

The anatomy of the atrioventricular bundle in the heart of domestic cats (*Felis catus*)

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The detailed anatomy and histology of the atrioventricular bundle (AVB) was studied in 10 adult cats (5 males and 5 females). The trunk of the atrioventricular bundle was a direct continuation of the atrioventricular node (AVN) with no sharp line of demarcation between node and the bundle. The AVB of the male cats measured 6.24 mm in length,

0.27 mm in width and 0.65 mm in thickness, while in the female cats it was 4.75 mm in length, 0.22 mm in width

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and 0.55 mm in thickness. The mean width of the right bundle branch (RBB) in male cats was 0.24 mm, while in the female cats it was 0.22 mm. The mean width of the left bundle branch (LBB) in the male cats was 0.46 mm, while in the female cats it was 0.41 mm. Also the length of LBB in the male cats was 6.60 mm, while in the female cats it was 5.63 mm. Histologically, the fibrous of the AVB appeared to be organized into fascicles separated by fine fibrous septa. The cells of the AVB were ovoid in shape with light cytoplasm and a central nucleus. The size of these cells were shorter and broader than working myocardial cells and stained paler than them. Myofibrils were located at the periphery of the cells and a large perinuclear clear zone that contained a large amount of glycogen were present. These cells showed faint cross striations and there was no intercalated disc at intercellular connections.

Keywords : Atrioventricular bundle, Bundle of his, Cat, Heart

Anatomy of the atrioventricular bundle was first described by His (1893, 6) which was later known by name and is today termed the trunk of the atrioventricular bundle (AVB). Since then the anatomy and histology of the AVB was studied in humans (9, 11, 12, 19, 20, 21), in monkeys and dogs (7, 14), in hoofed animals (13,16); in rabbits (8). In birds (18, 22), in lizards (15) and recently in camels (4).

The blood supply to the AVB was also studied in human beings (2), in sheep (3), in fetal sheep (17) and in camels (5). However, no comprehensive information was yet available in the anatomy and histology of the AVB of domestic cats. The present study was therefore undertaken to deal with the anatomy and histology of the AVB in the heart of domestic cats (*Felis catus*).

Material and methods

Ten adult cats were assigned into two groups of 5 males and 5 females. Each cat was weighed and the crown rump length was measured. After humane killing of the animal, the heart with its pericardium was dissected free, it was flushed with warm (40°C) normal saline. The long axis of the heart from the middle base to the apex and also the circumferential length of the heart at the level of the coronary groove was measured. The weight of the heart was also determined. The heart was perfused with 10% buffered normal saline and kept submerged in the same fixative for 72 hours. The lower part of the interatrial wall in continuation with the whole interventricular wall of each heart was collected, trimmed and processed. Serial sections at 10µ thickness was cut sagittally from the right endocardium towards the left endocardium. The sections were mounted and preserved.

The sections were selected by the interval of 10 and stained with the methods of green and blue Masson trichrome (best staining for the conduction system); Verhoeff-Van Giesson (elastic

Millimetre

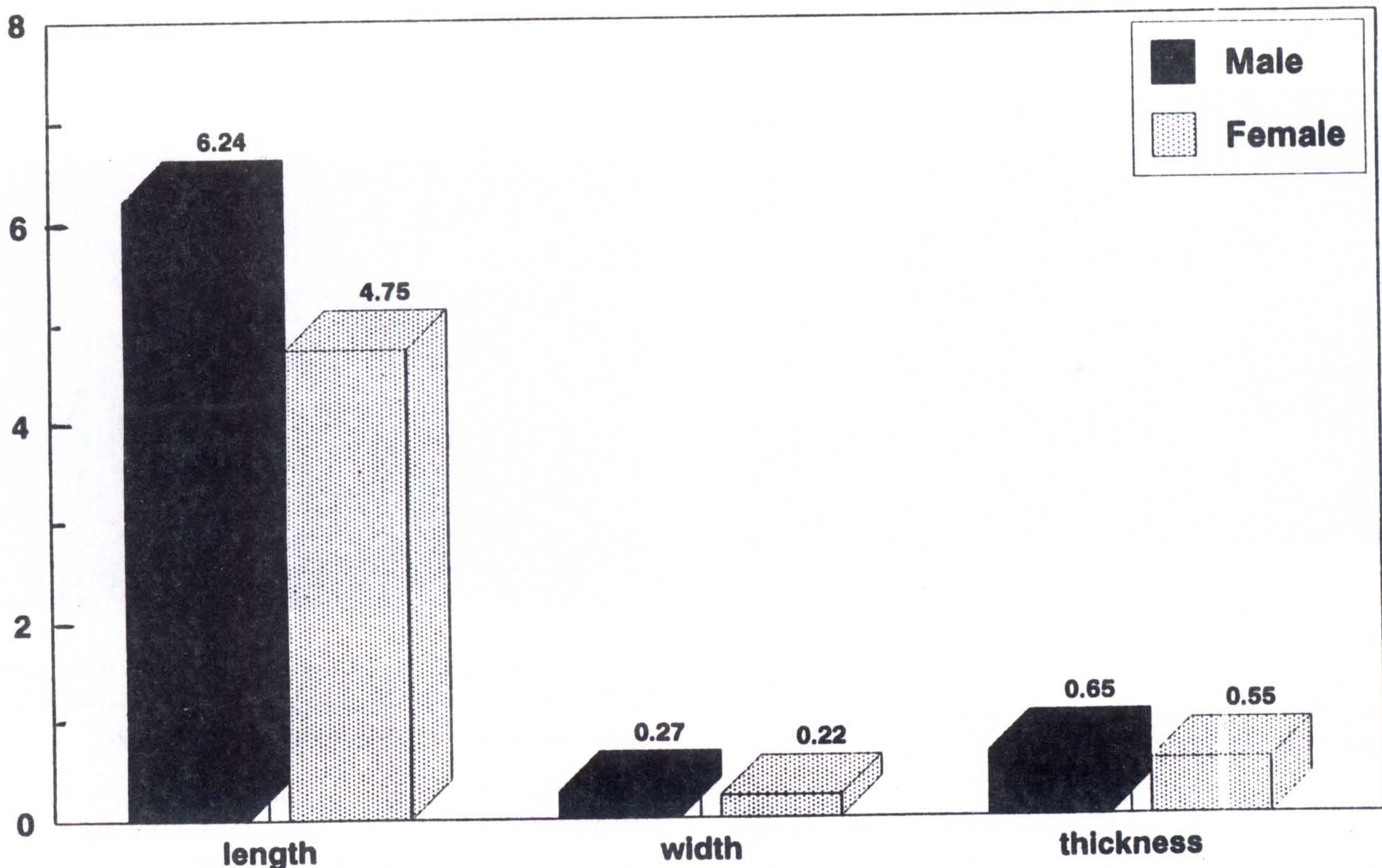


Fig. 1. The dimensions of the AVB in the cat.



Table 1. Mean values of the heart and AVB of the male and female cats

Sex	Cat		Heart				AVB		RBB	LBB	
	BW	CRL	WE	LA	CL	L	W	T	W	L	W
male	3562	442.60	13.23	42.20	78.60	6.24	0.27	0.65	0.24	6.60	0.46
	±	±	±	±	±	±	±	±	±	±	±
female	435.01	18.17	1.20	1.20	3.60	0.44	0.03	0.09	0.02	0.14	0.01
	±	±	±	±	±	±	±	±	±	±	±
female	2512	367.20	9.34	35.6	76.80	4.75	0.22	0.55	0.22	5.63	0.41
	±	±	±	±	±	±	±	±	±	±	±
	129.09	8.50	0.68	0.68	2.48	0.14	0.20	0.07	0.01	0.18	0.05

BW) Body Weight in gr, CRL) Crown Rump Length in mm, WE) Weight in gr, LA) Long Axis in mm, CL) Circumferential Length in mm, L) Length in mm, W) Width in mm, T) Thickness in mm

fibres); Golden (connective tissue) and Best carmine (Glycogen), then the sections were examined. The length and the width of the AVB and its bundle branches were measured by micrometry and their thickness was measured by multiplying the number of sections to 10 μ .

Results

The common AVB is difficult to define precisely, so that its dimensions especially length are somewhat arbitrary. It may be considered to extend from the region of the nodal-bundle Junctional area to the point at which the components of the right and left bundle branches are separated. With this definition, the AVB in adult male cats had a mean dimensions of 6.24mm in length; 0.27mm in width and 0.65 mm in thickness, while in the female cats it was 4.75mm in length 0.22mm in width and 0.55mm in thickness (Fig. 1).



Fig. 2. Microphotograph of the AVB of the cat showing nodal-bundle junctional area, (arrow); atrioventricular node (AVN); atrioventricular bundle (AVB); fibrous ring (R); atrial myocardium (M); interventricular myocardium (M) (blue Masson trichrome staining, $\times 148$).

In the nodal-bundle Junctional area, the apparently irregularly disposed fibres of the AVN assume a more orderly parallel arrangement, became the AVB (Fig. 2).

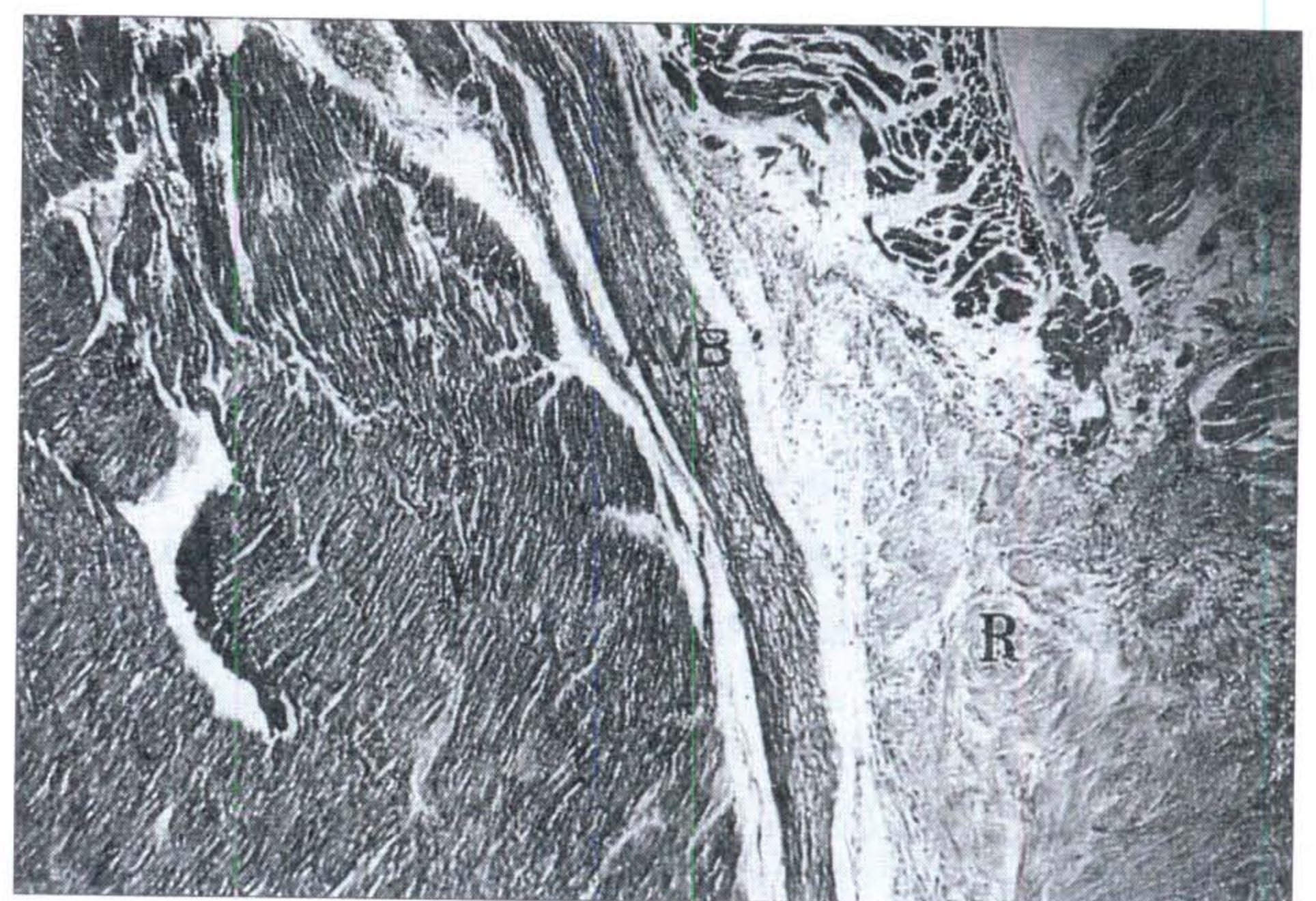


Fig. 3. Light micrograph of the atrioventricular bundle (AVB); interventricular myocardium (M); atrioventricular fibrous ring (R), (green Masson trichrome staining, $\times 59$).



Fig. 4. Microphotograph of the right bundle branch (RBB) in the heart of cat; interventricular myocardium (M); atrioventricular fibrous ring (R), (green Masson trichrome staining $\times 92$).

The compact AVB composed of the parallel fibers of the Purkinje cells (Fig. 3), passed through the fibrous atrioventricular ring at the posterior-inferior direction towards the membranous



ventricular septum and at the summit of this septum it divided into RBB and LBB. The RBB was given off as a compact structure (Fig. 4), from the right lateral surface of the AVB. After passing of 5 mm within the muscular intercentric septum the Purkinje cells of this branch was changed into the transitional cells and thereafter the differentiation of these cells from the working myocardial cells were somehow impossible and therefore more distal ramifications of these fibres were difficult to follow and study anatomically. The mean width of the RBB in male cats was 0.24mm while in the female cats it was 0.22mm.

After the emergence of the RBB, the continuation of the AVB was termed the LBB. The proximal part of this branch was a compact structure consisting of a mixture of T and P cells but gradually the rate of T cells was increased. The LBB after a short course terminated to a brush like structure consisting of T cells (Fig. 5). This structure passed over the crest of the muscular interventricular wall and entered the muscular interventricular wall. The mean length of the LBB in the male cats was 6.60mm and the width was 0.46mm, while in the female cats the length was 5.36mm, and the width was 0.41 mm.

Histologically, the cells of the AVB were ovoid in shape with a light cytoplasm and a central nucleus (Fig. 6). These cells were shorter, broader and paler than the working myocardial cells. Myofibrils were located at the periphery of the cells and a large perinuclear clear zone that contained a large amount of glycogen were present. The cells showed faint cross striations and there was no intercalated discs at intercellular connections. Mean values of the heart and AVB of the male and female cats are shown separately in Table 1.

Discussion

The length of AVB in adult male cats (6.24mm) and adult female cats (4.75mm) is in the same range as that of camels (4.12mm; 4) sheep (4-6mm; 1) and humans (6.5-20mm; 20), though in humans there is a large individual variations. The width of AVB in either male or female cats (0.27mm and 0.22mm, respectively) is much lower than camels (3.66mm; 4) and humans (1.5mm; 20). Also the thickness of AVB in either sexes of cats (0.65mm in female) is thinner than that of camels (1.13mm; 4) and in humans (2.00mm; 20).

Histologically, the appearance of AVB in cats was similar to that of camels, except that in cats the intercellular Junctions were not connected by intercalated discs as earlier was reported in camels (4) and it was also similar to that of human beings.

In cats the AVB consisted of multiple strands of Purkinje cells, which were largely separated from one another by collagen fibers. This arrangement was similar to that of the heart of humans and dogs, though collagen was more prominent in dogs than in the heart of human beings (10) and also collagen was much more

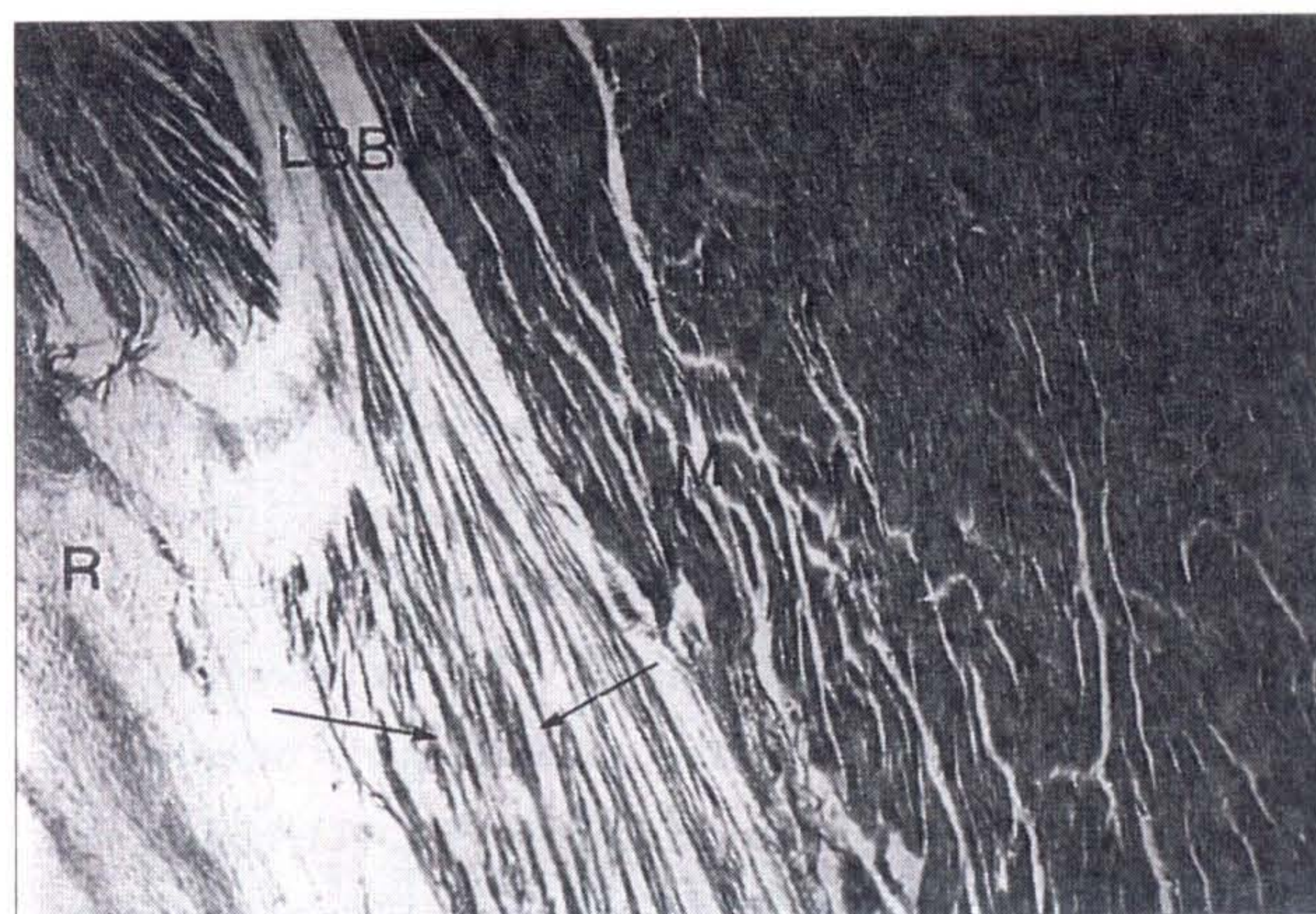


Fig. 5. Microphotograph of the left bundle branch (LBB) in the heart of cat; brush like termination of the LBB (arrows); atrioventricular fibrous ring (R); interventricular myocardium (M); (green Masson trichrome staining, $\times 59$).

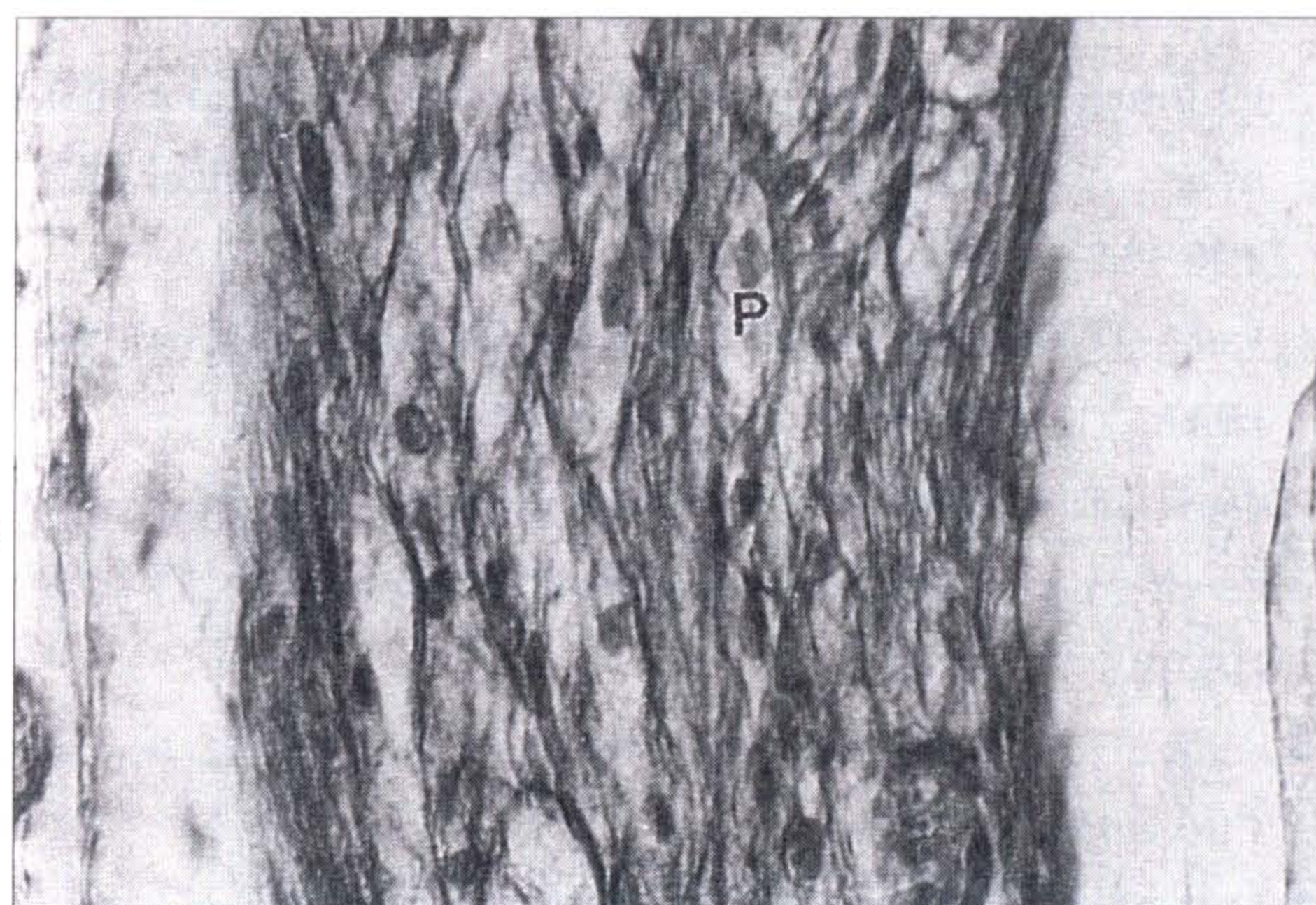


Fig. 6. Microphotograph of the atrioventricular bundle (AVB) in the heart of cat; Purkinje cells (P), note the clear zone around the nucleus of the purkinje cells, (green Masson trichrome staining, $\times 592$).

prominent in camels than in the heart of cats (4).

The AVB of cats was composed almost exclusively typical Purkinje cells, while the RBB and LBB were composed of both Purkinje and transitional cells though the ratio of transitional cells were increased as more distal ramifications were occurred. This finding is different from that of camels (4) and humans (9) in which the RBB and LBB were composed of only Purkinje cells.

Acknowledgements

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آناتومی دسته دهلیزی بطنی در قلب گربه اهلی

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آناتومی و بافت‌شناسی دسته دهلیزی بطنی در ۱۰ قلاده‌گربه بالغ (۵ نر و ۵ ماده) بطور مبسوط مطالعه گردید. تنه دسته دهلیزی بطنی، ادامه مستقیم گره دهلیزی بطنی، بدون وجود مرز مشخصی بین گروه و دسته بود. اندازه دسته دهلیزی بطنی در گربه‌های نر عبارت بود از ۶/۲۴ میلی‌متر طول، ۰/۲۷ میلی‌متر عرض و ۰/۶۵ میلی‌متر ضخامت، در حالیکه در گربه‌های ماده این اندازه‌ها عبارت بودند از ۴/۲۵ میلی‌متر طول، ۰/۲۲ میلی‌متر عرض و ۰/۵۵ میلی‌متر ضخامت. میانگین عرض شاخه راست دسته دهلیزی بطنی، در گربه‌های نر ۰/۲۴ میلی‌متر و در گربه‌های ماده ۰/۲۲ میلی‌متر بود. میانگین عرض شاخه چپ دسته دهلیزی بطنی در گربه‌های نر ۰/۴۶ میلی‌متر و در گربه‌های ماده ۰/۴۱ میلی‌متر بود. همچنین، طول شاخه چپ دسته دهلیزی بطنی در گربه‌های نر ۶/۶۰ میلی‌متر و در گربه‌های ماده ۵/۶۳ میلی‌متر بود. از لحاظ بافت‌شناسی الیاف دسته دهلیزی بطنی بصورت دسته‌های سازمان یافته‌ای بنظر می‌رسیدند که بوسیله دیواره‌های فیبروزی ظریفی از یکدیگر جدا شده باشند. از لحاظ شکل، سلولهای دسته دهلیزی بطنی، بیضی شکل با سیتوپلاسم روشن و هسته مرکزی بودند. اندازه این سلولها کوتاهتر و پهن‌تر از سلولهای میوکاردا بودند و رنگ‌پذیری کمتری از آنها داشتند. میوفیبریلها، در کناره‌های سلولها قرار داشتند و یک منطقه شفاف بزرگ در اطراف هسته وجود داشت که محتوی مقدار زیادی گلیکوژن بود. این سلولها تخطط عرضی ضعیفی نشان می‌دادند و در تماسهای بین سلولی آنها، دیسک پلکانی یا اینتر کالیتد دیسک وجود نداشت.

واژه‌های کلیدی: دسته دهلیزی بطنی، دسته هیس، گربه، قلب، دیسک پلکانی

