ORIGINAL ARTICLE

Arterial anatomy of subdermal plexus of the face

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(Received for publication on November 13, 2000)

Abstract. The subdermal plexus of the face was angiographically investigated using ten fresh cadavers injected with a radio-opaque lead oxide-gelatin mixture over the entire body. The subdermal vessels were unique in each region of the face, and the author classified the vessels into three kinds according to their running forms, shape of their skin territories, and arrangement of the territories. A kind of line by anastomoses of the subdermal vessels which are mutually adjacent or by the quite elongated subdermal vessels was observed. The line depicted by those vessels almost coincided with the relaxed skin tension lines. The author believes that when local flaps in the face are utilized, the flaps should be better designed along the line to obtain better blood supply and aesthetic outcome. (Keio J Med 50 (1): 31–34, March 2001)

Key words: arterial anatomy, angiogram, face, subdermal plexus, relaxed skin tension lines

Introduction

Local flaps on the face are usually elevated above the muscles of either facial expression or the superficial musculoaponeurotic system in order to prevent injury of the facial nerve. Therefore, the blood supply to the flaps is almost dependent upon the subdermal plexus. To raise the flaps safely, a thorough understanding of flap vascular anatomy is imperative, however the anatomical detail of the subdermal vessels has remained unknown. Although arterial anatomy encompassing the entire body has been angiographicaly investigated in detail, previous angiographic studies have generally treated the skin and underlying soft tissue as a mass and therefore were not designed to examine the subdermal vessels.[1–3]

The blood vessels in the skin form some plexus. The subdermal or cutaneous plexus is considered to be the junction between the deep reticular portion of the dermis and the underlying subcutaneous fat tissue.[4] From the superficial side of the subdermal plexus, numerous arterioles run upward to form the dermal plexus. The subepidermal or subpapillary plexus, the most superficial plexus in the skin exists in the papillary-reticular border of the dermis. Although the dermal plexus has been considered in the reticular layer of the dermis, some investigators[5,6] didn't describe the existence of the plexus as being independent and considered it as part of the subdermal plexus. Terminology of the plexus in the deep part of the dermis is controversial. An appropriate demonstration and explanation for the subdermal and dermal plexus have not been realized.

Recently, Imanishi *et al.*[7] investigated the arterial anatomy of the subdermal plexus in the lower back area and clearly demonstrated the existence of the subdermal plexus in their preliminary report. They also found that the subdermal plexus did not show uniform vasculature, but it did have directionality, which must be taken into account when raising a thin flap. In this time, the author has built upon their studies and focused on the arterial anatomy of the face. The purpose of the study is to elucidate the arterial anatomy of the subdermal plexus in the face.

Materials and Methods

Ten fresh cadavers with ages ranging from 56 to 92 years at the time of death were studied. The cadavers were dedicated to the Department of Anatomy, Keio University for basic research. Four cadavers were female, and six were male. Lead oxide-gelatin mixture was injected over the entire body.[8] The skin and underlying soft tissue of the head and neck were elevated, and the specimen was radiographed. Dissection was performed under the dermis and was then divided into two layers which included the skin (including the epi-

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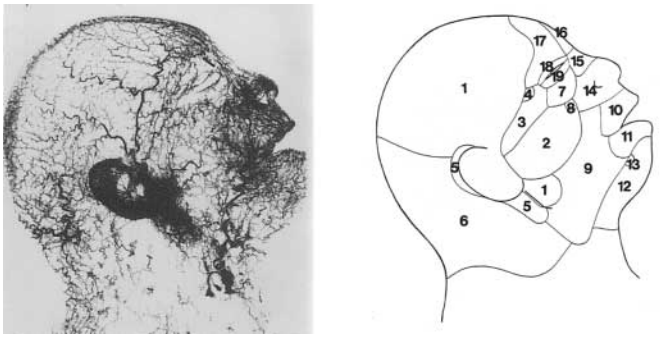

Fig. 1 Fresh cadaver arterial study of the face. The specimen included the skin and underlying soft tissue of the head and neck. (Left) Arteriogram of the lateral view of the right face and (Right) Schematic picture of the skin territories. 1. superficial temporal artery. 2. transverse facial artery. 3. zygomaticoorbital artery. 4. zygomaticotemporal artery. 5. posterior auricular artery. 6. occipital artery. 7. infraorbital artery. 8. zygomaticofacial artery. 9. facial artery. 10. superior labial artery. 11. inferior labial artery. 12. submental artery. 13. mental artery. 14. angular artery. 15. dorsal nasal artery. 16. supratrochlear artery. 17. supraorbital artery. 18. superior palpebral artery. 19. inferior palpebral artery.

dermis and dermis), and the subcutaneous adipose tissue. The superficial specimen including the skin with the various amount of the subdermal fat tissue was also radiographed. The stem vessels for the subdermal plexus were determined, and the structure of the subdermal plexus was observed.

Results

The blood supply of the face was provided by many branches of the internal and external carotid artery. Angiographic study revealed the rich anastomotic vascular networks that occur in the scalp between the occipital, posterior auricular, and superficial temporal branches of the external carotid artery and the supratrochlear, and supraorbital, and dorsal nasal branches of the internal carotid artery (Fig. 1). The subdermal plexuses are formed by the terminal portions of these branches (Fig. 2).

The vessels forming the subdermal plexus were unique in each region of the face. Upon analysis, those vessels appeared to be grouped into three kinds (Fig. 3). In the cheek, lower lip, jaw and posterior neck, three or four subdermal vessels which had branched off from a subcutaneous perforator were considerable in length. Each skin territory of the subdermal vessels showed an elliptical shape, and those territories were arranged in a spoke-like fashion (Fig. 3, Left). In the parietal, frontal, palpebral, posterior auricular regions, nasal alar, nasal dorsum, and upper lip, the subdermal vessels were also quite elongated. Each skin territory of the subdermal vessels showed a further long elliptical shape or a large elliptical shape, and those territories were arranged

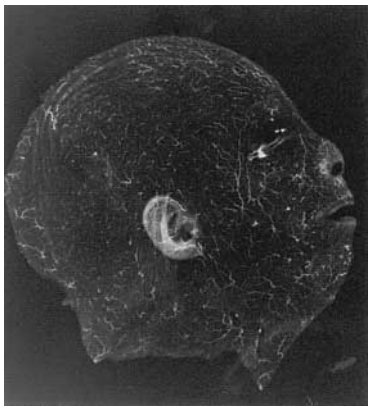

Fig. 2 Arteriogram of the superficial layer which includes the epidermis and dermis of the face. The subdermal plexuses were demonstrated. The ear includes a whole layer.

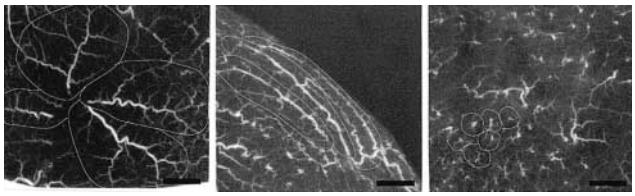

Fig. 3 Three kinds of the subdermal vessels. The vascular territory for one subdermal vessel is depicted by an enclosed circle. The scale is a one-centimeter long. (Left) Vessels showing an elliptical skin territory arranged in a spoke-like fashion. (Center) Vessels showing an elliptical skin territory arranged parallel. (Right) Vessels showing a small and circular skin territory.

parallel (Fig. 3, Center). In the occipital, temporal regions, red lip, nasal tip, and eyebrow, the subdermal vessels radiated at the subdermal layer and their branches were running short way. Each skin territory of the subdermal vessels was small and circular in shape (Fig. 3, Right). Although there were differences in the distribution of the three kinds of the subdermal vessels among individuals, a typical distribution was shown in Fig. 4A.

On the other hand, a kind of line appeared partially by relatively large anastomoses of the adjacent subdermal vessels or by the quite elongated subdermal vessels themselves. The lines were longitudinal in the midline of the anterior face, horizontal in the cheek, palpebral, mental and lateral regions to the eyebrow, and oblique, in the nasolabial fold and jaw. A schematic drawing of these lines was shown in Fig. 4B.

Discussion

In this study systemic injection of lead oxide mixture was used for analysis of the arterial circulation in fresh

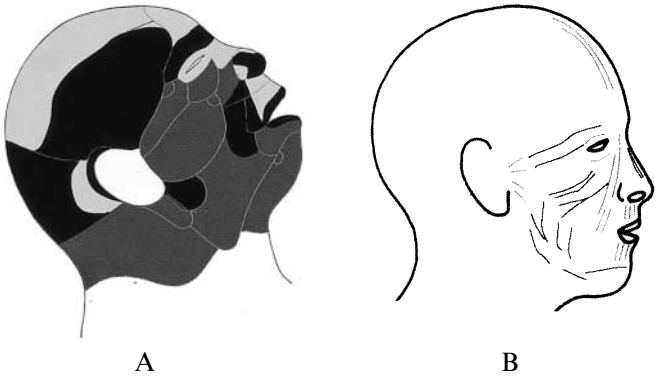

Fig. 4 A) Distribution of the three kinds of the subdermal vessels. Dark gray area: Vessels showing an elliptical skin territory arranged in a spoke-like fashion. Light gray area: Vessels showing an elliptical skin territory arranged parallel. Black area: Vessels showing a small and circular skin territory. B) Lines by the subdermal vessels.

Fig. 5 Distribution of the three kinds of the subdermal vessels by Whetzel and Mathes. Dark gray, Light gray and Black areas show the same meaning in the figure 4A. White area: type of the subdermal vessels is uncertain.

human cadaver.[8] In comparison to local injection, systemic injection produces sharp radiographs with high contrast and detail.

This study showed that the structure of the subdermal plexus was angiographically varied in each region of the face. The vascular territories defined by each subdermal plexus anastomose with one another to form the continuous vascular networks. Those connections between the territories were formed by reduced caliber, choke anstomoses, in the face and the scalp area as described by Houseman, *et al.*[9] True anastomoses (i.e. the connection without change in caliber) have not been seen between the territories of the facial skin in this study.

Angiographically distinct three patterns of the subdermal vascularization were observed in the head and neck area. A typical distribution of vascular pattern was obtained, but there were differences in the distribution among the cadavers. Although characteristics of the subdermal vessels were almost consistent from region to region, the size of each vascular territory varies. Mapping of the subdermal vascular territory can be made by comparing several specimens.

Previous studies have not demonstrated a variety of detail in the subdermal vessels.[1,10–13] However, Whetzel and Mathes[14] identified three different groups of the vascular territories by macroscopic subdermal dissection. The transverse facial territory was supplied by one or two subcutaneous perforators which branched upon reaching the subdermal plexus into large and long terminal branches. The submental territory was also supplied predominantly by one perforator that characteristically branched three to four times to supply separate subcutaneous islands of dermis. The musculocutaneous blood supply in the anterior face reached the dermis by means of hundreds of small perforators that terminated in a fine reticular pattern characterized by the labial artery territories. The fasciocutaneous supply to the scalp was also characterized by a dense subdermal vascular plexus supplied by hundreds of small subcutaneous perforators. The distribution of the subdermal vessels described by Whetzel and Mathes[14] was depicted in Fig. 5, although they did not refer to many regions in the face and scalp. In this study, all the areas in the face were angiographically investigated and it was found that the subdermal vessels were divided into three different distinct groups as Whetzel and Mathes had pointed out. However, there were many differences between the author's findings and their's (See Figs. 4A and 5). Different level of subdermal dissection while preparing the specimens may contribute to the differences. The skin was separated just below the dermis in this study while the specimens were excised in the subdermal plane by Whetzel and Mathes. As a result of the difference in dissectional planes, the subdermal vessels may show different morphology even within the same region.

This study provides additional data that local skin flaps in the face include the subdermal vessels along the flap and there is a possibility of thinning of the flaps. The midline forehead flap[1,15] can be raised on a narrow pedicle which includes two supratrochlear and dorsal nasal arteries. Although the flap is elevated in the subgaleal plane at the proximal portion, thinning of the flap is possible in the upper half of the forehead. The frontalis muscle and the subcutaneous tissue beneath the dermis may be removed from the distal half of the flap because the numerous fine branches of the arteries lie in the subdermal layer, which was demonstrated in Fig. 2. The nasolabial flap[1,15] is generally marked

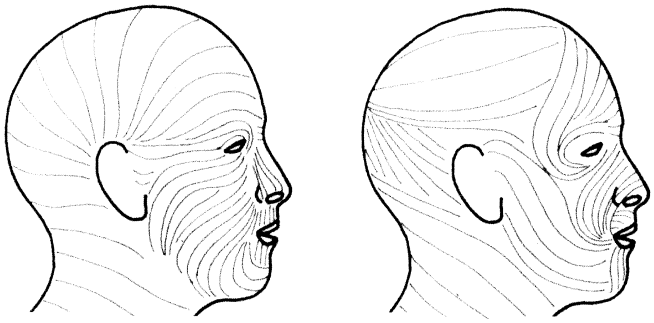

Fig. 6 Kraissl's line (left) and Langer's cleavage line (right).

over the nasolabial fold and dependent on the numerous subdermal branches given off by the facial, angular artery and dorsal nasal artery. Those branches are also illustrated in Fig. 2 and they run parallel to the source arteries in the subdermal plane of the nasolabial fold. The lateral orbital flap[16] is the subcutaneously-pedicled flap and includes the skin between the lateral orbital wall and auricle. The flap is based on the branches of the zygomaticofacial artery. In the arteriogram of the skin specimen we demonstrated that the rich subdermal vascular networks exist in the area lateral and inferior to the eyelid which are contributed by the branches of the zygomaticofacial, the zygomaticoorbital and the transverse facial artery. The flap may be raised for eyelid or socket reconstruction as the subcutaneously-pedicled flap inferomedially or superomedially.

The subdermal plexus presented a kind of line by anastomoses with neighboring vessels or by an elongated pathway of the subdermal vessels themselves. This line is considered to be equal to a kind of an axiality in a previous study.[7] The surface of the skin and its deeper structure show various ''skin lines''. Skin creases, flexure lines and papillary ridge etc are externally visible skin lines, and Langer's cleavage lines and Kraissl's lines are detectable after manipulation or incision[17] (Fig. 6). Among these lines, Kraissl's lines (relaxed skin tension lines) are applied to minimize postoperative scarring in the field of plastic surgery. The lines by the subdermal vessels approximately coincided with Kraissl's lines except for the forehead area.

These anatomic data play an important role when designing incisions or raising local flaps. Local flaps on the face are usually designed as preventing suture lines from standing out, and blood supply to the flaps is not usually taken in account. Local skin flaps in the head and neck may be raised safely due to the high density of the subdermal plexus of the face. This study shows that a rich subdermal anastomosis of vessels provides the superb blood supply to these flaps. In conclusion, when a local flap with a large length to width ratios is elevated in the face, the long axis of the flap should better be designed along Kraissl's lines in order to incorporate the subdermal vessels in the flap.

Acknowledgments: I wish to express my gratitude to Dr. Tatsuo Nakajima of the Department of Plastic and Reconstructive Surgery, School of Medicine, Keio University for his valuable advice. I also gratefully acknowledge the help of Dr. Hideo Nakajima of the Department of Plastic and Reconstructive Surgery and Dr. Nobuaki Imanishi and Dr. Sadakazu Aiso of the Department of Anatomy, School of Medicine, Keio University for their useful information and technical advice.

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