

The Lateral Cutaneous Branch of the Intercostal Nerves — Its Frequency on Macroscopic Examinations*

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Macroscopic examinations were made of 50 sides of the body in 25 Japanese adult cadavers to determine the frequency of the lateral cutaneous branch for each intercostal nerve.

The first intercostal nerve is said to usually lack the lateral cutaneous branch, but a case was found in which this branch was present on one side (2%).

The second intercostal nerve was found to not have the lateral cutaneous branch on two sides (4%), the fifth intercostal nerve also lacked this branch on two sides (4%), and the seventh intercostal nerve did not have this branch on one side (2%) among the cases examined. The absence of the lateral cutaneous branch was confirmed for these intercostal nerves by stereomicroscopic inspection of the nerve fibers that compose the lateral cutaneous branch of adjacent intercostal nerves in these cases. Furthermore, review of the fifth and seventh intercostal nerves from the morphological standpoint in relationship to the external oblique abdominal muscle also indicated the absence of the lateral cutaneous branch in these cases.

INTRODUCTION

The detailed report by DAVIES *et al.* (1931) described the basic pattern of distribution of the intercostal nerves on the thoracic wall, and their report is quoted in most anatomy textbooks. Various studies have mentioned the intercostal nerves in discussions of the relation between the intercostal muscles and the abdominal muscles (FORSTER, 1917; FUJITA, 1963; SATO, 1973), but no notable study has been made of the frequency of the lateral cutaneous branch of the intercostal nerves except for those of CAVE (1929), KASAI *et al.* (1966), and SATO (1971). However, even these investigators had referred to the lateral cutaneous branch of only the first and second intercostal nerves and

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had not studied all of the intercostal nerves.

This author previously found a rare case in which the fifth intercostal nerve lacked the lateral cutaneous branch, and the nerve supply to the external oblique abdominal muscle was by a filament from the ramus muscularis externus (FUJITA, 1963) of the fifth intercostal nerve (MIYAUCHI, 1982). Because of the discovery of this case, it was felt that there is a strong need for a study of the frequency of the lateral cutaneous branch of the intercostal nerves. Therefore, macroscopic examinations were recently made of each intercostal nerve in a comparatively large number of cases. Some findings not reported in previous papers were obtained and will be described.

MATERIALS AND METHODS

Each intercostal nerve on 50 body-halves of 25 Japanese adult cadavers (18 males and 7 females) was examined. The cases examined consisted of 17 cadavers provided for anatomical dissection studies by medical students of the Medical College of Oita during the 1981 school year, and 8 cases selected at random from among the cadavers preserved at this school. Each cadaver had been fixed by injection of 10% formalin solution into the femoral artery.

Inspection was first made of each intercostal space to determine whether or not the lateral cutaneous branch was present. Those cases in which the lateral cutaneous branch was found to be present in the first intercostal space and found to be absent in any of the other intercostal spaces were selected for further detailed examination. The sternum and abdominal wall of these cases were severed sagittally along the median line, and then each rib and the soft tissue within each intercostal space were severed at about the costotransverse joint. In this way, each half of the thorax was removed from the vertebral column. Inspection of the intercostal nerves was made from the pleural side using magnifying lenses equipped with an illumination attachment. When necessary, stereomicroscopic examinations were made of the fibers of the intercostal nerve.

FINDINGS AND DISCUSSION

The findings will be described using the nomenclature of DAVIES *et al.* (1931) for the major branches of the intercostal nerves, and the nomenclature of FUJITA (1963) will be used for the nerves that supply the external intercostal muscles.

1) *The first intercostal nerve is said to usually not have the lateral cutaneous branch. In contrast to this, a case (Cadaver number 42) was found in which the first intercostal nerve had the lateral cutaneous branch on one side, in this study (2%).*

Examination of this case from the pleural side showed the innermost intercostal muscle to be absent in the first intercostal space, and because of this the first intercostal nerve was present immediately beneath the pleura. In the area near the dorsal edge of

the external intercostal muscle within the first intercostal space, this nerve was found to definitely separate into the main nerve and the intermediate branch, the lateral cutaneous branch, but there was no collateral branch (Figs. 1a and b).

2) *The second intercostal nerve did not have the lateral cutaneous branch on two sides (4%) among the cases examined.*

(1) Near the dorsal edge of the internal intercostal muscle within the second intercostal space of one case (Cadaver number 51), the second intercostal nerve separated into the main nerve and the collateral branch, and the lateral cutaneous branch was absent. However, the collateral branch, after giving off an anastomosing branch to the third intercostal nerve, united with the main nerve of the second intercostal nerve (Figs. 2a and b).

The fibers of the lateral cutaneous branch of the third intercostal nerve were traced back centrally under the stereomicroscope. It was confirmed that the fibers which composed this branch had no association with the anastomosing branch given off to the third intercostal nerve from the collateral branch of the second intercostal nerve.

(2) In the region near the dorsal edge of the internal intercostal muscle within the second intercostal space of the other case (Cadaver number 41), the second intercostal nerve was found to separate into the main nerve and the collateral branch, but the intermediate branch, that is, the lateral cutaneous branch was absent (Figs. 3a and b).

3) *The fifth intercostal nerve did not have the lateral cutaneous branch on two sides (4%) among the cases examined.*

(1) The fifth intercostal nerve of one case (Cadaver number 41) ran within the fifth intercostal space towards the sternum to an area medial to the anterior axillary line where it separated into the main nerve and the collateral branch. The fifth intercostal nerve did not have the intermediate branch, that is, the lateral cutaneous branch.

The uppermost digitation (with origin from the fifth rib) of the external oblique abdominal muscle of this case received from its inner surface the filaments from the ramus muscularis externus of the fifth intercostal nerve (Figs. 3a and b).

(2) In the area near the dorsal edge of the external intercostal muscle of the other case (Cadaver number 59), the fifth intercostal nerve first gave off a small anastomosing branch to the sixth intercostal nerve. During its course within the fifth intercostal space towards the sternum, it received a slender twig from the fourth intercostal nerve in the region near the posterior axillary line. Upon reaching the area near the insertion of the transversus thoracic muscle, it separated into the main nerve and the collateral branch. However, it did not have the intermediate branch.

The fibers that compose the lateral cutaneous branch of the sixth intercostal nerve were traced back centrally under the stereomicroscope, and it was confirmed that these fibers had no relationship with the small anastomosing branch which was

given off to the sixth intercostal nerve from the fifth intercostal nerve.

The uppermost digitation (arising from the fifth rib) of the external oblique abdominal muscle of this case was found to receive from its outer surface a twig from the lateral cutaneous branch of the fourth intercostal nerve and also a filament from the ramus muscularis externus of the fifth intercostal nerve (Figs. 4a, b and c).

4) *The seventh intercostal nerve did not have the lateral cutaneous branch on one side (2%) among the cases examined.*

In the area near the dorsal edge of the external intercostal muscle within the seventh intercostal space, the seventh intercostal nerve of the case (Cadaver number 60) separated into the main nerve and the collateral branch. The main nerve received a twig from the sixth intercostal nerve after which it ran within the seventh intercostal space towards the sternum. On the other hand, the collateral branch sent off an anastomosing branch to the eighth intercostal nerve after which it ran towards the sternum to a region near the origin of the diaphragm, where it anastomosed with the main nerve of the seventh intercostal nerve.

The fibers which compose the lateral cutaneous branch of the eighth intercostal nerve were traced back centrally by stereomicroscopy, and it was confirmed that these fibers were unrelated with the anastomosing branch given off to the eighth intercostal nerve from the seventh intercostal nerve.

A filament from the ramus muscularis externus of the seventh intercostal nerve was found entering into the outer surface of the digitation of the external oblique abdominal muscle that arose from the seventh rib (Figs. 5a, b and c).

Review of literature concerning the frequency at which the first intercostal nerve had the lateral cutaneous branch revealed reports of its presence at rates of 92.3% by CAVE (1929), 16.2% by KASAI *et al.* (1966), and 8.7% by SATO (1971), respectively. The results of the investigators in these reports are inconsistent, and moreover the frequencies reported are considerably higher than that of this author. On the other hand, in an examination of the descriptions of the lateral cutaneous branch of the intercostal nerves in anatomy textbooks, it was found that RAUBER and SPALTEHOLZ state that the first intercostal nerve usually does not have the lateral cutaneous branch, while CUNNINGHAM's Textbook of Anatomy mentions that the lateral cutaneous branch of this nerve is frequently absent. In view of these reports, it seems appropriate to consider the first intercostal nerve as frequently not having the lateral cutaneous branch, and the difference between the results of this author and those of other investigators was simply due to chance.

There has been no mention of the absence of the lateral cutaneous branch of the second intercostal nerve except in the report by SATO (1971). He found the lateral cutaneous branch of this nerve to be absent in one (0.4%) out of 242 sides of the body examined. The second intercostal nerve in the two cases of this author may respectively be considered as essentially lacking the lateral cutaneous branch even when considered

on the basis of the stereomicroscopic findings. Therefore, the second intercostal nerve should be regarded as not having the lateral cutaneous branch in rare instances.

The fifth intercostal nerve of two cases and the seventh intercostal nerve of one case, respectively, were noted to lack the lateral cutaneous branch. Such findings have not been reported previously, and it appears to be appropriate to consider the intercostal nerve in these cases to essentially not have the lateral cutaneous branch in view of the stereomicroscopic findings.

Furthermore, it appears that the absence of the lateral cutaneous branch for these intercostal nerves can be proven from the relationship between them and the external oblique abdominal muscle. Discussion will next be made of what behavior is taken by the intercostal nerve in order to supply the external oblique abdominal muscle when it lacks its lateral cutaneous branch.

RUGE (1892), SEYDEL (1892) and BARDEEN (1900, 1903) reported that the upper part of the external oblique abdominal muscle in mammals, like that in amphibia and reptilia, maintains a prominent segmental condition in association with its nerve supply. Moreover, the upper limit of the location of this muscle is said to be shifted caudalwards in higher animals (NISHI, 1938).

The uppermost digitation of the external oblique abdominal muscle in cadaver number 59 was found to be innervated by the lateral cutaneous branch of the fourth intercostal nerve. In this case, the digitation of the external oblique abdominal muscle which should have had origin from the fourth rib seems to have retrogressed and disappeared during the course of ontogeny, and it seems that only the nerve supply had remained. Moreover, in connection with the nerve supply to the digitation with origin from the fifth rib, because the fifth intercostal nerve did not have the lateral cutaneous branch, the nerve fibers which should supply this digitation are assumed to have become included in the ramus muscularis externus.

The uppermost digitation of the external oblique abdominal muscle in cadaver number 41 received from its inner surface the filaments from the ramus muscularis externus of the fifth intercostal nerve. This pattern of entry of the nerve into this digitation is similar to that for the external intercostal muscle. Therefore, it would be appropriate to consider this uppermost digitation in this case to be the *m. obliquus abdominis externus profundus* (KNOTT; cited from EISLER, 1912).

The digitation of the external oblique abdominal muscle which had origin from the seventh rib in cadaver number 60 was found to receive from its outer surface a filament from the ramus muscularis externus of the seventh intercostal nerve. Because the seventh intercostal nerve in this case did not have the lateral cutaneous branch, it is assumed that the nerve fibers that should supply this segment of the digitation of the external oblique abdominal muscle had become included in the ramus muscularis externus of the same segment.

SUMMARY

Previously a very rare case was found in which the fifth intercostal nerve did not have the lateral cutaneous branch and instead gave off a filament from its ramus muscularis externus to the external oblique abdominal muscle. Therefore, it was felt that there is a strong need for a study of the frequency of the lateral cutaneous branch of the intercostal nerves. For this reason, macroscopic examinations were made of the lateral cutaneous branch of all intercostal nerves on 50 sides of the body of 25 Japanese adult cadavers.

The first intercostal nerve is said to usually lack the lateral cutaneous branch, but a case was found in which it had the lateral cutaneous branch on one side of the body (2%).

The second intercostal nerve was found to not have the lateral cutaneous branch on two sides (4%) among the cases examined. Stereomicroscopic inspection of the fibers which compose the lateral cutaneous branch of adjacent intercostal nerves in these cases confirmed that this intercostal nerve did not have the lateral cutaneous branch.

The fifth intercostal nerve lacked the lateral cutaneous branch on two sides (4%), and the seventh intercostal nerve also was found to not have this branch on one side (2%) among the cases examined. These are findings not available in previous reports. Inspection of the fibers which compose the lateral cutaneous branch of adjacent intercostal nerves by stereomicroscopy confirmed the absence of the lateral cutaneous branch. Furthermore, examinations from the relationship to the external oblique abdominal muscle also indicated that these intercostal nerves did not have the lateral cutaneous branch.

Explanation of Figures

Abbreviations of All Figures

c: collateral branch, EI: external intercostal muscle, EOA: external oblique abdominal muscle, II: internal intercostal muscle, m: main nerve, me: ramus muscularis externus, PMA: pectoralis major muscle, PMi: pectoralis minor muscle, S: sternum, SA: serratus anterior muscle, 1-9: first-ninth ribs.

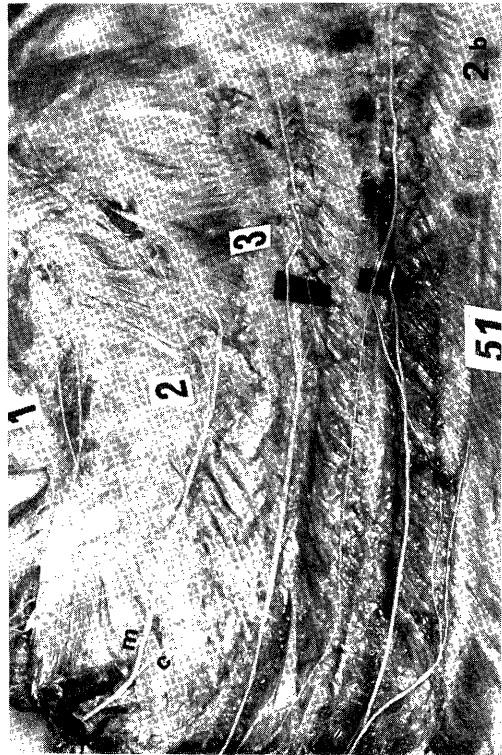
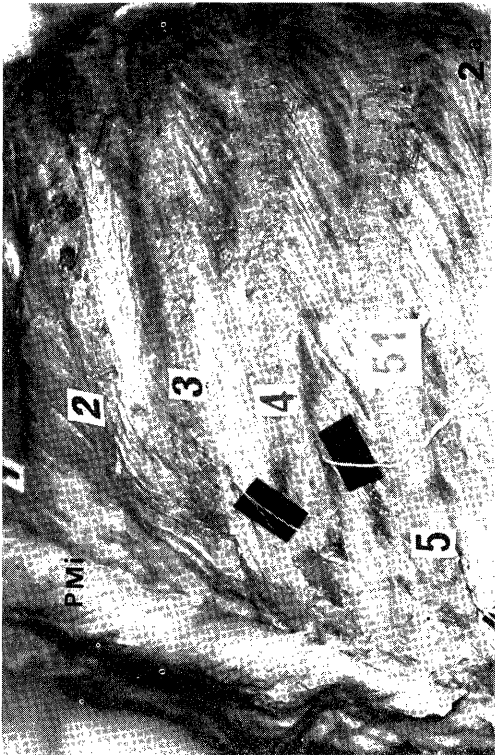
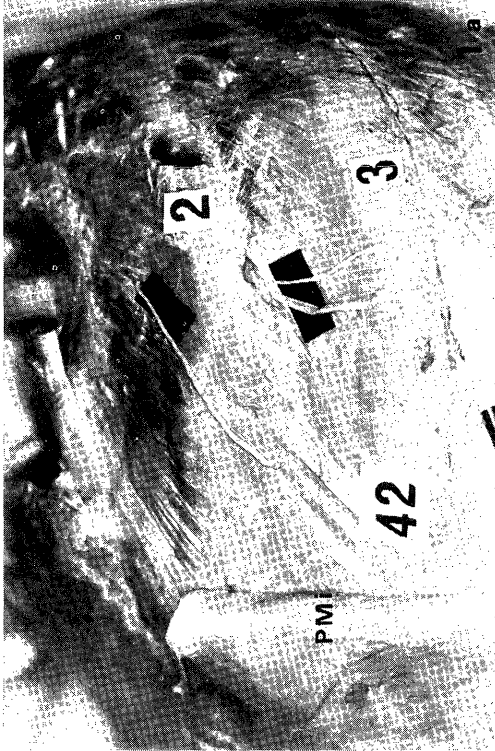
Figs. 1a and b. Cadaver number 42; Japanese male; age 70 years at time of death; death due to cardiac insufficiency. The location of lateral cutaneous branch of each intercostal nerve is indicated by a small piece of black paper. a: Lateral view. The serratus anterior muscle has been removed so as to expose the lateral cutaneous branch of each intercostal nerve. The pectoralis minor muscle has been reflected medialwards. The lateral cutaneous branch is present in the first intercostal space. b: View from pleural side. The subcostal and innermost intercostal muscles have been removed so as to expose the intercostal nerves. The intermediate branch of the first intercostal nerve pierces the lateral thoracic wall.

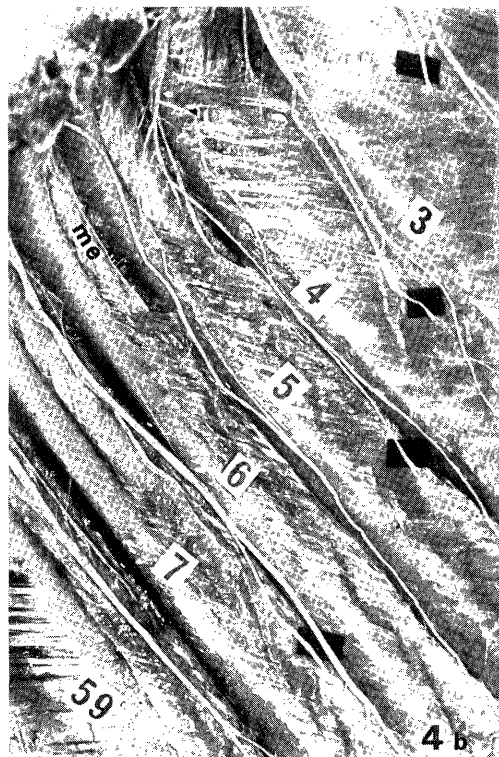
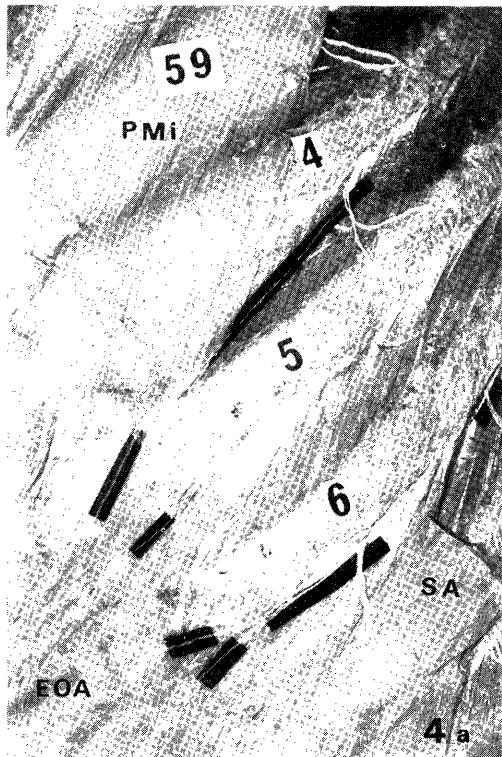
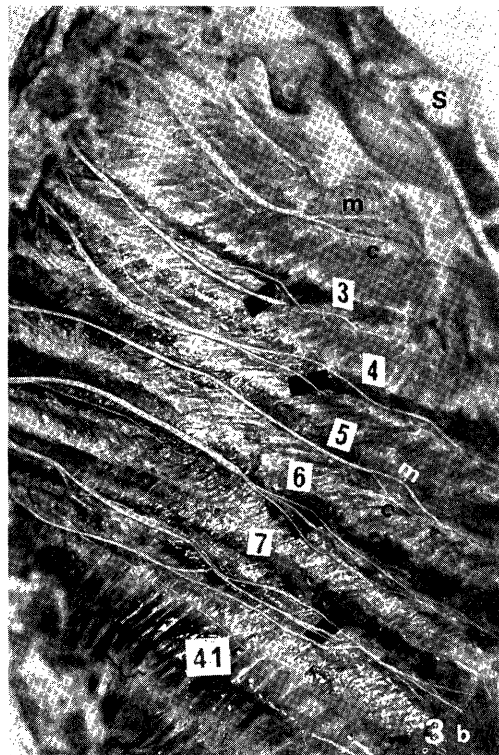
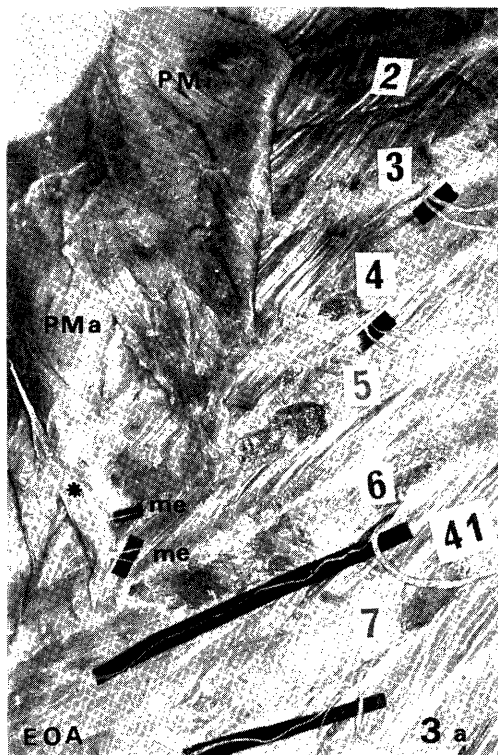
Figs. 2a and b. Cadaver number 51; Japanese female; age 74 years at time of death; death due to carcinoma of uterus. The location of each lateral cutaneous branch of the third and fourth intercostal nerves is indicated by a small piece of black paper. a: Lateral view. The serratus anterior muscle has been removed. The pectoralis minor muscle has been reflected medialwards. The lateral cutaneous branch is absent in the second intercostal space. b: View from pleural side. The subcostal and innermost intercostal muscles have been removed.

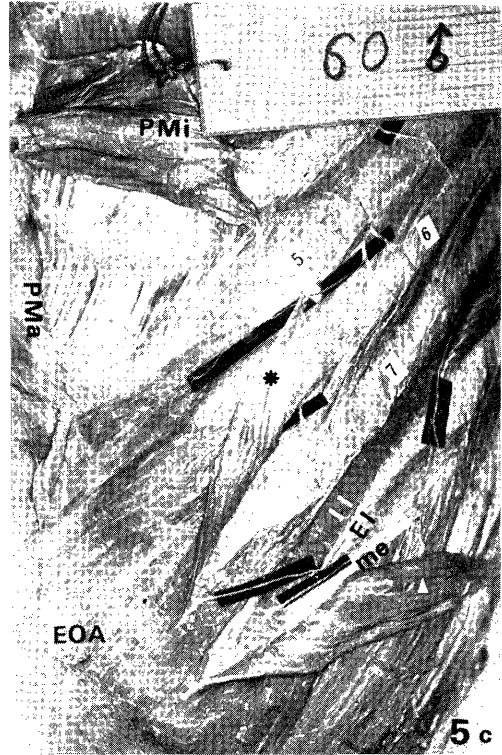
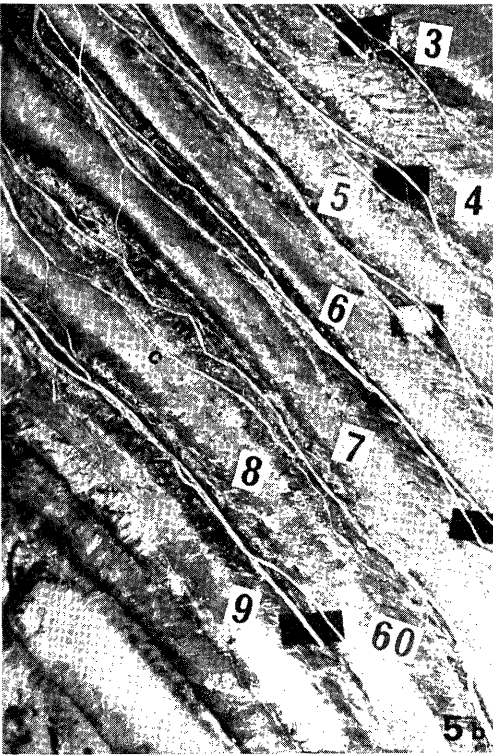
Figs. 3a and b. Cadaver number 41; Japanese male; age 73 years at time of death; death due to bronchopneumonia. The locations of the lateral cutaneous branches and the filaments from the ramus muscularis externus are indicated by the small pieces of black paper. a: Lateral view. The serratus anterior muscle has been removed. The pectoralis major and minor muscles have been reflected medialwards. The uppermost digitation (*) of the external oblique abdominal muscle has been reflected medialwards so as to expose its innervation. The lateral cutaneous branch is absent in the second and in the fifth intercostal spaces. b: View from pleural side. The subcostal and the innermost intercostal muscles in the upper thoracic wall have been removed.

Figs. 4a, b and c. Cadaver number 59; Japanese male; age 79 years at time of death; death due to encephalomalacia. The locations of the lateral cutaneous branches and a filament of the ramus muscularis externus are indicated by the small pieces of black paper. a: Lateral view. The serratus anterior muscle except for its digitation originating from the seventh rib has been removed. The lateral cutaneous branch is absent in the fifth intercostal space. b: View from pleural side. The subcostal and the innermost intercostal muscles in the upper thoracic wall have been removed. c: Lateral view. The pectoralis minor muscle has been reflected medialwards. The lower part (*) of the uppermost digitation of the external oblique abdominal muscle has been reflected downwards. The external intercostal muscle within the fifth intercostal space has been reflected downwards so as to expose the ramus muscularis externus of the fifth intercostal nerve.

Figs. 5a, b and c. Cadaver number 60; Japanese male; age 90 years at time of death; death due to cardiac insufficiency. The locations of the lateral cutaneous branches and a filament from the ramus muscularis externus are indicated by the small pieces of black paper. a: Lateral view. The serratus anterior muscle has been removed. The pectoralis minor muscle has been reflected medialwards. The lateral cutaneous branch is absent in the seventh intercostal space. b: View from pleural side. The subcostal and the innermost intercostal muscles have been removed. c: Lateral view. The lower part (*) of the digitation originating from the sixth rib of the external oblique abdominal muscle has been reflected upwards. The lower part (Δ) of the digitation originating from the seventh rib of the external oblique abdominal muscle has been reflected downwards. The external intercostal muscle within the seventh intercostal space has been reflected downwards so as to expose the ramus muscularis externus of the seventh intercostal nerve.







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