

THE ARTERIAL SUPPLY OF THE HUMAN PROSTATE AND SEMINAL VESICLES

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INTRODUCTION

Much of the difficulty experienced in evaluating and comparing work on vascular anatomy is a result of lack of uniformity in nomenclature, and the literature on this particular region of the arterial system is no exception.

Previous workers appear to be divided on the question of the existence of a specific artery to the prostate gland (Kraas, 1935; Awataguti, 1939), but the measure of agreement is greater than would appear from a superficial survey of the literature, and differences in results may be explained as resulting from differences in terminology, rather than from fundamental anatomical variations.

The object of this report is to describe in some detail the blood supply to the human prostate and seminal vesicles, to compare the various systems of nomenclature used by previous workers, and to provide an accurate representation of the vascular patterns as a basis for surgical practice.

MATERIALS AND METHODS

Fresh post-mortem material was used whenever possible, the ages of the subjects varying between 36 and 64 years. In no case did the prostate show pathological hypertrophy.

After ligating the common and external iliac arteries close to their origin the former was cannulated distally, and an injection of 10–15 ml. of a radio-opaque medium ('Micropaque'; Damancy and Co. Ltd) was made. This injection mass combines high density for radiographic purposes with good colour contrast for dissection. The injection was made at pressures varying from 100 to 200 mm. mercury; it was found that at lower pressures the viscosity of the medium prevented good filling of the vessels.

When a sufficient quantity of medium had been introduced (this could be judged by the appearance of the vessels on the superior surface of the bladder and the pubic branches of the obturator artery), the cannula was removed, and the pelvis eviscerated. A certain amount of leakage occurred when the parietal branches of the internal iliac artery were divided, but this loss was not serious.

Subsequent, a polythene cannula was tied in the superior rectal artery above its bifurcation, and the specimen radiographed with the rectum nearest the plate, and the emptied bladder drawn upwards. Without moving the specimen, 5 ml. of 'Micropaque' were injected into the superior rectal artery, and a further radiograph was taken. Dissection was commenced as soon as possible, the specimens being fixed in formol saline, and the dissected specimen radiographed again in certain cases.

Clearing by the Spalteholtz method was not employed because of the difficulties inherent in such large specimens.

A total of twenty-one pelvic halves were examined, of which four were pelvic halves from dissecting-room specimens. Of the remaining seventeen, seven were whole pelvic contents in which one side only (the right) had been injected, and the remaining ten comprised five bilaterally injected specimens. In the case of the superior rectal artery, the injections were bilateral. Hence, in this respect, a total of twenty-eight pelvic halves were examined.

The anastomoses between vessels of opposite sides were studied radiologically and by dissection in six of the seven unilaterally injected specimens.

In the study of the general topography of the vascular patterns, more reliance was placed on dissection than on the radiographical findings. The latter method was used to indicate the adequacy of the injection and to assist the analysis of the arterial supply of the organs by dissection.

RESULTS

Despite the anatomical contiguity of the organs, the blood vessels supplying the prostate gland and seminal vesicle have less in common than might be expected. The two organs will, therefore, be considered separately.

The arterial supply of the prostate gland

In all cases the gland is supplied by the prostatic branch of the prostatico-vesical artery, which is always a well-defined trunk of variable origin (Table 1). As a rule, the vessels of the two sides are of comparable size, but in one case the left prostatic artery was much larger than the right, and crossed the midline on the anterior surface of the gland.

Table 1. *The origin of the prostatico-vesical artery (Text-fig. 1)*

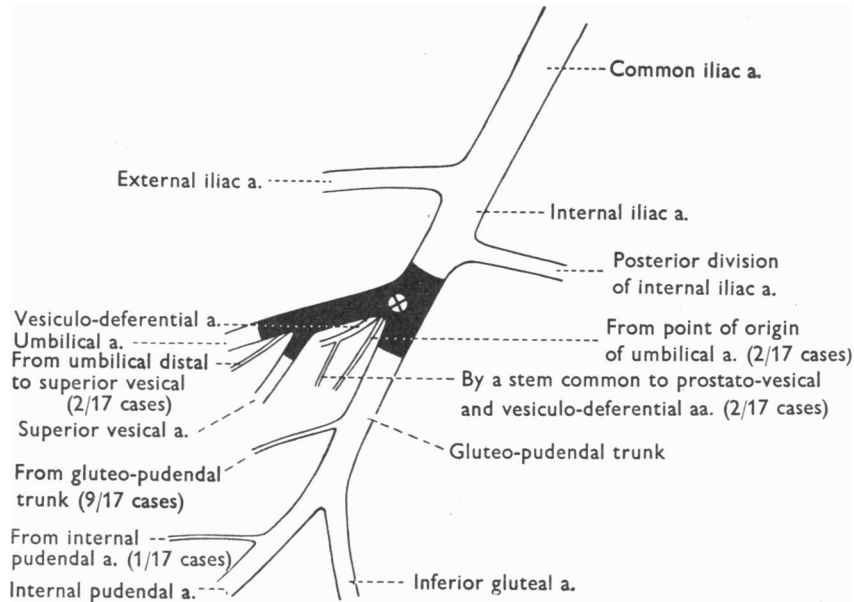
Gluteo-pudendal trunk	Origin of umbilical artery	Umbilical artery	Common trunk with vesiculo-deferential artery	Internal pudendal artery	Obturator artery
9	2	2	2	1	1

The course of the prostatico-vesical artery is fairly constant. It passes obliquely downwards, forwards and medially on the antero-inferior surface of the bladder towards the prostate gland, at a varying distance from which it divides into its two terminal branches, the inferior vesical and prostatic arteries (Pl. 1, fig. 1). This subdivision is by no means constant, however, as is shown in Table 2.

Table 2. *Mode of division of the prostatico-vesical artery*

Prostatic and inferior vesical arteries	Large prostatic artery—small inferior vesical artery	Several inferior vesical arteries	No inferior vesical artery
6	5	3	5

The prostatic artery, on the other hand, is a constant branch of this trunk. It reaches the gland on its antero-lateral surface, and passing down the lateral border (Pl. 1, figs. 2, 3), gives off fine twigs to the surface of the organ (Table 3), finally terminating as a bunch of small vessels which supply the pelvic floor. Some of these twigs pass to the rectum and anal canal, and may be classed as middle rectal arteries. Not infrequently one of these vessels may be enlarged, and in such a case it may appear that the prostatic artery is a branch of the middle rectal.



Text-fig. 1. Diagrammatic representation of the sites from which the prostatic artery can arise. The shaded area shows the region from which the vesiculo-deferential artery may arise and X marks its most frequent site of origin.

Table 3. *Distribution of the prostatic artery to the gland*

Branches to both surfaces	Anterior branches larger than posterior	Anterior surface only	Posterior surface only
13	8	6	2*

* In these cases (two sides of one pelvis) the artery passed on a more posterior plane than usual to supply only the posterior surface of the gland. In this pelvis the anterior branches of the artery were replaced by two large vessels which descended across the pelvic floor from the obturator artery.

Another not infrequent branch of the prostatic artery is the *posterior vesicular artery* (author's terminology). This vessel, which, as its name suggests, supplies the posterior aspect of the seminal vesicle, arose from the prostatic artery in eight out of fourteen cases, and in one case it had a common origin with the latter from the gluteo-pudendal trunk.

The superior rectal artery was found to supply the gland in nine out of twenty-

eight cases, this total being made up of three pelves in which the supply was bilateral, and three in which the left branch only supplied the gland.

These vessels are given off from their parent trunk opposite the middle third of the rectum, and pass around its lateral borders, eventually running deeply below the peritoneal floor of the recto-vesical pouch to the upper lateral angle of the gland, where they communicate with the other vessels of supply, some of these communications being of considerable size.

Other arteries which occasionally supplied the gland included the posterior vesicular (three cases) and vesiculo-deferential arteries (three cases), but since their main territory of supply is the seminal vesicle, they will be described in the next section.

It is interesting to note here that in the three cases in which the vesiculo-deferential artery supplied the prostate, the prostatic artery supplied the anterior surface of the gland only, and a similar finding was recorded in two out of the three cases in which the posterior vesicular artery supplied the gland. When a supply was derived from the superior rectal artery, the posterior branches of the prostatic artery were smaller than usual in all but one case.

A very prominent feature of the vessels on the surface of the prostate is their tortuosity (Pl. 2, fig. 1). This is of a characteristic 'corkscrew' pattern, and can be seen in vessels penetrating the stroma of the gland (Pl. 2, fig. 2). It is not so well marked on the surface of the seminal vesicle.

A study of six unilaterally injected specimens revealed that there were few anastomoses of arteriolar size or larger between vessels of opposite sides in the gland itself. This could be equally well demonstrated in radiographs of bilaterally injected specimens (Pl. 1, figs. 2, 3), in which very few connexions could be seen between the vessels of the two sides.

The arterial supply of the seminal vesicle

Just as the prostatic artery is the main source of supply of the prostate gland, so the vesiculo-deferential artery (Pl. 1, fig. 2) supplies the seminal vesicle in all cases examined.

The various sites of origin of this vessel are shown in Table 4.

Table 4. *The origin of the vesiculo-deferential artery*

At the site of origin of the umbilical artery from the internal iliac artery	First cm. of umbilical artery	Superior vesical artery	Umbilical artery distal to superior vesical artery	Anterior division of internal iliac proximal to umbilical artery	Gluteo-pudendal trunk
10	2	2	1	1	1

In one case also the vessel arose as two separate stems, a vasal artery and a vesicular artery arising with the superior vesical artery. The two cases in which the vesiculo-deferential and prostatico-vesical arteries arose by a common trunk have been grouped here with the most frequent mode of origin of the vesiculo-deferential artery.

The vessel constantly passes medially behind the supero-lateral border of the bladder, in front of the ureter, to which it gives branches (Cerf, 1895; Farabeuf, 1905; Braithwaite, 1952). It continues medially to the lateral end of the seminal vesicle where it normally divides into three branches, vesical, deferential and *anterior vesicular* (author's terminology). Not infrequently the artery gives off its deferential branches between the ureter and seminal vesicle, occasionally lateral to the ureter. The vesical branch gives off the marginal trigonal artery (Braithwaite, 1952), and a less constant branch which runs towards the opposite side along the upper boundary of the trigone.

The anterior vesicular artery is the largest branch of the vesiculo-deferential artery. In nine out of thirteen cases it was double, in three single, and in one case there were four arteries. If single it usually divides into two or more branches which ramify in the depths of the grooves on the anterior surface of the seminal vesicle. In cases in which two arteries are present, the upper one usually anastomoses over the upper border of the vesicle with the posterior vesicular artery, and along the lower border of the ampulla of the vas deferens with the proximal deferential artery.

The lower anterior vesicular artery runs along the front of the inferior border of the seminal vesicle. It may communicate with the vesical branches of the vesiculo-deferential artery.

The vasal artery generally arises as a single stem which runs to the vas deferens, and there divides into proximal and distal branches. In four cases out of fifteen, however, the distal deferential artery was given off first, and the segment of vas deferens between its origin and that of the proximal deferential artery presumably received its blood supply directly from the vesiculo-deferential artery, which lies closely applied to the vas in this position.

The *posterior vesicular artery* (author's terminology) supplies mainly the posterior surface of the seminal vesicle, although it invariably sends branches which pass over the upper border of the vesicle to anastomose with the upper anterior vesicular artery. Its origin is shown in Table 5.

Table 5. *The origin of the posterior vesicular artery*

Prostato- vesical artery	Gluteo- pudendal trunk	Vesiculo- deferential artery
8	5	1*

* In this case the prostato-vesical and vesiculo-deferential arteries arose by a common stem which bifurcated after a course of 1 cm.

The artery is usually of small or moderate size, and passes medially upwards or downwards, according to its origin, to the lateral end of the seminal vesicle, where it turns downwards to run behind its inferior border, giving off several small branches which supply its posterior surface. Its anastomotic branches with the anterior vesicular artery have already been described.

As mentioned above, both the vesiculo-deferential and the posterior vesicular arteries supplied the prostate gland in three cases.

(a) In the three out of seventeen cases in which the former artery supplied the gland, one was via a large anastomosis with the superior rectal artery, in another the artery supplied the postero-lateral surface of the gland, and in the third, branches of the anterior vesicular artery passed downwards and forwards to supply the bladder neck and upper part of the prostate.

(b) In the three out of eighteen cases in which the posterior vesicular artery supplied the gland, it was by a continuation of the main stem of the vessel medially on the posterior surface of the organ. This stem was of small size and communicated with the other vessels to this region of the gland.

Occasional anastomoses between the two vesicles could be demonstrated, both by dissection and, with less certainty, by radiography. Quite often the vessels supplying the ampullae communicated across the midline posteriorly, and in two cases a fairly large vessel passed between the proximal vasal arteries on the posterior surface of the trigone. The vessels on the vesicles did not show the same degree of tortuosity as those on the surface of the prostate gland.

DISCUSSION

The arterial supply of the prostate gland

There would appear to be a difference of opinion in the literature concerning the existence of a definitive prostatic artery. In favour of its existence are Cerf (1895), Poirier (1896), Farabeuf (1905), Loeschke (1920), Adrion (1922), Tsaknis (1929) and Kraas (1935). Henle (1868) mentions, without giving a reference, an alternative name for the middle rectal artery, the '*arteria prostatica s. vesico-prostatica*'. The existence of a prostatic artery is specifically denied by Cammerat (1923), Flocks (1937) and Awataguti (1939). Testut (1895), without actually denying the existence of the vessel, emphasized the variability of the vascular pedicles to the gland.

This apparent difference of opinion is almost certainly due to a confusion in nomenclature. Those authors who deny the existence of a prostatic artery, emphasize the constancy of the supply of the gland from the middle rectal and inferior vesical arteries, either of which, from the results of the present investigation, may spring from the vessel which also supplies the prostate gland. Of these three vessels, by far the most constant is the prostatic artery, and the trunk which gives rise to this vessel and the inferior vesical and middle rectal arteries might well be termed the 'prostato-vesico-haemorrhoidal trunk'. However, the middle rectal vessel is so varied in its origin, that an equally accurate and less cumbersome term might be the 'prostato-vesical artery'. This interpretation has already been used by Cerf (1895), Poirier (1896) and Farabeuf (1905).

The site of origin of the prostato-vesical artery agrees fairly well with the work of Braithwaite (1952). This author found that the 'inferior vesical artery' arose from the gluteo-pudendal trunk or one of its branches in 59.1% of cases, compared with ten out of seventeen (58.8%) in the present series. The main difference lies in the different frequencies of origin of the vessel from the trunk or its individual branches.

The course of the prostatic artery, and its division into anterior and posterior branches follow the usual descriptions.

In the present series, a surprisingly high number of cases was found (32.1%) in which the prostate received branches from the superior rectal artery. This mode of

supply has been described by Awataguti (1939), who found the superior rectal artery supplying the gland in 14·3% of cases, while Quénu (1893) stated that the superior rectal artery supplies the prostate by unilateral branches.

The arterial supply of the seminal vesicle

Little work appears to have been performed on the more detailed anatomy of the arterial circulation in this organ, and some authors, and most of the standard textbooks, even ignore the existence of the vesiculo-deferential artery. Probably the best descriptions of this vessel are by Cerf (1895), Delbet (1923) and Farabeuf (1905).

The site of origin of the vessel is reasonably constant, although the present findings differ slightly from those of Awataguti and Braithwaite. The former found the 'deferential artery' to arise from the umbilical artery in 90% of cases, and the latter in 93·2%, compared with 83·3% in the present series. However, there is agreement that the commonest site of origin is from the angle between the umbilical and gluteopudendal trunks.

The anterior and posterior vesicular arteries have not been hitherto described, although it is possible that the latter is the 'accessory middle rectal artery' of Awataguti, which supplies the prostate in ten out of seventy-seven pelvic halves examined, and arises in forty out of forty-two cases from the gluteo-pudendal trunk or one of its branches.

The tortuosity of the vessels supplying the prostate has received brief reference in the works of Poirier (1896), and Bumpus & Antopol (1934). This phenomenon is not so well marked in the seminal vesicles, but a definite 'corkscrew-like' appearance may be observed in the vasal artery during its course on the vas deferens. It was observed that the tortuosities are much more marked in the vessels on the posterior surface of the gland.

The reason for these appearances is unknown. Possibly they are related to variations in size or position, or to the amount of smooth muscle in the organs where they are marked. The fact that the vessels on the surface of the seminal vesicle, a much less muscular organ, do not show these tortuosities to the same extent, lends a certain amount of support to the last hypothesis.

SUMMARY

1. In a total of twenty-one pelvic halves, the blood supply to the prostate gland and seminal vesicle was studied by dissection and radiologically.
2. A definitive prostatic artery was found in all cases examined; it was the most constant branch of the prostatico-vesical artery.
3. The superior rectal artery was found to supply the gland in 32·1% of cases, a much higher figure than that of Awataguti (1939).
4. The vesiculo-deferential artery was found to supply the seminal vesicle in all cases through its anterior vesicular branch (author's terminology). In eight cases out of fifteen the posterior vesicular artery (author's terminology) was a branch of the prostatico-vesical artery, and in six cases a branch of the gluteo-pudendal trunk.
5. It is considered that variations in the nomenclature of blood vessels in this region account, in the main, for the wide diversity of findings in the blood supply of the prostate and seminal vesicles.

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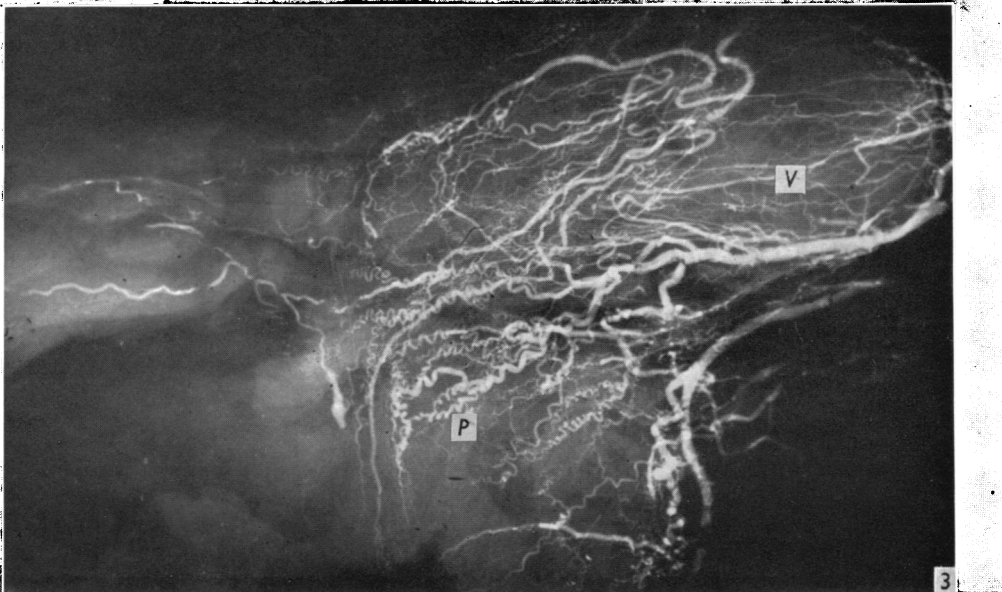
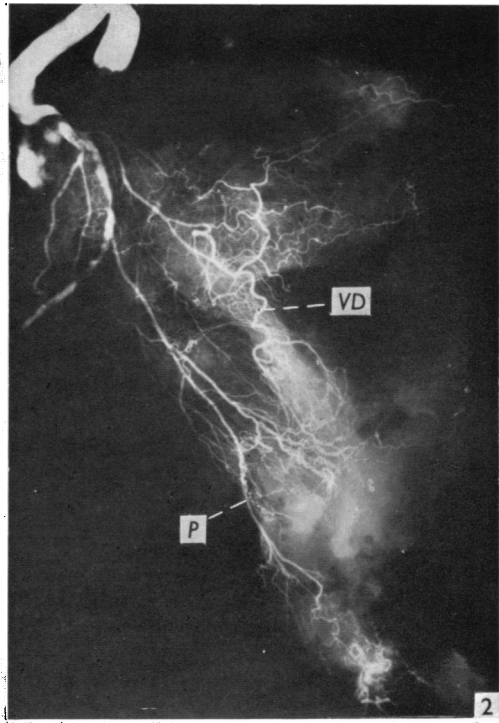
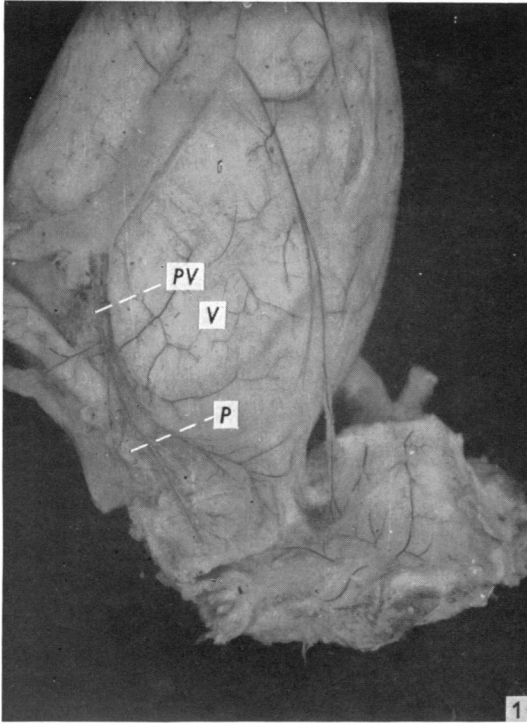
EXPLANATION OF PLATES

PLATE 1

- Fig. 1. Photograph of the bladder and prostate of a stillborn foetus, injected with indian ink. The division of the prostatovesical artery (*PV*) into prostatic (*P*) and inferior vesical branches (*V*) can be seen. In this case the inferior vesical artery was small, and the prostatic artery supplied a large vessel running between the bladder and prostate, giving branches to both. ($\times 1.5$). (Courtesy of Dr J. L. Braithwaite.)
- Fig. 2. Radiograph of the bladder and prostate of a man aged 36, unilaterally injected with 'Micropaque'. The prostatic artery (*P*) can be seen coursing along the lateral border of the gland, finally terminating by supplying the anal canal. The vesiculo-deferential artery (*VD*) can be seen to be a branch of the superior vesical artery.
- Fig. 3. Radiograph of the prostate (*P*) and seminal vesicle (*V*) of a man aged 47, unilaterally injected with 'Micropaque'. The bladder has been removed. The ramifications of the vessels on the surfaces of the seminal vesicle are visible. The 'corkscrew-like' tortuosities of the prostatic vessels are easily distinguished from those of the vesicular arteries.

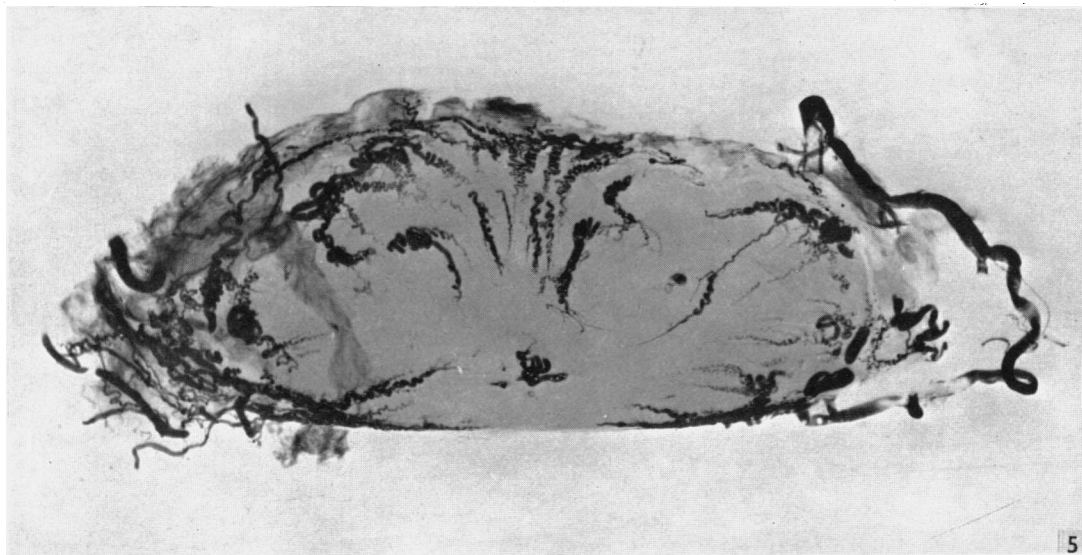
PLATE 2

- Fig. 4. Photograph of the arteries on the posterior surface of the prostate of a 47-year-old man after bilateral injection with 'Micropaque'. The tortuosity of the vessels is evident. A vessel on the ampulla (*A*) of the vas deferens shows similar features.
- Fig. 5. Radiograph of a 1 cm. thick transverse section of the prostate illustrated in fig. 4. The typical tortuosity of the vessels penetrating the substance of the gland can be seen.



CLEGG—ARTERIAL SUPPLY OF PROSTATE AND SEMINAL VESICLES

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