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Research Article

THE ARCUATE ARTERIES AND THEIR BRANCHING PATTERN IN THE KIDNEY OF CAMEL (CAMELUS DROMEDARIUS)

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ABSTRACT

The origin, course and distribution of the arcuate arteries of the kidney in adult camel were studied on 20 kidneys. The arcuate arteries arose from the interlobar arteries at the corticomedullary junction. They detached 3-5 side branches from their convex surfaces and then ended by dividing into 2-4 terminal branches. These side branches and terminal branches were present in a radiating manner and were described as the interlobular arteries. The interlobular arteries were of two types viz. radiating and deep interlobular arteries. The interlobular arteries gave off the intralobular arterioles. These intralobular arterioles were short and long and terminated into 3-4 afferent arterioles which in turn entered the glomerulus. It was concluded that the arterial blood supply to the kidneys of camel (specially the arcuate arteries and their branches) is basically similar to the other domestic animals including the two humped camel.

Key words: Arcuate arteries, kidney, camel

Since the kidneys are responsible for regulation of fluid balance in the body, it is essential to carry out a full investigation of the arterial system of kidneys especially the arcuate arteries and their branches in this species. The objective behind this study is to find out if there is any special feature attached to the kidneys for adaptation of this animal to the mode of living under adverse climatic and environmental conditions of limited water supply. In this respect, the available literature lacks the data on kidneys of camel except a brief general description given by Leese (1927), Grahame (1944), Tayeb (1948) and Anuradha *et al.* (2000).

MATERIALS AND METHODS

Ten apparently healthy camels of either sex were embalmed with 10 per cent formalin solution (Grossman, 1959). The abdominal cavity was exposed and the kidneys along with the blood vessels were segregated from the carcasses. The renal artery was cannulated and the arterial system was flushed by injecting luke-warm heparinized saline solution (100 I.U./ 100 ml). A radio-opaque suspension (20% lead oxide in liquid soap) was injected by steady and constant digital pressure. After satisfactory filling, the organ was radiographed at 8 Mas, 50 KVP and 900 mm FFD in M/L profile to obtain the radiographs depicting the branching pattern of the vessels.

The tissues for histological examination were collected in 10% neutral buffered formalin and were fixed for 48 hours. The fixed tissues were then processed for routine paraffin embedding and sections of 6 μm were cut and stained with routine Harri's hematoxilin and eosin stain (Luna, 1968).

RESULTS AND DISCUSSION

The arcuate arteries of the kidney in camel arose from the interlobar arteries. The latter arose from the lobar branches of the renal artery. These interlobar arteries in the renal medulla coursed towards the periphery of the kidney and at the corticomedullary junction formed 2-7 arched branches called as arcuate arteries (Fig 1). These vessels curved in various directions at acute to right angles. Generally, they followed the curvature of the base of the medullary pyramids. El-Shaieb *et al.* (1981)

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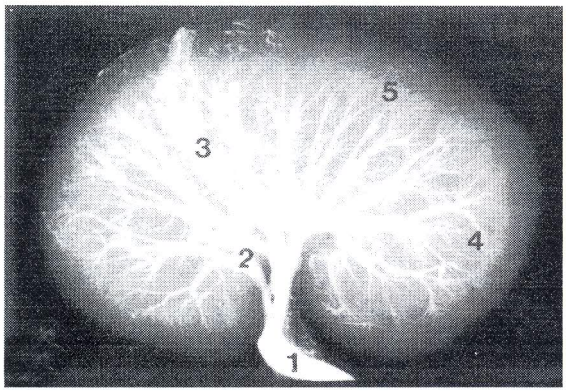

Fig 1. Negative image reproduction of the arteriogram of the kidney of camel.
1- Renal artery, 2- Lobar artery, 3- Interlobar artery, 4- Arcuate artery, 5- Interlobular artery.

reported that each interlobar artery divided into 1-5 arcuate arteries which passed in the grooves produced by the crenations of the free edges of the renal recesses. Jain and Singh (1987) observed similar arrangement in bovine calf. Trautmann and Fiebiger (1952) named them as subcortical arteries. Similarly, Jain and Dhingra (1986) stated that the interlobar arteries formed several arched branches referred to as arcuate arteries in donkeys.

The arcuate arteries detached 3-5 side branches from their convex surfaces and then ended by dividing into 2-4 terminal branches. These side branches and terminal branches were present in a radiating manner and were described as the interlobular arteries. However, in few cases the arcuate arteries terminated directly as afferent arterioles. In addition to these, the arcuate arteries also gave off 2-5 minute long branches to the renal medulla. These medullary branches divided into 10-15 very fine branches named as arteriolae rectae verae (Fig 2). Similar finding has been reported by El-Shaieb *et al.* (1981) and Morison (1926). However, these were not reported by Grahame (1944) in Indian elephant. At few places the intra-arterial anastomoses were also observed between adjoining arcuate arteries. El-Shaieb *et al.* (1981) observed similar findings in camel while Jain and Singh (1987) stated that the cortical surface of arcuate arteries in bovine calves gave numerous interlobular arteries which supplied the cortex and capsule of the kidney and there was no intra-arterial anastomosis between these vessels.

The interlobular arteries were straight, fine and nearly lay at right angle to the arcuate arteries. These interlobular arteries supplied the renal cortical parenchyma and capsule of the kidney. The interlobular arteries were of two types viz. radiating and deep interlobular arteries. El-Shaieb *et al.* (1981) gave similar classification in camel. Holle (1964) in sheep and goat, Wille (1968) in horse and cattle gave similar classification, but they also reported the presence of perforating capsular arteries. The radiating interlobular arteries arose at right angles from their parent vessels and ran towards the kidney in a radiating manner either singly or after giving off 2-4 side branches at acute angles (Fig 2). Each radiating interlobular artery detached about 20-70 afferent arterioles which terminated either by splitting into 4-10 afferent arterioles or by dividing into 2-9 interlobular arterioles which in turn detached the afferent glomerular arterioles. Few radiating interlobular vessels reached the perforated renal capsule which supplied the peri-renal fat. The perforating capsular arteries were also observed in the lobulated kidneys (Morison, 1926).

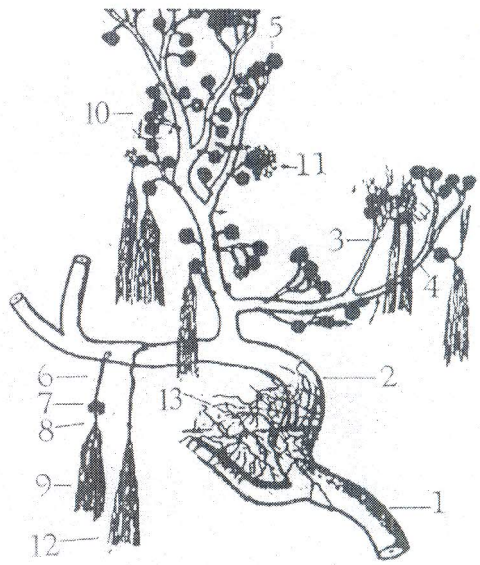

Fig 2. Diagram showing the arcuate artery and its branching pattern in the kidney of camel.
1- Interlobar artery, 2- Arcuate artery, 3- Radiating interlobular artery, 4- Deep interlobular artery, 5- Intralobular artery, 6- Afferent arteriole, 7- Glomerulus, 8- Efferent arteriole, 9- Arteriolae rectae spurie, 10- subcapsular capillary bed, 11- Periglomerular capillaries, 12- Arteriolae rectae verae.

The deep interlobular arteries followed the course parallel to the arcuate arteries and then curved towards the surface of kidney after a short course to terminate at a deeper level than that of the radiating interlobular arteries. These vessels gave off 2-3 side branches which might be afferent or intralobular arterioles and terminated by splitting into 5-10 afferent arterioles (Fig 2). Both the radiating and deep interlobular arteries gave off in addition to the other branches arteriolae rectae verae which supplied the medulla (Fig 2). The interlobular arteries gave off the intralobular arterioles. These intralobular arterioles were short and long and terminated into 3-4 afferent arterioles. Arnautovic (1959) in dog also reported the presence of intralobular arterioles. The afferent arterioles might be short or long, straight or slightly twisted. They might arise either singly or by several branches (3-10) from intralobular arteries and entered into the glomerulus (Fig 3).

The efferent arterioles soon after emerging from the glomerulus divided several times (Fig 4). They gave off about 7-18 very long twigs called as arteriolae rectae spuriae which traversed into the renal medulla (Fig 2). However, some of the efferent arterioles issued small twigs which formed the periglomerular capillary network surrounding the corresponding glomerulus. El-Shaieb *et al.* (1981) described that in addition to the arteriolae rectae spuriae, the efferent arterioles also gave off the dorsal and ventral branches. The dorsal branches were directed towards the cortex forming a capillary

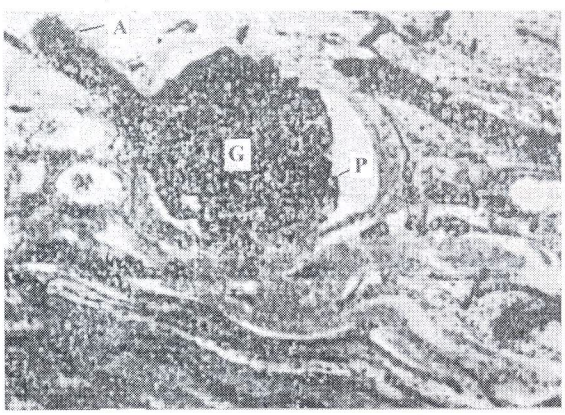

Fig 3. Photomicrograph of the kidney showing the afferent arteriole (A), glomerulus (G) and peritubular capillaries (P) (H&E stain x50)

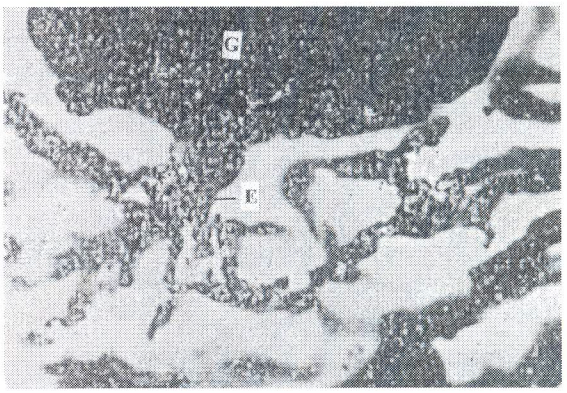

Fig 4. Photomicrograph of the kidney showing the efferent arteriole (E), which gets branched and glomerulus (G) (H&E stain x100)

network and ventral branches proceeded towards the medulla where they divided to constitute the arteriolae spuriae . They further stated that the efferent arterioles situated close to the surface of the kidney divided into small twigs which anastomosed with each other forming a network, the subcapsular capillary bed. Similar findings have been reported in horse and cattle (Wille, 1968). Morison (1926) also gave similar description except that he did not refer to the formation of the peri-glomerular capillaries. However, Grahame (1944) did not describe the various modes of distribution of efferent arterioles in Indian elephant. The renal cortex received its blood supply from the capillary plexuses derived from the efferent glomerular arterioles in the cortical and juxtamedullary zones. Similar description has been given in rat, pig, monkey and other domestic animals (Morison, 1926), while the renal medulla received its blood supply from the arteriolae rectae spuriae and arteriolae rectae verae (Fig 2). Similar finding has been reported earlier in this species (El-Shaieb *et al.,* 1981), in dog (Kugelgen and Braunger, 1962), domestic mammals (Plakke and Pfeiffer, 1964) and in sheep and goat (Holle, 1964).

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