The Cutaneous Cervical Plexus Nerves of the Crab-eating Macaque (Macaca Fascicularis), Eastern Grey Kangaroo (Macropus Giganteus), and Koala (Phascolarctos Cinereus)

By

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Summary: The origin, course and distribution of the cutaneous nerves of the cervical plexus were examined in the crab-eating macaque (4 body-halves), the grey kangaroo (5 body-halves) and koala (3 body-halves). The cutaneous nerves, n. auricularis magnus, nn. supraclaviculares, n. transversus colli, and n. transversus cervicis, were recognized. Cranial and caudal branches were identified in the latter 2 nerves. Some intermediate, relatively small branches were recognized between these main nerves. The n. occipitalis minor was not recognized in all our specimens. Four segmental nerves, C2 to C5, gave rise to all the cutaneous nerves and branches of the cervical plexus described. However, between species there was some variation. In the crab-eating macaque the n. auricularis magnus and n. transversus colli tended to arise from a lower segment than in the grey kangaroo and koala. In the grey kangaroo the nn. supraclaviculares arose from a lower segment than in the crab-eating macaque and koala.

The cutaneous nerves of the cervical plexus in mammals have been reported by some authors (Kohlbrugge, 1898; Bolk, 1902; Hartman and Straus, 1933), but few detailed observations of the cutaneous nerves are available for comparative anatomical study. The aim of this investigation is to describe the origin and distribution of the cervical cutaneous nerves in the crab-eating macaque, grey kangaroo, and koala.

Materials and Methods

Four body-halves taken from 2 crab-eating macaques (1 male, 1 female), 5 body-halves from 4 eastern grey kangaroos (1 male, 3 females) and 3 body-halves from 2 male koalas were used for this study. All except one young koala were adults. The eastern grey kangaroos were collected in New South Wales, Australia, by commercial hunters under license from the National Parks and Wildlife Service of N.S.W., and the bodies of the koalas were made available by the Service after their death from natural causes.

The specimens were fixed in 10% formalin and stored in 50% alcohol. All the specimens were dissected in situ. The nerves were followed from their origin to their distribution in the skin. Particular attention was paid to their topographical relationships.

Observations

1. Comments on terminology
   Nomina Anatomica (5th ed.) lists 4 cutaneous nerves: the n. occipitalis minor, n. auricularis magnus, n. transversus colli, and nn. supraclaviculares. Nomina Anatomica Veterinaria (3rd ed.) lists the latter three but not the n. occipitalis minor. In addition, Braus and Elze (1960) used the name, n. transversus cervicis, for the branch which supplies the latero-ventral skin over the cervical portion of the trapezius in man.

   Four nerves were described in the specimens:
   N. auricularis magnus
   N. transversus colli
   Nn. supraclaviculares
     N. supraclaviculis ventralis
     N. supraclaviculis intermedius
     N. supraclaviculis dorsalis
   N. transversus cervicis
Moreover, 2 branches, cranial and caudal, were recognized in both the n. transversus colli and the n. transversus cervicis. Some intermediate, relatively small branches between these main nerves were named alphabetically from “a” to “f” (Fig. 1).

Where spinal segments of origin are presented in parentheses, the parentheses indicate the possibility of supply through further communicating branches of the cervical plexus.

2. Crab-eating macaque

In the crab-eating macaque the n. auricularis magnus arose from cervical spinal nerves (C2) and C3, or C3 and (C4) (Table 1). It appeared at the dorsal border of the sternocleidomastoid and passed cranially across the superficial surface of the muscle, dividing into a few small branches which supplied the auricle and the skin adjacent to it. In Specimens 1 and 2 the nerve communicated with the n. facialis in the parotid gland (Plates I & II).

The n. transversus colli arose, as a common trunk, from C3, or C3 and (C4), and then divided into cranial and caudal branches in all specimens. The cranial branch appeared superficially at the dorsal border of the sternocleidomastoid near its caudal third. It ran superficial to the external jugular vein, obliquely cranially towards the lower jaw, and ramified in the skin of the dorsal half of the lower jaw. In Specimens 3 and 4 it communicated with the n. facialis in the parotid gland. The cranial branch appeared, beneath the cranial branch, at the dorsal border of the sternocleidomastoid, and passed towards the ventral mid-line of the neck, extending radially and supplying the skin.

The nn. supraclaviculares arose from C4, or C4 and (C5). They passed obliquely medio-caudally across the clavicle, to ramify in the skin of the cranial portion of the chest. The n. supraclavicularis intermedius crossed the lateral half of the clavicle, and innervated the skin of the latero-cranial portion of the chest and the ventral portion of the shoulder. In Specimen 4 this nerve penetrated the external jugular vein. The n. supraclavicularis dorsalis ran obliquely dorso-caudally, crossing the superficial surface of the trapezius and acromion, to supply the skin of the dorsal portion of

Table 1. Segmental origin of the cervical cutaneous nerves in the crab-eating macaque and koala.

<table>
<thead>
<tr>
<th>Species</th>
<th>Crab-eating macaque</th>
<th>Koala</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>2(L)</td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>N. auricularis magnus</td>
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<tr>
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<td>C3</td>
<td>C3, (4)</td>
</tr>
<tr>
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<td>C3</td>
<td>C3, (4)</td>
</tr>
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<tr>
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<td>C4</td>
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<td>C3, 4</td>
</tr>
<tr>
<td>Nn. supraclaviculares</td>
<td>C4</td>
<td>C4</td>
</tr>
<tr>
<td>(N. sup. ventralis)</td>
<td>C4</td>
<td>C4</td>
</tr>
<tr>
<td>(N. sup. intermedius)</td>
<td>C4</td>
<td>C4</td>
</tr>
<tr>
<td>(N. sup. dorsalis)</td>
<td>C4</td>
<td>C4</td>
</tr>
</tbody>
</table>

Parentheses indicate the possibility of supply through communicating branch.
the shoulder.

The cranial branch of the n. transversus cervicis arose from C3 and C4, or C4. In Specimens 1 and 2 one branch originated from the communication between C3 and C4, and the other from the base of C4. These were comparatively small branches (Plates I & II). In Specimen 4 the branch was well developed. It supplied the dorso-cranial skin of the neck along the ventral border of the trapezius. The caudal branch of the n. transversus cervicis arose, as in the cranial branch, from C3 and C4, or C4. In Specimen 3 this branch was absent. In Specimen 4, however, it was well developed. It supplied the small area of the dorso-caudal skin of the neck just adjoining the area supplied by the n. supraclavicularis dorsalis. According to Hartman and Straus (1933), these two branches sometimes arose as a common trunk with the muscular branches to the atlantoscapularis anterior or the trapezius.

Between these main branches, there were some intermediate branches. Branch a (Plates I & II) originated from C3, or C3 and (C4) in Specimens 1, 2 and 3.

3. Eastern grey kangaroo

In the kangaroo, the n. auricularis magnus arose from (C2) and C3, or C3 (Table 2). In Specimens 3, 4, and 5 it derived from the relatively large communication between C2 and C3 (Plates III & IV). In 3 specimens it communicated with the n. facialis in the parotid gland. Before supplying the lateral two thirds of the auricle, it tended to divide into two branches.

The n. transversus colli, cranial branch, was well developed in all the specimens. It arose from the same segmental nerves as the n. auricularis magnus, i.e., C2 and C3. However, it tended to arise from the more ventral layer of the roots than the n. auricularis magnus. It ran superficial to the mandibular gland and supplied the skin of the caudal half of the lower jaw. The cranial branch of the n. transversus colli arose from C3, C3 and C4, or C4 and (C5). In the grey kangaroo the two branches of this nerve did not form a common trunk as in the crab-eating macaque. In Specimens 1, 4, and 5, the caudal branch communicated with the n. supraclavicularis ventralis. It supplied the ventro-cranial two thirds of the neck.

The nn. supraclavicularares arose from C3, C4 and (C5), or C4 and C5. In the grey kangaroo the nerves did not form a single trunk, as in the crab-eating macaque, but arose separately from the communicating branch between C4 and C5. In Specimens 1 and 4 the n. supraclavicularis ventralis alone arose from the base of C4. The n. supraclavicularis ventralis supplied the caudal-most skin of the neck and the cranial portion of the chest. The n. supraclavicularis intermedius supplied the ventro-lateral skin over the deltoid, and the n. supraclavicularis dorsalis the skin over the trapezius and the dorsal portion of the deltoid.

The cranial branch of the n. transversus cervicis arose from C3 and C4, or C4, and the caudal branch arose from C4, or C4 and (C5). In Specimen 1 these branches formed a common trunk. In all the specimens these branches supplied the skin over the cranio-ventral portion of the trapezius. They may be identified dividing into a few small filaments between branch f (Plates III & IV) and the n. supraclavicularis dorsalis.

Branch a (Plates III & IV) appeared as two small branches in Specimens 2, 3, and 4. It arose from the n. auricularis magnus, or from the cranial branch of the n. transversus colli. In Specimen 3, however, branch al arose from C3, forming a common trunk with branch fl.

Branch b appeared in Specimens 2, 3, 4, and 5. It arose from C3 and C4.

Branch c appeared as a small branch of the n. supraclavicularis ventralis in Specimen 2.

Branch d arose, with branch b, from the communicating branch between C3 and C4 in Specimen 4.

Branch e was a small branch, arising from C4 and communicating with the n. supraclavicularis dorsalis in Specimen 1.

Branch f appeared in all the specimens. It derived

<table>
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<th>Specimen No. (side)</th>
<th>Sex</th>
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<th>2(L)</th>
<th>3(R) Female</th>
<th>4(R) Female</th>
<th>5(R) Female</th>
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<td></td>
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<td>C3,4</td>
<td>C4(5)</td>
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<tr>
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<td>(Cranial branch)</td>
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from the auricularis magnus. In Specimens 4 and 5, however, it had another origin from the communicating branch between C3 and C4.

4. Koala

In the koala the n. auricularis magnus arose from the communicating branch between C2 and C3 (Table 2, Plate V). In the parotid gland it divided into two branches. The ventral branch supplied the ventral skin of the external ear and communicated with the n. facialis, and the dorsal branch supplied the dorsal skin of the external ear.

The n. transversus colli, cranial branch, was well developed, as in the two other species. The caudal branch of the n. transversus colli arose from C3 in Specimens 2 and 3. It supplied the ventral portion of the neck. However, it was not present in Specimen 1.

The nn. supraclaviculares arose from C3 and C4, or (C3) and C4. These tended not to form a common trunk, as in the crab-eating macaque. The n. supraclavicularis ventralis ran obliquely to the cranial skin over the pectoralis major. The n. supraclavicularis intermedius ran to the ventral skin over the deltoid, and the n. supraclavicularis dorsalis ran to the dorsal skin over the deltoid and the latero-caudal skin of the neck.

The n. transversus cervicis, cranial branch, arose from C2 and C3, or C2, C3, and C4. The caudal branch of the n. transversus cervicis arose from C3 and C4, C3 and (C4), or C4. These two branches communicated with each other in all specimens. They supplied the lateral portion of the neck.

Branch a appeared in Specimens 1 and 3. It arose from the cranial branch of the n. transversus colli and the caudal branch of the n. transversus cervicis.

Branch b arose as two small branches from C3 in Specimen 3. These two intermediate branches supplied the ventro-cranial portion and a small lateral portion of the neck near where the cutaneous nerves appear superficially.

Branch c arose as a small branch from the n. supraclavicularis ventralis in Specimen 2.

Branch f arose from C2 and C3, or C2, C3, and C4 in Specimens 1 and 2. In Specimen 1, however, it arose with the cranial branch of the n. transversus cervicis, and in Specimen 2 it derived from the n. auricularis magnus and the cranial branch of the n. transversus cervicis.

Discussion

Kohlbrugge (1898) did not recognize n. occipitalis minor in some marsupials and lower primates. Hartman and Straus (1933) described it in the rhesus monkey. In our specimens branch f showed an origin from the cervical plexus similar to that described by Hartman and Straus for the n. occipitalis minor in the rhesus monkey. Even though branch f was most evident in Specimen 1 of the crab-eating macaque (Plate I), it was still not well developed where it supplied the skin over the occipital region. However, branch f, which also resembled the n. occipitalis minor as described in man (Nakano, 1977), was not recognized in all our specimens. Consequently, the observation of Kohlbrugge (1898) would appear to be correct.

In general, the n. transversus colli arises from C2 and C3. In man (Gray, 1967), it divides into two branches, ascending and descending, after perforating the deep cervical fascia. These two branches are recognized in both the Nomina Anatomica (5th ed.) and the Nomina Anatomica Veterinaria (3rd ed.). In our specimens of the crab-eating macaque the two branches arose as a common trunk from the cervical plexus, although the branches appeared separately at the dorsal border of the sternocleidomastoid. In the kangaroo and koala, however, these two branches originated separately from the plexus, according to their cranial and caudal distribution. If the development of the n. occipitalis minor is related to that of the dorsal portion of the auricle, as stated by Bolk (1902), the separation of the n. transversus colli may be related to the development of the lower jaw.

The cutaneous nerve, which supplies the lateral-ventral skin over the cervical portion of the trapezius, was called the n. transversus cervicis in man by some authors (Toldt, 1927; Braus and Elze, 1960; Nakano, 1977), and the n. cutaneous nuchae by Yamada and Mannen (1985). In our observations several rather small branches were recognized in the latero-dorsal area between the n. auricularis magnus and n. supraclavicularis dorsalis. Many of these branches, except e and f, arborized from the two main branches. In most of the specimens these main branches arose separately from the cervical plexus, and grey kangaroo, however, the branches arose as a common trunk from the plexus. We named these branches the cranial and caudal branches of the n. transversus cervicis, as in man.

Regarding the positional relationships between the cutaneous nerves at the cervical plexus, the cranial and caudal branches of the n. transversus colli, and the nn. supraclavicularis ventralis and intermedius tended to derive from the ventral layer of the plexus. The n. auricularis magnus, the cranial and caudal branches of the n. transversus cervicis, and the n. supraclavicularis dorsalis tended to derive from the dorsal layer. In the crab-eating macaque the n. auricularis magnus and n. transversus colli tended to arise from a lower segment than in the grey kangaroo and koala, and in the grey kangaroo, likewise, the nn. supraclavicularis tended to arise from a lower segment than in the crab-eating macaque.
Fig. 2. Diagrams showing the typical positional relationships between the cutaneous nerves of the cervical plexus in the crab-eating macaque, grey kangaroo, and koala. d: dorsal. v: ventral.

macaque and koala (Fig. 2).

References


Abbreviations for all figures

Ac : n. accessorius
AC : acromion
Am : n. auricularis magnus
As : ansa cervicalis
Ca : caudal branch of the n. transversus cervicis
Cb : communicating branch
CL : clavicle
Cr : cranial branch of the n. transversus cervicis
CT : cervical thymus
Hy : n. hypoglossus
L : left side
MG : mandibular gland
Om : n. occipitalis minor
PG : parotid gland
Ph : n. phrenicus
R : right side
Sd : n. supraclavicularis dorsalis
Si : n. supraclavicularis intermedius
SM : sternocleidomastoid
SV : n. supraclavicularis ventralis
Ta : caudal branch of the n. transversus colli
TP : trapezius
Tr : cranial branch of the n. transversus colli
V : external jugular vein
Explanation of Figures
Plate I

The cervical cutaneous nerves (latero-ventral aspect) of the crab-eating macaque, together with the cervical plexus (ventral aspect).
Specimen 1. Male, right side.
The cervical cutaneous nerves (latero-ventral aspect) of the crab-eating macaque, together with the cervical plexus (ventral aspect).

Specimen 2. Male, left side.
Kangaroo-3(R)

Plate III

The cervical cutaneous nerves (latero-ventral aspect) of the grey kangaroo, together with the cervical plexus (ventral aspect). Topographical interrelationships at the dorsal border of the sternocleidomastoid are given. Specimen 3. Female, right side.
Plate IV

The cervical cutaneous nerves (latero-ventral aspect) of the grey kangaroo, together with the cervical plexus (ventral aspect). Topographical interrelationships at the dorsal border of the sternocleidomastoid are given. Specimen 4. Female, right side.
Plate V

The cervical cutaneous nerves (latero-ventral aspect) of the koala, together with the cervical plexus (ventral aspect). Specimen 3. Male, left side.