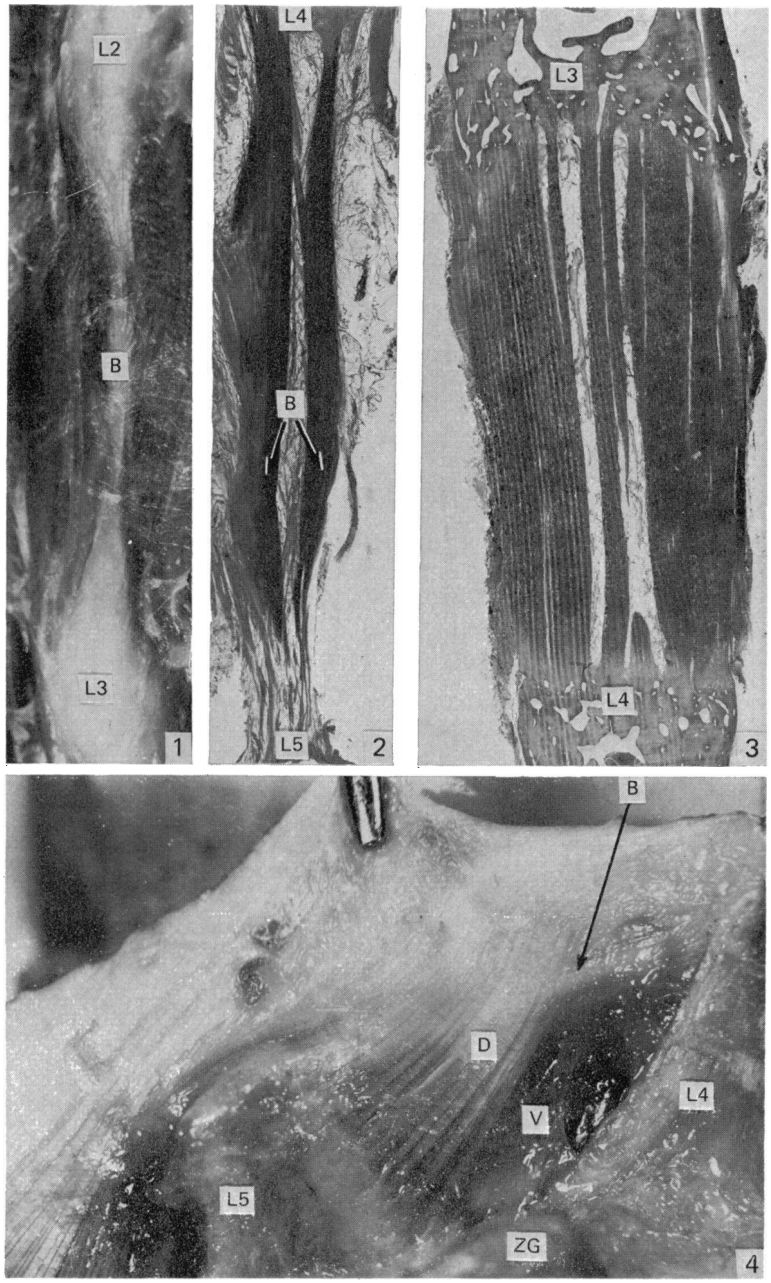

Fig. 1. Bilateral band (B) of tissue lying between spinous processes L2 and L3 in the dog. ×3·0.

Fig. 2. Coronal section of the bilateral band (B) lying between the tips of L4 and L5 spinous processes in the dog. Weigert's elastin stain and Van Gieson. ×4·8.

Fig. 3. Coronal section of the elastic ligament lying between L3 and L4 spinous processes in the baboon. Weigert's elastin and Van Gieson. ×8·8.

Fig. 4. The left side of a flexed specimen showing the spinous processes L4 and L5 in the dog. The interspinous ligament is poorly developed. B, bilateral band; D, dorsal part of interspinous ligament; V, ventral part of interspinous ligament; ZG, zygapophysis (articular process). ×2·1.

the latter being essential for accurate removal of loose connective tissue and the identification of ligamentous fibres lying superficial to the lumbodorsal fascia. Each specimen was first placed with the lumbodorsal fascia uppermost, then the loose connective tissue was removed and a search made for a supraspinous ligament. After this, with the specimen on its side, the erector spinae musculature was carefully removed, leaving a preparation of vertebrae with its ligaments and lumbodorsal fascia still attached.

The dissected specimens were fixed in 10% formalin, embedded in low viscosity nitrocellulose and thick sections cut for histological confirmation of the direction of the fibres in the interspinous ligament and the presence or absence of a supraspinous ligament. Most sections were examined unstained, but representative ones were stained with Weigert's elastin and/or Van Gieson stains.

OBSERVATIONS

In no specimen of dog, cat or baboon was there macroscopic or microscopic evidence of a supraspinous ligament in the human sense of the term, i.e. a longitudinal ligament lying superficial to the plane of the lumbodorsal fascia and running along the tips of the spinous process. In all cases the fibres of the lumbodorsal fascia could be seen criss-crossing the mid-line with a deep attachment to the tips of the spinous processes. Removal of this fascia did not reveal any decussation of the medial tendons of the erector spinae. In the dog, there was a bilateral bundle of fibres just beneath the lumbodorsal fascia and closely associated with it (Fig. 1). Histologically, these bundles consisted of elastic fibres running between adjacent spinous processes and attaching near their tips (Fig. 2). In the cat these bundles were not so obvious, being represented by some elastic fibres in the deepest part of the lumbodorsal fascia. These bundles in the dog and cat cannot be equated with either the supraspinous or interspinous ligaments of man, although topographically they are interspinous.

In the baboon a thick (about 3 mm) bilateral ligament completely occupied the interspinous space and so must be regarded as an interspinous ligament even though, histologically, it consisted almost entirely of thick *elastic* fibres running directly craniocaudally between adjacent spines (Fig. 3) unlike the obliquely directed collagenous fibres in the human ligament.

In the dog and cat the ventral part of the interspinous space contained a 'ligament' so thin that it was transparent in the recent state. However, the dorsal part of the space contained a ligament which was rather more substantial, with fibres passing dorsocranially and tending to merge with either the lumbodorsal fascia or the erector spinae tendons (Fig. 4). On histological examination these ligaments were found to be elastic in the cat, but mainly collagenous in the dog, and the dorsocranial direction of the fibres was confirmed.

DISCUSSION

In his dissection manual Bradley (1943) states that the supraspinous ligament in the dog is a "strong cord-like object attached to the summits of the (spinous) processes from the sacrum to about the first thoracic vertebra, where it is continuous with the ligamentum nuchae". Evans & De Lahunta (1971) have a similar description of the ligament in their dissection guide. In the light of the present observation that there is no supraspinous ligament in the human sense in these species, one can only

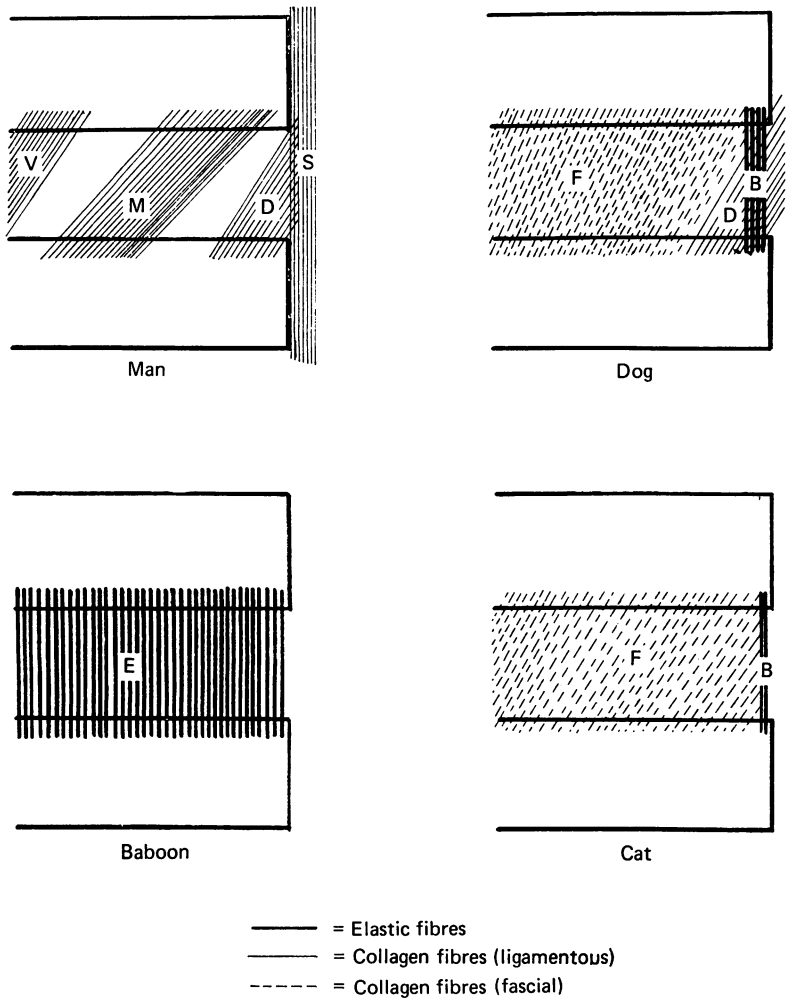

Fig. 5. Schematic diagrams of the interspinous ligament in man, dog, baboon and cat. V, Ventral part of the interspinous ligament; M, middle part of the interspinous ligament; D, dorsal part of the interspinous ligament; S, supraspinous ligament; B, bilateral elastic band; F, thin collagenous fascia; E, elastic interspinous ligament.

conclude that the authors mentioned were either referring to the thin bilateral bands of elastic tissue which lie deep to the lumbodorsal fascia below the level of the tips of the spinous process, or to residual tendon attachments of the erector spinae – not to any structure resembling the human supraspinous ligament.

Figure 5 summarizes the differences between the interspinous ligaments in dog, cat, baboon and man.

In the dog and cat the interspinous ligament is poorly developed except dorsally, where there is (1) a thin double band of elastic fibres and (2) oblique bands of collagenous (dog) or elastic (cat) fibres lateral to the former which pass cranially to merge with the lumbodorsal fascia or erector spinae tendons. In the baboon the interspinous ligament is well developed and consists of elastic fibres which take a direct course between the spinous processes. In the dog and cat the dorsal part of the interspinous

interval is occupied by (1) a ligament which resembles the dorsal part of the human interspinous ligament in its fibre direction and (2) elastic bands between the tips of the spinous processes which perhaps represent the dorsal part of the wholly elastic interspinous ligament of the baboon.

It has already been mentioned that the human interspinous ligament has three parts – a ventral which can be regarded as an extension of the ligamentum flavum, a middle which is the main part of the ligament, and a dorsal which can be regarded as a deep attachment of the lumbodorsal fascia and erector spinae. Compared with the interspinous ligament of man, that of the dog and cat is a feeble structure, while the baboon's ligament is entirely different in structure and fibre direction from its human counterpart.

In searching for an explanation of these species variations certain morphological and functional differences need to be considered. Thus the human lumbar spine is naturally lordotic, has only five vertebrae, is designed for weight-bearing in the erect posture, and specializes in extension. The cat and dog lumbar spines, on the other hand, are slightly kyphotic, have seven vertebrae, and are designed for springy motion with considerable flexion in quadripedal gait. The baboon lumbar spine is intermediate in several of these respects: it is straight, has seven vertebrae, and is designed both for semi-erect weight-bearing and quadripedal running, again with flexion predominating.

It seems clear that virtually inextensible collagenous supraspinous and interspinous ligaments would be incompatible with the free flexion of the lumbar spine exhibited by the dog and cat. The baboon's spine does not have to be quite so flexible, and so a strong but elastic interspinous ligament is appropriate for limiting and controlling flexion. Flexion in the more supple carnivores is best controlled by the dorsal musculature.

The strong collagenous supraspinous and interspinous ligaments in man not only give good control of flexion, but also, because of the dorsocranial obliquity of the main interspinous bundles, they are able to take the backward shearing stress of one vertebra relative to its caudal neighbour when the erector spinae is in strong contraction, a stress which would otherwise fall on the disc.

A lesson to be learnt from the present work is that great caution should be exercised in extrapolating from work done on non-human spines when considering the pathomechanics of 'low back' disorders in man.

SUMMARY

The ligamentous attachments of the lumbar spinous processes were studied by dissection and histological examination in seven dogs, three cats and six baboons.

Unlike man, the lumbar spines of these animals do not possess a supraspinous ligament and there is no decussation of the erector spinae tendons in the lower lumbar region.

In the baboon the lumbar interspinous ligaments are thick bilateral structures composed of elastic fibres running in a direct craniocaudal direction (Fig. 5).

In the dog and cat the interspinous ligaments are rudimentary, with very thin ventral and middle parts, but with a somewhat better developed dorsal part, most of whose fibres run obliquely dorsocranially as in man, but with some elastic fibres in addition which run directly craniocaudally as in the baboon. The baboon is clearly intermediate between man on the one hand and the dog and cat on the other in these

respects, and this would appear to reflect the intermediate requirements of the baboon in relation to the control of flexion of the lumbar spine during locomotion.

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