

# The arterial supply to the digits of the forelimb in the Bactrian camel (*Camelus bactrianus*)

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(Accepted 24 August 1999)

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## ABSTRACT

The arterial supply of the digits of the forelimb of the Bactrian camel is described. The arteries supplying the digits were the palmar metacarpal and common palmar digital arteries III. The palmar metacarpal artery III was the continuation of the deep medial proximal metacarpal branch which was derived from the medial branch of the radial artery. It gave rise to a nutrient branch, medial branch, lateral branch and distal perforating palmar branch at the proximal end of the distal sixth of the cannon bone (fused third and fourth metacarpal bones). The common palmar digital artery III was the continuation of the median artery, which divided into medial and lateral branches. The medial branch of common palmar digital artery III which occasionally arose from the axial palmar proper digital artery III, after giving rise to the axial proximal proximal phalangeal branch, divided into the axial and abaxial palmar proper digital arteries III. The axial palmar proper digital artery III gave off the dorsoaxial distal proximal phalangeal, dorsoaxial proximal middle phalangeal, dorsoaxial distal middle phalangeal, palmoaxial middle phalangeal, palmoaxial distal phalangeal, dorsoaxial distal phalangeal branches, coronal artery and some digital tori branches. The abaxial palmar proper digital artery III gave rise to the abaxial proximal proximal phalangeal, dorsoabaxial distal proximal phalangeal, dorsoabaxial middle phalangeal, palmoabaxial middle phalangeal, palmoabaxial distal phalangeal, dorsoabaxial distal phalangeal branches, coronal artery and some digital tori branches. The lateral branch of the common palmar digital artery III in its origin, course, branching pattern and supply in the fourth digit was similar to the medial branch of common palmar digital artery III in the third digit.

*Key words:* Vasculature; adaptation to arid conditions.

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## INTRODUCTION

It is important to know the details of the blood supply of the forelimb digits to understand the physiological specialisation of the Bactrian camel (*Camelus bactrianus*) in view of its existence in arid and semiarid areas. The arterial supplies of the shoulder and metacarpophalangeal joints of the Bactrian camel have been studied by Wang & Xie (1994, 1998). However, the blood supply of the digits of the Bactrian camel has never been described. The main arteries and some small arterial branches of the forelimb in the dromedary (*Camelus dromedarius*) were studied by Smuts & Bezuidenhout (1987), but their description was not detailed. Those of the horse, donkey and ox have been reported by Getty (1975)

and Xie (1987). The aim of the present study was to describe the origin, course, anatomical relationships and branches of the arteries supplying the digits of the forelimb of the adult Bactrian camel. The paper provides a basis for further research on the comparative anatomy of the camel.

## MATERIALS AND METHODS

Six specimens of the forelimb (3 left, 3 right) of adult Bactrian camels were collected from the slaughterhouse of the Right Alasan Banner Food Company in the Inner Mongolia Autonomous Region, China and fixed by injecting 10% formalin through the axillary artery. The specimens were coloured by

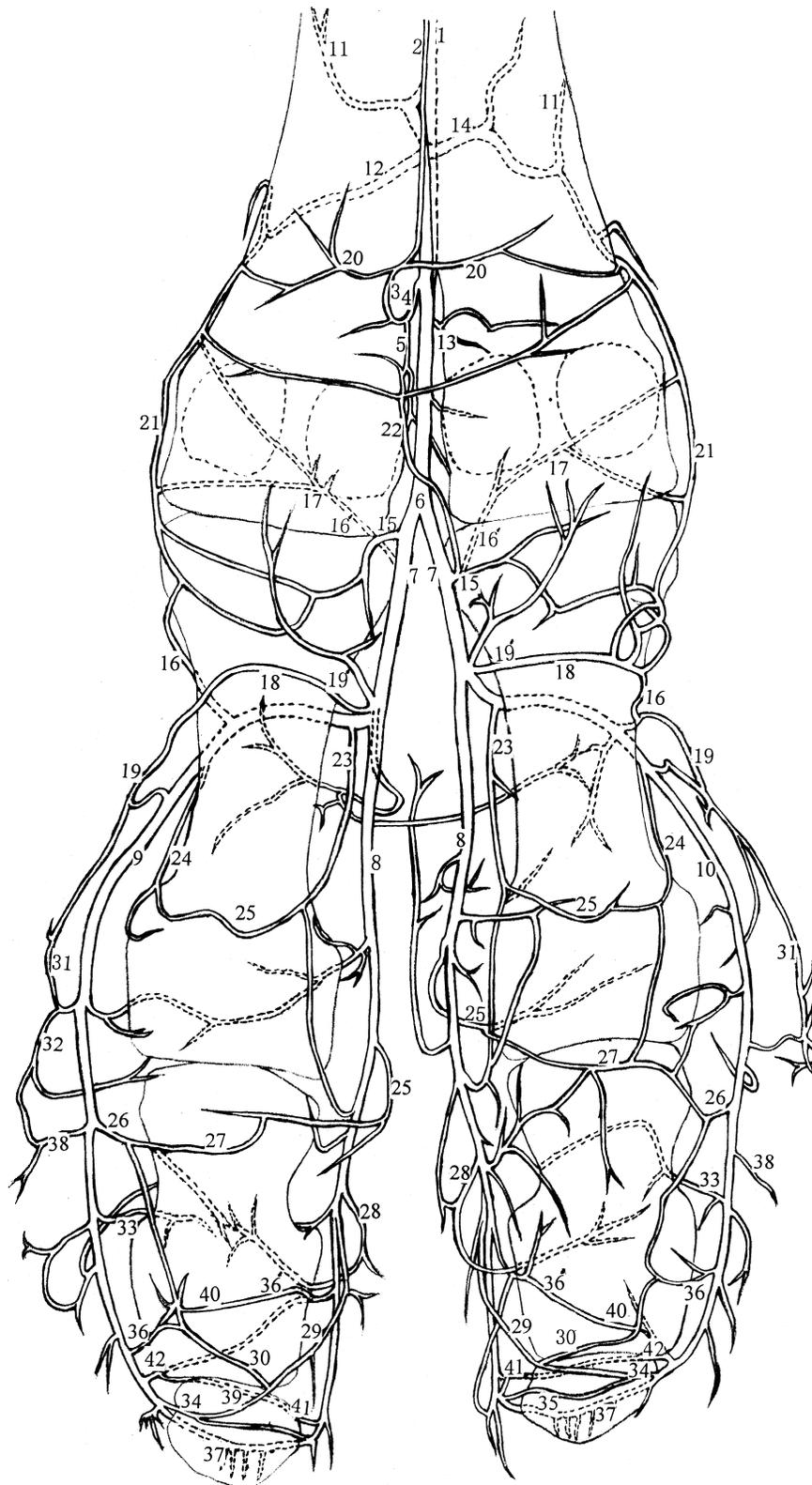


Fig. 1. Arterial blood supply to the digits of the right forelimb of the Bactrian camel; dorsal view (derived from anteroposterior radiographs and specimens). A, cannon bone (fused third and fourth metacarpal bones); B, proximal phalanx; C, middle phalanx; D, distal phalanx; 1, median artery; 2, dorsal metacarpal artery III; 3, ascending branch of distal perforating palmar branch; 4, distal perforating palmar branch; 5, descending branch of distal perforating palmar branch; 6, common palmar digital artery III; 7, medial and lateral branches of 6; 8, axial palmar proper digital arteries III and IV; 9, abaxial palmar proper digital artery IV; 10, abaxial palmar proper digital artery III; 11, cutaneous branch; 12, lateral branch of palmar metacarpal artery III; 13, palmar distal metacarpal branch; 14, medial branch of palmar metacarpal artery III; 15, distal dorsoaxial distal metacarpal branch; 16, palmoaxial proximal proximal phalangeal branch; 16', palmoaxial

injecting a solution of red oils in ether (15:1) into the same artery. One of the left-sided fresh specimens was injected with a suspension of barium sulphate in 50 % glucose (1:10) through the median artery (Figs 1, 2, 3(1)) and then an orthophoric shadowgraph was taken immediately. After these forelimbs were stored for 1 wk, the arteries supplying the digits were studied.

## RESULTS

The digits of the forelimb of the bactrian camel were supplied by the palmar metacarpal and common palmar digital arteries III. The palmar metacarpal artery III was the continuation of the deep medial proximal metacarpal branch which was a branch of the medial branch of the radial artery. It gave rise to a nutrient branch, medial branch, lateral branch and distal perforating palmar branches at the proximal end of the distal sixth of the cannon bone (fused third and fourth metacarpal bones).

The common palmar digital artery III was the continuation of the median artery (Figs 1, 2, 3(1)), which divided into medial and lateral branches. The medial branch of the common palmar digital artery III, after giving off the axial proximal proximal phalangeal branch which sometimes arose from the axial palmar proper digital artery III, divided into the axial and abaxial palmar proper digital arteries III. The axial palmar proper digital artery III gave off the dorsoaxial distal proximal phalangeal, dorsoaxial proximal middle phalangeal, dorsoaxial distal middle phalangeal, palmoaxial middle phalangeal, palmoaxial distal phalangeal, dorsoaxial distal phalangeal branches, coronal artery and some digital tori branches. The abaxial palmar proper digital artery III gave rise to the abaxial proximal proximal phalangeal, dorsoabaxial distal proximal phalangeal, dorsoabaxial middle phalangeal, palmoabaxial middle phalangeal, palmoabaxial distal phalangeal, dorsoabaxial distal phalangeal branches, coronal artery and some digital tori branches.

The supply to the fourth digit by the lateral branch of the common palmar digital artery III was similar to the supply by the medial branch to the third digit.

### *Palmar metacarpal artery III* (Figs 1, 2, 3(6))

This was the continuation of the deep medial proximal metacarpal branch which was a branch of the medial branch of the radial artery. Accompanied by the palmar metacarpal veins III and IV, it descended between the cannon bone and interosseus muscle and gave rise to the nutrient branch which entered the metacarpal bone at the distal end of the proximal 2/5 section of the cannon bone, and the medial, lateral and distal perforating palmar branches at the proximal end of the distal sixth of the cannon bone.

*Medial branch* (Figs 1, 2, 3(14)). Above the palmar diverticulum of the capsule of the metacarpophalangeal joint of the third digit, this vessel traversed abaxially between the third metacarpal bone and the interosseous muscle and then divided into the cutaneous and distal abaxial metacarpal branches (Figs 1, 3(21)). The cutaneous branch supplied the skin on the medial surface of the distal end of the metacarpus. The distal abaxial metacarpal branch ran distally between the metacarpal bone and the interosseous muscle along the abaxial surface of the diverticulum of the capsule of the metacarpophalangeal joint and supplied the diverticulum, abaxial wall, abaxial collateral ligament, abaxial sesamoid collateral ligament of the capsule of the metacarpophalangeal joint and abaxial surface of the distal end of the metacarpal bone. In addition, the distal abaxial metacarpal branch gave rise to some anastomotic branches to connect with the proximal palmoabaxial proximal phalangeal branch (Figs 1, 2(16)), abaxial to the abaxial sesamoid bone, to the distal dorsoaxial proximal metacarpal branch (Figs 1, 2(20)), dorsal to the distal end of the metacarpal bone and to the distal dorsoaxial distal metacarpal branch (Figs 1, 2(15)), abaxial to the metacarpophalangeal joint.

*Lateral branch* (Fig. (12)). This was the same as the medial branch, supplying the distal end of the metacarpus and metacarpophalangeal joint.

*Distal perforating palmar branch* (Figs 1, 2, 3(4)). This was derived from the original portions of the medial or lateral branches of the palmar metacarpal artery III. It immediately formed the superficial

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proximal proximal phalangeal branch; 17, subsesamoid arch; 18, proximal dorsal proximal phalangeal arch; 19, dorsoabaxial proximal proximal phalangeal branch; 19', dorsoaxial proximal proximal phalangeal branch; 20, proximal dorsoaxial distal metacarpal branch; 21, abaxial distal metacarpal branch; 22, interosseous distal metacarpal branch; 23, dorsoaxial distal proximal phalangeal branch; 24, dorsoabaxial distal proximal phalangeal branch; 25, distal dorsal proximal phalangeal arch; 25', dorsoaxial proximal middle phalangeal branch; 26, dorsoabaxial middle phalangeal branch; 27, dorsal proximal middle phalangeal arch; 28, palmoaxial middle phalangeal branch; 29, dorsoaxial distal phalangeal branch; 30, superficial dorsal distal phalangeal arch; 31, ascending branch of dorsoabaxial middle phalangeal branch; 32, descending branch of dorsoabaxial middle phalangeal branch; 33, palmoabaxial middle phalangeal branch; 34, dorsoabaxial distal phalangeal branch; 35, deep dorsal distal phalangeal arch; 36, dorsoabaxial distal middle phalangeal branch; 36', dorsoaxial distal middle phalangeal branch; 37, terminal arch; 38, digital torus branch; 39, coronal artery; 40, dorsal distal phalangeal arch; 41, palmoabaxial distal phalangeal branch; 42, palmoaxial distal phalangeal branch.

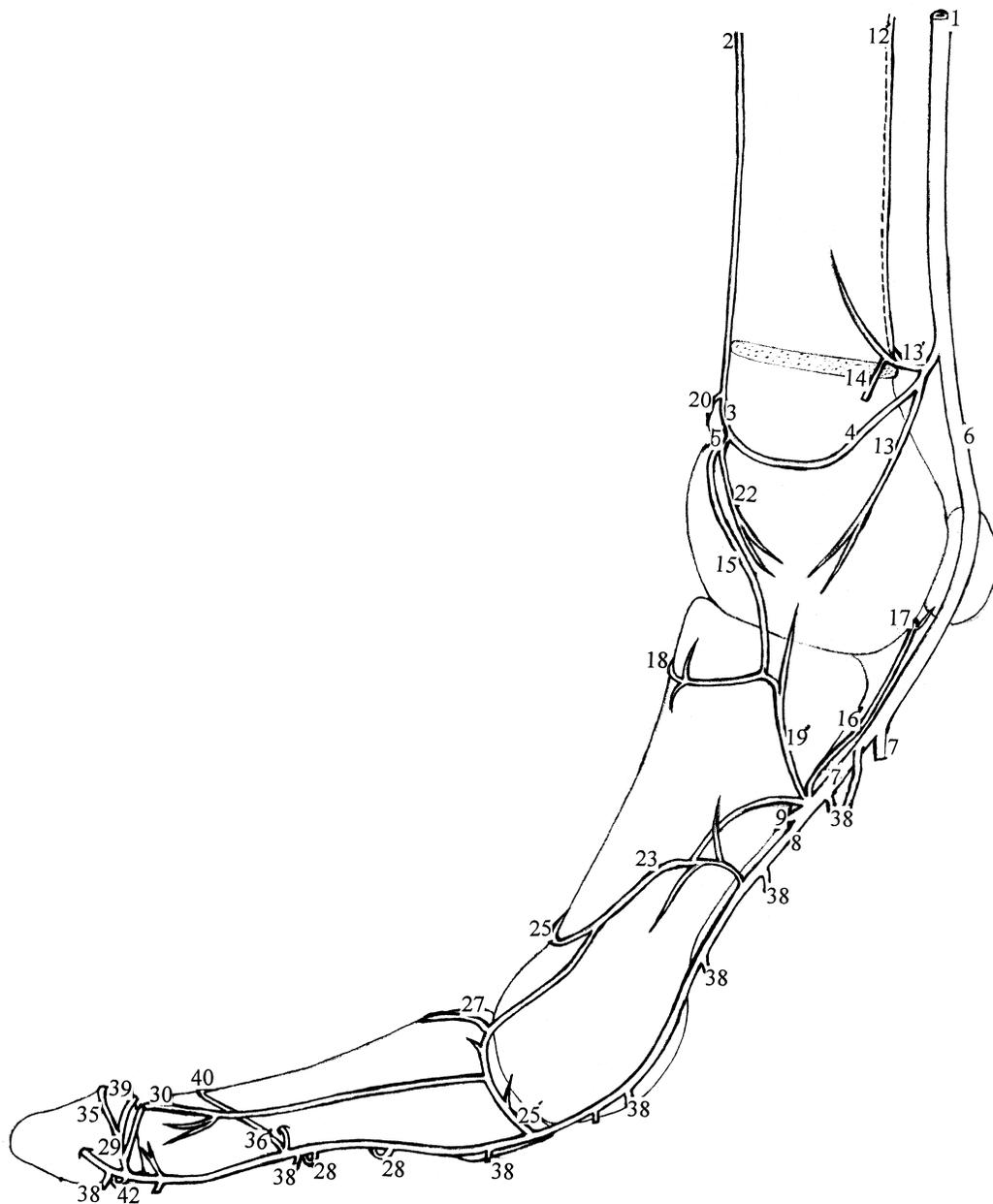


Fig. 2. Arterial blood supply to the fourth digit of right forelimb of the Bactrian camel; axial view. A, cannon bone (fused third and fourth metacarpal bones); B, proximal phalanx; C, middle phalanx; D, distal phalanx; 1, median artery; 2, dorsal metacarpal artery III; 3, ascending branch of distal perforating palmar branch; 4, distal perforating palmar branch; 5, descending branch of distal perforating palmar branch; 6, common palmar digital artery III; 7, medial and lateral branches of 6; 8, axial palmar proper digital arteries III and IV; 9, abaxial palmar proper digital artery IV; 12' palmar metacarpal artery III; 13, palmar distal metacarpal branch; 13', superficial distal metacarpal arch; 14, medial branch of palmar metacarpal artery III; 15, distal dorsoaxial distal metacarpal branch; 16' palmoaxial proximal proximal phalangeal branch; 17, subsesamoid arch; 18, proximal dorsal proximal phalangeal arch; 19', dorsoaxial proximal proximal phalangeal branch; 20, proximal dorsoaxial distal metacarpal branch; 22, interosseous distal metacarpal branch; 23, dorsoaxial distal proximal phalangeal arch; 25, distal dorsal proximal phalangeal arch; 25', dorsoaxial proximal middle phalangeal branch; 27, dorsal proximal middle phalangeal arch; 28, palmoaxial middle phalangeal branch; 29, dorsoaxial distal phalangeal branch; 30, superficial dorsal distal phalangeal arch; 35, deep dorsal distal phalangeal arch; 36', dorsoaxial distal middle phalangeal branch; 38, digital torus branch; 39, coronal artery; 40, dorsal distal phalangeal arch; 42, palmoaxial distal phalangeal branch.

palmar distal arch (Fig. 2(13')) with an anastomotic branch from the median artery between the medial and lateral branches of the digital flexor and interosseous muscle. From this, it extended distally and dorsally, arching over the palmar surface of the metacarpal bone and through the sagittal notch

(intertrochlear incisura) of the distal end of the cannon bone to divide into the ascending and descending branches, dorsal to the cannon bone. During its course, it gave off a nonpaired palmar distal metacarpal branch (Figs 1, 2(13)) which coursed distally along the palmar surface of the cannon bone



Fig. 3. Arterial blood supply to the third digit of right forelimb of the Bactrian camel; abaxial view. A, cannon bone (fused third and fourth metacarpal bones); B, proximal phalanx; C, middle phalanx; D, distal phalanx; 1, median artery; 4, distal perforating palmar branch; 6, common palmar digital artery III; 7, medial and lateral branches of 6; 8, axial palmar proper digital artery III and IV; 10, abaxial palmar proper digital artery III; 11, cutaneous branch; 12, palmar metacarpal artery III; 14, medial branch of palmar metacarpal artery III; 16, palmoabaxial proximal proximal phalangeal branch; 18, proximal dorsal proximal phalangeal arch; 19, dorsoabaxial proximal proximal phalangeal branch; 21, abaxial distal metacarpal branch; 24, dorsoabaxial distal proximal phalangeal branch; 25, distal dorsal proximal phalangeal arch; 25', dorsoaxial proximal middle phalangeal branch; 26, dorsoabaxial middle phalangeal branch; 27, dorsal proximal middle phalangeal arch; 30, superficial dorsal distal phalangeal arch; 33, palmoabaxial middle phalangeal branch; 34, dorsoabaxial distal phalangeal branch; 35, deep dorsal distal phalangeal arch; 38, digital torus branch; 39, coronal artery; 40, dorsal distal phalangeal arch; 41, palmoabaxial distal phalangeal branch.

to enter the sagittal notch (intertrochlear incisura) of the distal end of the cannon bone and then to supply the axial walls of the articular capsules and axial collateral ligaments of the metacarpophalangeal joints of the third and fourth digits. The ascending branch (Figs 1, 2(3)) lay along the longitudinal intermediate line of the dorsal surface of the cannon bone and

united with the dorsal metacarpal artery III (Figs 1, 2(2)) from the dorsal carpal rete. During its course, the ascending branch gave some small branches to supply the dorsal surface of the cannon bone and paired dorsoaxial distal proximal metacarpal branches (Figs 1, 2(20)) which ran abaxially to supply the dorsal surface of the distal end of the cannon bone and

dorsal wall of the capsule of the metacarpophalangeal joint to connect with the distal abaxial metacarpal branch. The descending branch (Figs 1, 2(5)) coursed distally in the sagittal notch of the distal end of the cannon bone and supplied the common digital extensor tendon at the proximal part of the interdigital space. On its way, the descending branch also gave off the interosseous distal metacarpal branch (Figs 1, 2(22)) to supply the axial walls of the articular capsules and axial collateral ligaments of the metacarpophalangeal joints of the third and fourth digits at the proximal portion of the sagittal notch and the paired distal dorsoaxial distal metacarpal branches (Figs 1, 2(15)) to supply the dorsal wall of the capsule of the metacarpophalangeal joint at the distal end of the cannon bone.

*Common palmar digital artery III* (Figs 1, 2, 3(6))

This vessel was the continuation of the median artery at the proximal end of the distal sixth of the cannon bone. It ran distally with the vein of the same name (dorsal), the lateral palmar digital nerve III (medial), the medial palmar digital nerve IV (lateral) and some lymphatic vessels (palmar) and then divided into medial and lateral branches.

*Medial branch of common palmar digital artery III* (Figs 1, 2, 3(7))

This branch passed towards the digital tip along the axial surface of the medial branch of the digital flexor tendon with the medial branch of the common palmar digital vein III and the lateral palmar digital nerve III in the interdigital space. After giving off the axial proximal proximal phalangeal branch (Fig. 2(19')) which sometimes arose from the axial palmar proper digital artery III (Figs 1, 2, 3(8)) at the proximal half of the proximal phalanx, it divided into the axial and abaxial palmar proper digital arteries III (Figs 1, 2, 3(8)) at the distal end of the proximal 2/5 of the proximal phalanx. The axial proximal proximal phalangeal branch gave off an anastomotic branch to connect with the abaxial proximal proximal phalangeal branch (Figs 1, 2, 3(16,19)) dorsal to the digital flexor tendon and a digital torus branch to enter the caudal end of the digital torus, and then passed proximally to divide into palmoaxial and dorsoaxial proximal proximal phalangeal branches, axial to the intermediate subsesamoid ligament. The palmoaxial proximal proximal phalangeal branch (Figs 1, 2(16')) coursed abaxially and united with the palmoabaxial proximal proximal phalangeal branch (Figs 1, 3(16)) between the digital flexor tendon and the intermediate

subsesamoid ligament, forming the subsesamoid arch (Figs 1, 2(17)) from which were given off some small branches to supply the palmar wall of the capsule of the metacarpophalangeal joint and subsesamoidean ligament. The dorsoaxial proximal proximal phalangeal branch (Figs 1, 2(19')) travelled dorsally along the axial aspect of the proximal end of the proximal phalanx, after giving off an anastomotic branch to unite with the distal dorsoaxial distal metacarpal branch. It then ran abaxially to connect with the dorsoabaxial proximal proximal phalangeal branch (Figs 1, 3(19)) on the dorsal surface of the proximal end of the proximal phalanx beneath the common digital extensor tendon, forming the proximal dorsal proximal phalangeal arch (Figs 1, 2, 3(18)). Some small branches arose from this arch to supply the dorsal wall of the capsule of the metacarpophalangeal joint and the dorsal aspect of the proximal end of the proximal phalanx.

*Axial palmar proper digital artery III* (Figs 1, 2, 3(8))

This travelled towards the digital tip in the interdigital space. It was located axial to the medial branch of the digital flexor tendon at the proximal phalanx and traversed the digital torus branch of the axial branch of the medial digital extensor tendon at the caudal section of the terminal cartilage-plate of the medial branch of the superficial digital flexor tendon. From this, it ran cranially over the axial aspect of the dorsal portion of the adipoelastic digital cushion and the axial aspect of the axial collateral ligament of the distal interphalangeal joint and then entered the distal phalanx to unite with the abaxial palmar proper digital artery III (Figs 1, 3(10)), forming the terminal arch (Fig. 1(37)). On its way, the axial palmar digital vein III was accompanied by the axial palmar digital nerve III and axial palmar digital nerve III. Additionally, the axial palmar proper digital artery III also gave off the dorsoaxial distal proximal phalangeal, dorsoaxial proximal middle phalangeal, dorsoaxial distal middle phalangeal, palmoaxial middle phalangeal, palmoaxial distal phalangeal, dorsoaxial distal phalangeal branches, coronal artery and some digital torus branches on its way.

*Dorsoaxial distal proximal phalangeal branch* (Figs 1, 2(23)). This arose from the axial palmar proper digital artery III at the distal half of the proximal phalanx, axial to the medial branch of the digital flexor tendon. After giving off the nutrient proximal phalanx branch dorsal to the medial branch of the digital flexor tendon, it passed distally, dorsally and

then abaxially along the dorsoaxial aspect of the proximal phalanx beneath the axial branch of the medial digital extensor tendon, dorsal to the axial condyle of the proximal phalanx. During its course, it gave rise to many small branches to supply the distal end of the proximal phalanx, palmar and dorsoaxial walls of the articular capsule, the axial collateral ligament of the metacarpophalangeal joint, neighbouring bone membranes and tendons, and united with the branch from the original portion of the abaxial proper palmar digital artery III. Finally, it anastomosed with the dorsoabaxial distal proximal phalangeal branch (Figs 1, 3(24)), forming the distal dorsal proximal phalangeal arch (Figs 1, 2(23)), 3(25)). It also gave off a branch to pass distally to unite with the dorsoaxial proximal middle phalangeal branch (Figs 1, 2(25')), dorsoaxial to the proximal end of the middle phalanx. The nutrient proximal phalanx branch ran proximally and dorsally over the deep surface of the axial branch of the medial digital extensor tendon to enter the axial nutrient foramen of the proximal phalanx.

*Dorsoaxial proximal middle phalangeal branch* (Figs 1, 2(25')). This detached from the axial palmar proper digital artery III at the proximal half of the middle phalanx. It ran dorsally over the deep aspects of the axial branch of the medial digital extensor tendon, the axial collateral ligament of the distal interphalangeal joint and tendon subdivisions near the axial angle of the distal phalanx and then anastomosed with the dorsoabaxial middle phalangeal branch (Figs 1, 3(26)) dorsal to the proximal end of the middle phalanx beneath the superficial branch of the common digital extensor tendon, forming an arterial arch which has been termed the proximal dorsal middle phalangeal arch (Figs 1, 2, 3(27)). In its course, it gave rise to an articular branch to supply the dorsoaxial wall of the capsule of the proximal interphalangeal joint, a cutaneous branch to supply the skin on the dorsoaxial aspect of the middle phalanx and a descending branch. The descending branch passed distally along the axial border of the dorsal (elastic) ligament and divided into superficial and deep branches at the axial condyle of the distal end of the middle phalanx. The superficial branch united with the superficial branch of the dorsoabaxial distal phalangeal branch (Figs 1, 3(34)) to form the superficial dorsal distal phalangeal arch (Figs 1, 2, 3(30)) at the distal end of the middle phalanx, dorsal to the dorsal (elastic) ligament. The deep branch supplied the dorsal wall of the capsule of the distal interphalangeal joint.

*Dorsoaxial distal middle phalangeal branch* (Figs 1, 2(36')). This was given off from the axial palmar

proper digital artery III at the proximal end of the distal third of the middle phalanx. After giving rise to the nutrient branch to the middle phalanx, it ran distally and dorsally and then connected with a branch from the dorsoabaxial middle phalangeal branch (Figs 1, 3(26)), forming the distal dorsal middle phalangeal arch (Figs 1, 2, 3(40)).

*Palmoaxial middle phalangeal branches* (Figs 1, 2(28)). These were 2 branches which arose from the axial palmar proper digital artery III at the axial condyle of the middle phalanx. They passed abaxially between the deep digital flexor tendon and middle phalanx to supply the tendon and phalanx. They also communicated with the corresponding abaxial arterial branch, palmar to the deep digital flexor tendon and middle phalanx.

*Palmoaxial distal phalangeal branch* (Figs 1, 2(42)). This was given off from the axial palmar proper digital artery III, axial to the distal interphalangeal joint. It ran abaxially between the distal interphalangeal joint and the capsule of the digital tori cushion. During its course, it gave rise to a branch to pass proximally along the axial border of the articular cartilage plate of the distal interphalangeal joint and then to unite with the palmoaxial middle phalangeal branches. Finally, it divided into 2 branches to supply the deep digital flexor tendon. These 2 branches anastomosed with corresponding abaxial arterial branches, palmar and dorsal to the deep digital flexor tendon respectively.

*Dorsoaxial distal phalangeal branch* (Figs 1, 2(29)). This vessel arose from the axial palmar proper digital artery III, axial to the distal interphalangeal joint. It traversed the surface of the axial collateral ligament of the distal interphalangeal joint. After giving off the coronal artery, it divided into 2 branches between the superficial branch of the common digital extensor tendon and dorsal wall of the capsule of the distal interphalangeal joint. One branch ran dorsoabaxially along dorsoaxial wall of the capsule of the distal interphalangeal joint, which it supplied and then united with a branch from the dorsoabaxial distal phalangeal branch (Figs 1, 3(34)), forming the superficial dorsal distal phalangeal arch (Figs 1, 2, 3(30)). Another branch entered the venous plexus of the parietal corium to supply the parietal corium and distal phalanx, and anastomosed with the corresponding abaxial arterial branch, forming the deep dorsal distal phalangeal arch (Figs 1, 2, 3(35)).

*Coronal artery* (Figs 1, 2(39)). This arose from the dorsoaxial distal phalangeal branch at the proximal end of the distal phalanx. It passed dorsally and then abaxially in the claw plica and united with the

corresponding abaxial artery, dorsal to the distal interphalangeal joint.

*Digital torus branches* (Figs 1, 2(38)). These were 6–7 branches. They were given off from the axial palmar proper digital artery III sequentially from middle portion of the proximal phalanx to the distal phalanx and ran in a palmar direction to enter the digital torus.

*Abaxial palmar proper digital artery III* (Figs 1, 3(10)). This vessel ran abaxially and penetrated between the proximal phalanx and the medial branch of the digital flexor tendon to reach to the abaxial aspect of the third digit. From there it passed cranially over the abaxial aspect of the terminal cartilage plate of the medial subdivision of the digital flexor tendon, and the dorsal portion of the adipoelastic digital cushion of the third digit and abaxial collateral ligament of the distal interphalangeal joint to enter the distal phalanx, forming the terminal arch (Fig. 1(37)). On its way, it was accompanied by the corresponding vein at the proximal phalanx and detached branches to supply the palmar wall of the capsule of the proximal interphalangeal joint and adjacent tendons and tendon sheaths. Abaxial to the third digit, it travelled with the corresponding vein and nerve and gave rise to the abaxial proximal phalangeal, dorsoabaxial distal proximal phalangeal, dorsoabaxial middle phalangeal, palmoabaxial middle phalangeal, palmoabaxial distal phalangeal and dorsoabaxial distal phalangeal branches, the coronal artery and some digital torus branches during its course.

*Abaxial proximal proximal phalangeal branch* (Figs 1, 2, 3(16 and 19)). This was given off from the abaxial palmar proper digital artery III at the middle portion of the proximal phalanx and ran proximally. After giving rise to the cutaneous branch to supply the skin on the abaxial and dorsal surfaces of the proximal phalanx, it divided into the palmoabaxial proximal proximal phalangeal branch (Figs 1, 3(16)) and dorsoabaxial proximal proximal phalangeal branch (Figs 1, 3(19)). The palmoabaxial proximal proximal phalangeal branch ran proximoaxially abaxial to the digital flexor tendon and palmar to the middle subsesamoid ligament at the proximal end of the proximal phalanx and anastomosed with the palmar branch of the axial proximal proximal phalangeal branch, forming the subsesamoid arch (Figs 1, 2(17)). The dorsoabaxial proximal proximal phalangeal branch passed dorsoproximally abaxial to the proximal end of the proximal phalanx. After detaching an anastomotic branch to unite with the distal dorsoaxial distal metacarpal and abaxial distal meta-

carpal branches, it travelled dorsally beneath the branch of the common digital extensor tendon and anastomosed with the dorsoaxial proximal proximal phalangeal branch on the dorsal aspect of the proximal end of the proximal phalanx, forming the proximal dorsal proximal phalangeal arch (Figs 1, 2, 3(18)).

*Dorsoabaxial distal proximal phalangeal branch* (Figs 1, 3(24)). This branch arose from the abaxial palmar proper digital artery III at the distal half of the proximal phalanx and ran dorsodistally, curving along the dorsoabaxial aspect of the proximal phalanx beneath the medial branch of the medial digital extensor tendon. In its course, it gave off many branches to supply the palmar and dorsoabaxial walls, abaxial collateral ligament of the capsule of the proximal interphalangeal joint and adjacent periosteum and tendon sheaths. Finally, it united with the dorsoaxial distal proximal phalangeal branch dorsal to the distal end of the proximal phalanx, forming the dorsal distal proximal phalangeal arch (Figs 1, 2, 3(25)).

*Dorsoabaxial middle phalangeal branch* (Figs 1, 3(26)). This branch arose from the abaxial palmar proper digital artery III on the abaxial aspect of the proximal half of the middle phalanx. It passed dorsoaxially and traversed the deep aspect of the tendinous slip from the middle branch of the medial digital extensor tendon which ran towards the abaxial condyle of the middle phalanx and abaxial angle of the distal phalanx. It then anastomosed with the dorsoaxial proximal middle phalangeal branch on the dorsal aspect of the proximal end of the middle phalanx, forming the proximal dorsal middle phalangeal arch (Figs 1, 2, 3(27)). In addition, it gave off ascending and descending branches. The ascending branch (Fig. 1(31)) passed dorsocaudally and entered the dorsoabaxial wall of the capsule of the proximal interphalangeal joint beneath the subdivision of the medial digital extensor tendon which ran towards the abaxial condyle of the middle phalanx and abaxial angle of the distal phalanx. Also beneath the same tendinous subdivision, the descending branch (Fig. 1(32)) ran distally to supply the abaxial collateral ligament and the capsule of the distal interphalangeal joint and gave rise to a branch to unite with the dorsoaxial distal middle phalangeal branch to form the distal dorsal middle phalangeal arch (Figs 1, 2, 3(40)).

*Palmoabaxial middle phalangeal branch* (Figs 1, 3(33)). These were 2 branches which were given off from the abaxial palmar proper digital artery III at

the middle portion and abaxial condyle of the middle phalanx respectively. They all passed axially to supply the palmar aspect of the middle phalanx and deep digital flexor tendon. They also communicated with the corresponding axial arterial branch, palmar to the deep digital flexor tendon and middle phalanx.

*Palmoabaxial distal phalangeal branch* (Figs 1, 3(41)). This arose from the abaxial palmar proper digital artery III, abaxial to the distal interphalangeal joint and passed axially between the distal interphalangeal joint and capsule of the digital torus cushion. After giving off a branch to pass proximally along the abaxial border of the articular cartilage plate of the distal interphalangeal joint to connect with the palmoabaxial middle phalangeal branches (Figs 1, 3(33)), it divided into 2 branches to supply the deep digital flexor tendon and to anastomose with the corresponding axial arterial branch, palmar and dorsal to the deep digital flexor tendon respectively.

*Dorsoabaxial distal phalangeal branch* (Figs 1, 3(34)). This detached from the abaxial palmar proper digital artery III, abaxial to the distal interphalangeal joint. It passed dorsoaxially and traversed the surface of the abaxial collateral ligament of the distal interphalangeal joint to divide into superficial and deep branches. The superficial branch united with the dorsoaxial proximal middle phalangeal branch dorsal to the dorsal (elastic) ligament beneath the skin, forming the superficial dorsal distal phalangeal arch (Figs 1, 2, 3(30)). The deep branch anastomosed with a branch of the dorsoaxial distal phalangeal branch between the superficial branch of the common digital extensor tendon and dorsal (elastic) ligament, forming the deep dorsal distal phalangeal arch (Figs 1, 3(35)).

*Coronal artery* (Figs 1, 3(39)). This arose from the abaxial palmar proper digital artery III and occasionally from the dorsoabaxial distal phalangeal branch at the proximal end of the distal phalanx. It passed dorsally and then axially in the claw plica and united with the corresponding axial artery, dorsal to the distal interphalangeal joint.

*Digital tori branches* (Figs 1, 3(38)). These were 7–9 branches which were given off from the abaxial palmar proper digital artery III sequentially from the middle portions of the proximal phalanx to those of the distal phalanx. They ran in a palmar direction and entered the digital tori.

*Lateral branch of the common palmar digital artery III* (Figs 1, 2, 3(7))

Its origin, course, branching pattern, supply, etc. in the fourth digit were similar to those of the medial

branch of common palmar digital artery III in the third digit.

#### DISCUSSION

The present study has shown that the arterial supply to the forelimb digits of the Bactrian camel originates from the palmar metacarpal and common palmar digital arteries III. Smuts & Bezuidenhout (1987) reported that the arterial supply to the digits of the dromedary arises from the common palmar digital artery II and dorsal and palmar metacarpal arteries III. In the ox, the palmar metacarpal arteries II, III and IV, dorsal metacarpal artery III and palmar common digital arteries II, III and IV all give off the branches to supply the digits (Getty, 1975). It has been found that the digits are supplied by the palmar and dorsal metacarpal arteries III and palmar common digital artery III in the water buffalo (Human Research Group, 1984). Xie (1987) reported that the dorsal metacarpal arteries II and III, palmar metacarpal artery III and palmar common digital artery II give off the branches to supply the carpal joint in the horse and donkey.

The axial and abaxial palmar proper digital arteries III of each digit (the third and fourth digits) of the forelimbs of the bactrian camel respectively give rise to 6–7 and 7–9 digital torus branches to supply the digital tori, which were not reported in the dromedary. It was due to the fact that the Bactrian camel has massive digital tori (in particular, there were 3 massive adipoelastic digital cushions in the camel's digital tori). This is one of the adaptations of the camel to arid conditions (Cui-Yan, 1996) and the need for a greater blood supply. The digital tori were less massive in the ox, water buffalo, horse or donkey than in the camel, so there were only a few digital tori branches in these species.

#### ACKNOWLEDGEMENTS

The authors thank Professor Zheng-ming Xie for his expert direction.

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