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Source artery of the dorso-cranial part of subcutaneous structures in the rat trunk

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Abstract

PURPOSE: This study aimed to confirm the source artery of dorso-cranial part of subcutaneous structures in the rat trunk. METHODS: Three Wistar rats were dissected and the distribution of the source artery to the subcutaneous layer in question was pursued macroscopically. RESULTS: The lateral thoracic artery (LT) arose from the axillary artery. It divided into three, i.e. ventral, intermediate, and dorsal branches. The dorsal branch distributed the cranial part of the dorsum and anastomosed with the contralateral counterpart. The thoracodorsal artery (TD) arose from the subscapular artery and furcated into the dorsal muscle branch and the superficial branch. The latter supplied small area cranial to the cutaneus trunci muscle. CONCLUSION: The main source artery of the dorso-cranial subcutaneous structures of the rat trunk was the dorsal branch of the LT, whereas the superficial branch of the TD supplied minor area. The anatomical knowledge about the source artery in the focused region would improve the animal skin experiment intended to the wound healing and flap design.

Key words: skin, wound healing, lateral thoracic artery, thoracodorsal artery, angiosome

Introduction

With the advent of super-aged society in Japan and other advanced countries, the skin wound including pressure ulcer has become increasingly a serious issue requiring nursing care and/or medical attendance in the clinical setting[1)]. To handle and overcome it, many animal experiments have been conducted in pursuing of pathogenic mechanism[2,3)], validation of medical agents[4,5)], development of the artificial skin[6,7)], efficient position change[8)], and so forth. One and significant matter of the wound healing functions is the source artery of the subcutaneous structures[9,10)].

A variety of laboratory animals has been used substituting for the human. Nevertheless, we must note the morphological difference between the animals and the human in performing the skin experiment. A typical structure is the cutaneus trunci muscle (CTM) that the human never possesses[11–13)]. In association with the CTM, the vascular distribution under the skin of the most mammals is quite different from that of the human.

Partitioning the subcutaneous dorsum of the mammals into three parts, general account is that the middle and caudal parts are supplied by the posterior intercostal and deep circumflex iliac arteries, respectively[12–15)]. However, different two arteries are supposed to be a source artery of the cranial part. One is the thoracodorsal artery (TD)[15–17)], and another is the lateral thoracic artery (LT)[18–21)]. Although their origin and

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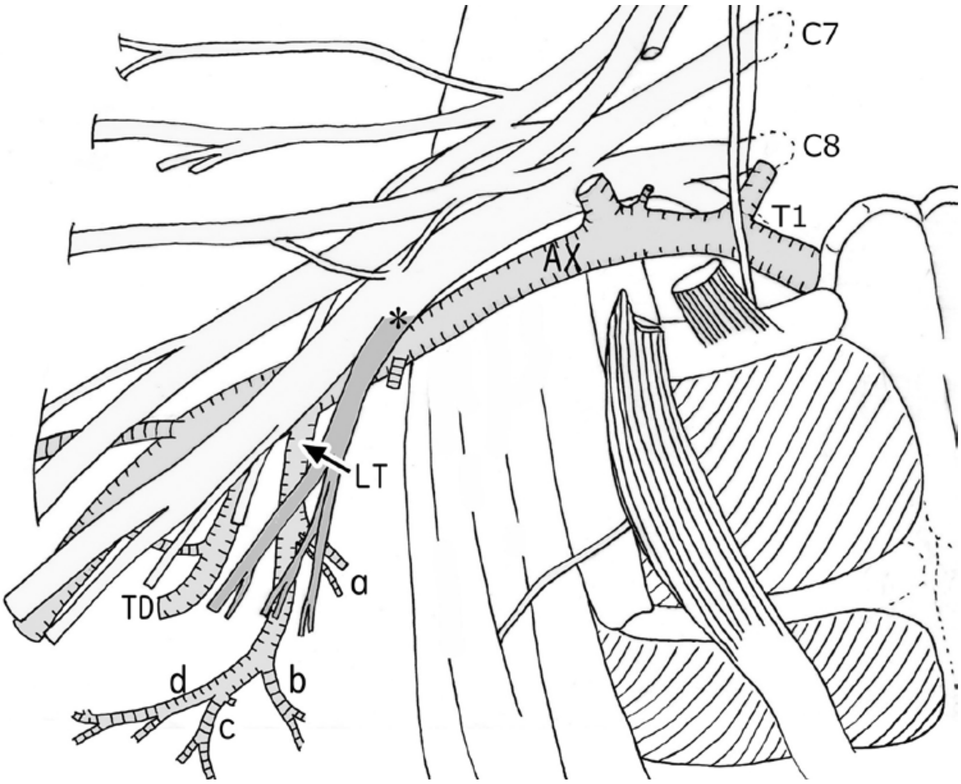

Fig.1 Schematic diagram of the branches arising from the axillary artery and the brachial plexus (right, ventral view).
AX, axillary artery; C7, C8, and T1, nerve roots of the brachial plexus; LT, lateral thoracic artery; TD, thoracodorsal artery; a-d indicate the branches of the LT: a, branch to the deep pectoral muscle; b, ventral branch; c, intermediate branch; d, dorsal branch.

distribution are essentially different, there is certain confusion in the literatures from 1990s[15,22,23]. In this study, we aimed to confirm the source artery of dorso-cranial part of the subcutaneous structures in the rat trunk, and to clean up the confusion for avoiding the erroneous procedure during the mammal skin experiment.

Materials and Methods

The animals used in this study were three male Wistar rats of 8 weeks of age. They were sacrificed for the control experiment of cerebral arteries by Dr. S. Okuyama[24] in 2004. After that, the dead bodies were handed us from him for exhaustive utilization of animal resources. Immersed in 10% formalin solution for enough fixations, the dermis was excised and the subcutaneous arteries were macroscopically pursued. The anatomical nomenclature of arteries and muscles followed the Nomina Anatomica Veterinaria Japonica[25] and Ura[26].

The study was performed pursuant to the experimental protocol of the Institutional Animal Care and Use Committee of Kagoshima University (No. M08015).

Results

The origin and course of the source arteries were detected first for the LT and then the TD. The morphology of the arteries was almost common to six sides. The peripheral courses of the accompanying vein revealed a close resemblance with the artery examined.

1. Lateral thoracic artery (LT)

From the the axillary artery (AX) distal to the branching point of the external thoracic artery, the LT arose with significant thick and ran caudally accompanying the caudal thoracic nerve (Fig.1). The main trunk of the LT divided into three branches, i.e. ventral, intermediate, and dorsal branches (Fig.2). The ventral branch supplied the pectoralis abdominalis and the humeroabdominalis muscles[26]. The intermediate branch descended in the flank along the inner surface of the ventral portion of the humerodorsalis muscle. It gave off three to five twigs perforating the CTM to course caudo-laterally. The continuation of the intermediate branch finally anastomosed with the superficial inferior epigastric artery at the hypogastric region. The main trunk of the LT continued into the dorsal branch that ran toward the dorsum. In a short distance

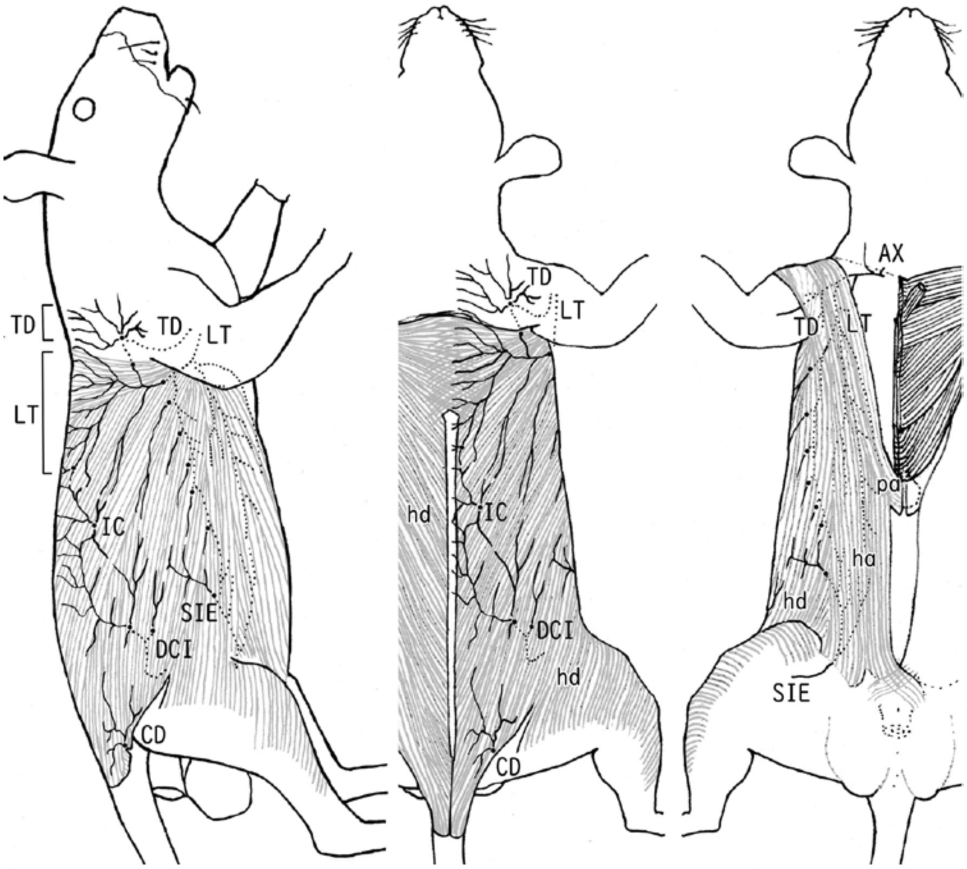

Fig.2 Sketches showing the arterial branches distributing to the subcutaneous layer of a male rat (right lateral, dorsal, and ventral views). The cutaneus trunci muscle (CTM) was shown with the fine lines in gray. The solid lines over the CTM indicate the arterial branches superficial to the CTM. The dotted lines indicate the courses deep to the CTM. The black circlets show the perforating points of which the superficial branches emerge. In the lateral view, the vascular territories of the LT and TD are shown roughly with brackets.
AX, axillary artery; CD, lateral caudal artery; DCI, deep circumflex iliac artery, IC, posterior intercostal arteries, LT, lateral thoracic artery; SIE, superficial inferior epigastric artery; TD, thoracodorsal artery; ha, humeroabdominalis muscle; hd, humerodorsalis muscle; pa, pectoralis abdominalis muscle.

caudal to the axilla, it perforated the CTM to appear in the most superficial layer. Then, two twigs were given off caudo-laterally along the muscular fascicles of the CTM and anastomosed peripherally with the posterior intercostal arteries. The transverse twig of the dorsal branch directed the midline and anastomosed with the counterpart of the contralateral side to form ladder-like arterial network. A cranialward twig from the dorsal branch anastomosed with a twig from the superficial branch of the TD around the cranial margin of the CTM as described below.

2. Thoracodorsal artery (TD)

The subscapular artery arose caudo-dorsally from the AX just distal to the origin of the LT. The main trunk of AX did not pierce the brachial plexus in the rats and continued into the brachium. The subscapular artery gave off the circumflex scapular artery at a point lateral to the teres major muscle and became named as the TD (Fig.1). It bifurcated into the muscular branch (to the latissimus dorsi, ventral serrate, and other muscles) and the superficial branch near the caudal angle of the scapula. After giving off the dorsonuchalis muscle[26] branch, the superficial branch emerged in the subcutaneous layer. At the midpoint of the scapula, it arched over the cranial margin of the latissimus dorsi muscle and the terminal twigs radiate out in the subcutaneous layer cranial to the CTM (Fig.2). A twig penetrating the CTM near its cranial margin was bound with a cranialward twig from the dorsal branch of the TL.

Discussion

A comparative anatomical study of the subcutaneous vasculature from the view point of wound healing and flap preparation was made intensively by the Taylor and Minabe[15]. They conducted it to reinforce the "Angiosome" concept[9,10]. The angiosomes are anatomic territories of the skin and underlying deep tissues supplied by the source vessels. They classified the animals into three categories in relation to the skin-mobility, i.e. fixed (represented by pig), intermediate (monkey and dog), and loose (rabbit) skin. The body integument (skin and subcutaneous tissue) of the fixed-skin animal was mainly supplied by numerous small perforators[15)]. In contrast, that of the loose-skin animal was characterized by the long and axial vascular trunk formed between the deep circumflex iliac and the thoracodorsal vessels dorsally, and between the superficial inferior epigastric and the lateral thoracic vessels ventrally. The rat was classified into the loose-skinned category by them. However, in depicting angiosome on the rat body, Taylor and Minabe[15)] probably mistook the dorsal branch of the LT for a branch of the TD. This error was remained until at least recent years[17)]. The angiograms which they used were powerful method, whereas it makes the relationship unclear whether an artery runs superficially or deep to the CTM[18,19)]. In other articles, the LT was attributed to the dominant source artery of the dorso-cranial part of the subcutaneous structures in the rat trunk[18–21)] as described in this study. Anyway, the TD is the minor source supplying a dorso-cranial subcutaneous region of the rat.

It is apparently true that the LT is more developed in most mammals than the human corresponding to the extension of the CTM from the humerus toward the whole body through the axilla. Accordingly, the muscles belonging to the ventral segments of the trunk like the pectoral muscles and the CTM are essentially supplied by the LT[18,19)]. Meanwhile, the TD distributes in the muscles derived from the dorsal segments like the latissimus dorsi and dorsonuchalis muscles[20,26)]. For a better understanding of the vascular distribution in the integument, further study is necessary because the development of the CTM would influence the skin mobility. Hitherto there has not been any attention from such a viewpoint. The recovery of the blood supply is crucial to the healing of skin wound. Similarly, engraftment of a skin flap is dependent on the revascularization or dilatation of the blood vessels. At all, the anatomical knowledge about the source artery in the focused region would improve the animal skin experiment intended to such medical and nursing issues[27,28)].

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