THE
NERVOUS SUPPLY OF THE UPPER EXTREMITY
IN ITS
MORPHOLOGICAL & PATHOLOGICAL
RELATIONS

THESIS

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On the Nervous Supply of the Upper Extremity in Its Morphological and Pathological Relations

Part I.

The question of the primitive derivation of the Upper Extremity in Man, is one upon which comparative anatomists are not agreed. Gegenbaur believes it to have been derived from the Gill arches and their Branchial rays, whilst other authorities, amongst whom I may mention Milne-Edwards, T.M. Balfour and J. H. F. Parker, the latter of whom has paid great attention to this subject, consider that the Upper Extremity is a derivative from a primordially continuous lateral fin, supported by cartilaginous rays and comparable to the primordially continuous lateral median fin.

To entangle the arguments for and against these hypotheses would be entirely beside the subject which I have selected for this Thesis, but I shall endeavor to trace shortly the various stages of the upper limb from the condition found in the Ichthyostegian, as the derivation from the primordially continuous fin appears to me to be the more probable.

In the development of the Ichthyostegian, two pairs of limbs appear as "differentiations of a continuous but not very conspicuous epidermic thickening, which is probably the rudiment of a continuous lateral fin" (Balfour's comparative Embryology. Vol. II. P. 49.)
Of these two pairs of limbs, the anterior develops in the
the position of time, and in front of the amnion,
and the latter appears some distance behind it
and approaches each other; and usually meet in the median
ventral line a little behind the anus. In the Sauria,
also, the anterior pair first appears before the posterior,
but there does not seem to be the same rudimentary
indication of a continuous lateral fin. The main part
of the cartilaginous framework in the tail of the Saurous
branch is made up of pieces arranged similarly to the
limbs in the Mammalian age; limb, the remainder
being composed of irregular pieces of cartilage. The
limbs in Pelycosaurs are in the form of long filaments,
made up of similarly arranged masses of forming
an axis with Pa - but no Post-anal rays, whilst in
Lipospondyls there are only Post-anal. It may here
get a condition so like the condition found in higher
amphibians that I shall not trace it further. I will only
add that it is to be noted that the longitudinal basal
bar, or Basiplatygynum, is at first in a lateral hori-
tontal position and that afterwards it becomes gradually
rotated outwards. Its anterior end remaining
attached to the palatal girdle.

Before entering on the next special consideration of the
Human Upper Extremity it will be convenient to note
the arrangement of the Spinal nerves in the forms I
have mentioned. In Amphibia, the nerves arise by
a single root from the cord throughout its length, in
series with the Intermuscular System, which correspond
tous, these nerves divide into dorsal primary branches supplying the median dorsal region, and ventral primary branches supplying the ventral aspect. In the dorsal branches, we find the nerves arising by two sets, the superior being purely sensory and marked by the presence of a ganglion, the inferior purely motor and having no ganglion. These two tend to join, except in the thoracic, below the posterior root ganglion, their ultimate distribution being, in the main, that already described, in this case there is in addition a branch given off from the posterior root ganglion.

We now come to the most special study of the upper extremity as found in man. It arises as an outgrowth from the lateral part of the trunk in the 3rd and 4th week after the fortification of the head. It does not possess any segmental part-whole segmentation, but it in some respects to be regarded as a lateral section of the spinal cord. (Quain's Anatomy, Vol. II, p. 392.) It buds out from a lateral ridge near the line of separation of the mesoblast into its parietal and visceral laminae, and is at first composed of a mass of mesoblast covered with a layer of epiblast which ultimately becomes differentiated into the arm, fore-arm and hand, the bones being formed from cartilaginous plates arising in the center of the mesoblast. It seems doubtful whether the muscles proceed directly from the muscle plates or whether they arise locally; probably the intrinsic muscles arise locally and the extrinsic that is trunk-muscles attached to the arm, like the Latissimus
Major, arise from the muscle plates.

The nerves are the ordinary Spinal nerves, but in this situation, as the limbs grow out it carries the nerves and so forth, and thus prolongs them. The original portion of the limb shows it to consist of a Dorsal and a Ventral aspect, which come to lie the extensor and flexor surfaces respectively, whilst the Radial branch is directed forwards and per-axially, the Ulnar backwards and post-axially. According to some authorities, an unnatural position of the Humerus takes place as in Quadrupeds, in order, in their case, to allow of the fore foot being placed in the ground to support the body, a mode of progression usually adopted by reptiles rather than a fact which would lead one to conclude that this position of the Humerus does take place, though Bain (Anat. Vol. I. p. 303) denies it.

Nerves. The nerves of the upper extremity, with the exception of the Descending Bicipital, are all derived from the Brachial Nerves, and it is to this Nerves I shall first turn attention.

We have seen that a typical Spinal nerve, in Batrachia, is formed by the junction of two nerves, i.e., and it then divides into Anterior (Dorsal) and Posterior (Ventral) Primary branches, the latter supplying the skin and muscles of the back, whilst the former pass round the body in connection with the ribs, and as they do so, they give off lateral branches which divide into Smaller Anterior and Posterior branches for the skin of the side. This arrangement holds throughout the whole series.
Of spinal nerves in a more or less complicated form, in
the Amphibians and in the Reptilia, where there are no
skeletal appendages to alter the arrangement. In Man,
too, it holds good in the posterior part of the Dorsal region,
but in the upper part and in the Cervical region, it is greatly
modified. I will not enter into the arrangement of the
upper cervical nerves, how they are believed to have been
brought up to supply the head by the enlargement taking
place in the Supra-spinal (Anterior) end of the central nervous
system, as this would be beside the issue, as it is so fully
entered into by Mr. Ross in his paper on the "Segmentation
of the Sensory Nerves. (Brain, Jan. 1888.)"

The Brachial Plexus is formed in Man by union of the
5\textsuperscript{th}, 6\textsuperscript{th}, 7\textsuperscript{th}, 8\textsuperscript{th} Cervical and 1\textsuperscript{st} Dorsal nerves with
branches from the 4\textsuperscript{th} Cervical and occasionally 2\textsuperscript{nd} Dorsal
i.e.: of their Anterior primary divisions, (Rami Ventrals)
the posterior primary divisions being distributed in their
usual manner. The number of nerves entering into the
formation of the Plexus varies in different animals, but
the 6\textsuperscript{th} (a part), 7\textsuperscript{th}, 8\textsuperscript{th} Cervical and 1\textsuperscript{st} Dorsal are con-
stant.

Do the whole of the Anterior primary divisions
enter into the formation of the Brachial Plexus?

Professor Godwin thought not, but that the nerves supplying
the limbs were radiating (Anterior) branches of these
"Spinal Membrane. Vol. II. p. 201. 1868."

He thought that
the Intercostal nerves are not strictly homologous with
the roots of the Brachial Plexus, but that the Thoracic
Nerves which are, are the Intercosto-humeral and the
Intercosto-cutaneous, i.e. the lateral branches mentioned
above. This, I think, has now been disproved, for, in the first place, if the Obliques only contain representations of the lateral branches, there is no reason distribution to account for the remainder of the anterior primary divisions, which, were such an arrangement the case, one would expect to find supplying the skin of the face, which we do not. Dr. Paterson, from a series of observations in different animals, has concluded that the whole of the anterior (ventral) primary divisions of these nerves, enter into the formation of the Obliques, and he has been able to formulate these principles (Journal of Anat. & Physiol. July 1867):—

1. That the posterior (ventral) primary divisions of the nerves entering the Obliques divide into dorsal and ventral trunks.

2. That dorsal divisions of the nerves always combine with dorsal, and ventral with ventral to form nerves of distribution. (To this principle Dr. Paterson has since found two exceptions, but both are situated in the Sacral Obliques, viz.: Small Sacral and Small Septal nerve trunks.)

3. That the same dorsal branches always combine with dorsal, and the same with the ventral in all animals.

In the same paper he goes on to show that the nerves of distribution formed by the union of ventral branches are distributed to supply the skin and muscles of the ventral (fossa) surface of the arm already mentioned, and the dorsal nerves supply the dorsal...
(Salmon) surface. The following table copied from St. Paterson's paper will explain more clearly:

<table>
<thead>
<tr>
<th>Origin</th>
<th>Nerve</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior (Int. + Ext.)</td>
<td>Psin's muscles</td>
<td>Muscles on front of humerus, skin on outer side and front of fore-arm.</td>
</tr>
<tr>
<td>Musculocutaneus</td>
<td></td>
<td>Skin on outer side and front of fore-arm.</td>
</tr>
<tr>
<td>Medial</td>
<td></td>
<td>Muscles and skin on front of arm and fore-arm.</td>
</tr>
<tr>
<td>Cubital</td>
<td></td>
<td>Skin on inner side and front of arm and fore-arm.</td>
</tr>
<tr>
<td>Internal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cutaneous</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supraspinatus: Muscles on dorsal of scapula.

Subscapularis: Subscapularis muscle.

Circumflex: Deltoide, teres minor.

Inferior branches: Skin on back and outer side of shoulder and arm.

Middle Subscapular: Subscapular and teres major.

Muscule spiral: Muscles on back of humerus.

Teres major: Muscles and skin on back of fore-arm and hand.

Long subscapular: Latissimus dorsi.

The position as well as the composition of the brachial plexus varies in different animals. It changes when the position of the limb changes. "The anterior appendage has undergone great changes in position owing to the continual increase in the number of cervical vertebrae (Gaebel's) and owing to the continual proliferation of the appendages, the Plexus has moved farther and farther back from the

...
to Brads and at last in Man it comes to natural from the lower part of the Side of the Neck into the Occiput.

Coming now to the constitution of the Phrenus, we also meet with variations. The most common arrangement is as follows: the 3/5 and 6/5 Crural end to form an Upper Cord, the 7/5 is continued as the Middle Cord, while the 8/5 Crural and 1/5 Succal unite to form a Lower Cord. Each of these three cords divide into an Anterior and a Posterior Branch. The Anterior Branches of the Upper and Middle unite to form an Outer Cord. The Anterior Branch of the Lower becomes the Inner Cord. While the two Posterior branches unite to form the Posterior Cord of the Phrenus.

A second arrangement is that described by Sir J. Y. Ives: the 3/5 and 6/5 Crural join to form a large nerve which is then joined by the 7/5 to form the Upper Cord of the Phrenus; the 8/5 Crural and 1/5 Succal unite to form the Lower Cord. From each of these a large branch arises which unite to form a third or Posterior Cord, the Outer Cord being the continuation of the Upper and the Inner of the Lower Cord.

Other rare arrangements have been described, but these will suffice, and in studying any of these one will see that they are but mechanical variations and that the source of any particular nerve may be the same whichever arrangement is taken.

The wish of tracing up each of these nerves of the arm to its own part or parts of the Brachial Phrenus may be approached from two points of view: the anatomical and the pathological. The former method has been applied by Brasse
and Dr. Herringham (Publssed: Bay. Scie. Lond. 1886), the latter method has not, as far as I am aware, been systematically worked out, but Mr. Richardson of Manchester, in his 18th work on the Surgery of the Spinal Cord, has to a great extent supplied the material required.

Let us take first the anatomical method. The plan adopted by Traube was to trace the fiber after the Brachial Plexus had been well macerated and Mr. Herringham bases his results on 55 dissections, 32 male and 23 adult. The results arrived at by these two authorities are, in the main, the same, but Traube generally states that a nerve arises from a greater number of parts, and always higher parts, than does Mr. Herringham. A comparative table of their results will show this, the nerves only in which they differ being quoted.

<table>
<thead>
<tr>
<th></th>
<th>Traube</th>
<th>Herringham</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscapularis</td>
<td>5 1/2, 8°, 6 1/2°C.</td>
<td>5 1/2, 6°C.</td>
</tr>
<tr>
<td>Circumflex</td>
<td>do.</td>
<td>do.</td>
</tr>
<tr>
<td>Musculo-spiral</td>
<td>do.</td>
<td>5 1/2, 6°C.</td>
</tr>
<tr>
<td>Median</td>
<td>6°C, 8°, 6°C + 1/2° D.</td>
<td>6°C, 8°, 6°C + 1/2° D.</td>
</tr>
<tr>
<td>Ulnar</td>
<td>8°, 8°C + 1/2° D.</td>
<td>8°, 8°C + 1/2° D.</td>
</tr>
</tbody>
</table>

Mr. Herringham has carried his researches still further and has made out not what part of the Plexus the nerve to and muscle is connected, and as a result has laid down the following law, which I will here quote:

I. Any given fiber may also be present relative to the Vertebra Column, but will maintain its position relative to the joints.

(This law may account for the slight discrepancies in...
With regard to the Motor Supply,

II. A. Of two muscles or of two parts of a muscle that which is nearer the head end of the body tends to be supplied by the higher, that which is nearer the tail end, by the lower nerve.
B. Of two muscles that which is nearer the origin of the body tends to be supplied by the higher, that which is nearer the insertion, by the lower nerve.
C. Of two muscles that which is nearer the surface tends to be supplied by the higher, that which is further from it, by the lower nerve.

With regard to Sensation,

III. A. Of two spots in the skin that which is nearer the pre-axial border tends to be supplied by the higher nerve.
B. Of two spots in the pre-axial area, the closer tends to be supplied by the lower nerve; and of two spots in the post-axial area the closer tends to be supplied by the higher nerve.

With regard to the Pathological evidence on this point, it will, I think, be best left, until after the distribution of the nerves in the arm has been considered.

Distribution of Nerves. I. Motor. In reference to the distribution of the motor nerves to the appendicular muscles there is nothing to be noted as it is given in any treatise both of anatomy, and on this point authorities are agreed.

III. Sensory. The distribution of the sensory nerves in the arm and fore-arm may be briefly stated as follows. The minor surface of the arm and forearm as well as the adjoining portions of the anterior and posterior surfaces, are supplied
by the Intercostal, humeral, the nerve of Wrisberg, the Internial Cutaneous and branches of the Ulnar. The upper part of the Shoulder by the Supra. Clavicular and Supra. Acromial branch of the Vertebal Plexus. The lower and outer part of the Shoulder, as far as the insertion of the Deltid muscle by the Circumflex. The outer Surface of the Arm and free arm as well as the adjoining Surface anteriorly and posteriorly by the Internial and Externial Cutaneous branches of the Musculo. Spinal and the Cutaneous branches of the Musculo Cutaneous.

![Diagram of the arm](image)

1 cm = Lesser Internial Cutaneous. 3 cm = Cutaneous filaments of the Musculo-Spinal. 4 cm = Internial Cutaneous. 5 cm = Musculo-Cutaneous.

The above diagrams taken from Prof. Macalister's recent work on Anatomy map out the distribution of the skiny nerves more definitely.

In the Hand, according to most authorities, British and Continental, the Ulnar nerve supplies both sides of the little finger and the Ulnar border of the ring finger on
both Dorsal and Palmar aspects: while the Median sub-
plasia the radial border of the ring finger, both sides of the
Middle and Index fingers and the Thumb, on their Palmar
aspect, while the radial has a similar distribution on the
Dorsal aspect.

Pathological. I will next pass to the various effects of in-
jury to the Brachial Plexus and the nerves arising from it,
and see how far the truth of the anatomical statements re-
tained above is borne out.
First, I will refer to a case of injury to the whole of the Brach-
ial Plexus. Dr Ross (Brain Vol. VIII pp. 70) records a
case of rupture of the Brachial Plexus involving all its sets
with the exception of the communicating branch from the
4th Cervical. In this case away from sensibility in the
Skin of the hand was lost, as also of the fore arm, with the
exception of a small portion adjoining the elbow in its poste-
rior and internal aspects. The Skin of the inferior half of the
Antebrachial surface of the Arm was completely anesthetie, but
the superior half of that surface, and the whole of the retinacu-
lar posterio and internal surfaces of the arm was sensitive,
though the Sensibility was diminished, the transition being
comparatively abrupt. It is thus evident that the Sensation
in these parts must have been conferred by the sensory
fibres of the communicating branch from the 4th Cervical
(if the diagnosis of the extent of the injury be correct), the De-
scending branches of the Cervical Plexus, and the Musculo-
humeral nerves for the small part near the Elbow.
With regard to the muscles, the upper 1/3rd of the Pectoralis
major, the Pectoralis minor and the internal and external pote-
...
of the humerus were alone unaffected. Dr. Herringham says (loc. cit.) that the 6th, 7th, and 8th nerves give origin to the external anterius thoracic N. which supplies the upper part of the Pectoralis major, the middle and lower parts being supplied by the 7th, 8th, and 9th, and the Pectoralis minor also from these nerves; moreover, he says that the lower internal cutaneous takes origin from the 8th nerve; 1 1/2 Drs. in this case would seem to show that these three nerves must arise from the 4th nerve; or, at least, that the 2 anterior thoracic nerves do so; there may be some doubt about the lower internal cutaneous as its function may have altered, sensation being so often regained long before motion. The external rotators of the humerus, as given by Sir C. P. Turner are the Supra- and Infra-Ospinales and the Pectoralis minor; the nerves to all these muscles Dr. Herringham places to the 5th cervical. The internal rotators are the Subscapularis, Pectoralis, Latissimus D. and Pecor major; the 4th nerve supplies to the Subscapularis, he traces to the 5th, 6th, 7th nerves, and the Pecora major to the 6th nerve. The Pectoralis has been referred to. Hence we see that all these nerves, with the exception of that to the Latissimus, do not confirm Dr. Herringham's statements, at least upon the evidence of this one case only, supposing to that the diagnosis be correct.

It may be urged that this case was one of old standing and consequently that there may have been a re-union of some of the nerves, but Dr. Priest says (p. 74) "the absence of electrical action in the affected muscles is totally opposed to the supposition that any re-union had taken place." - Granted that
This only refers to the affected muscles, but the Deltoid, Biceps, Anconus, Superior Tungs and S. Biceps, are among these, and Dr. Heminghame traces the nerve to the Deltoid to the 5th Cerv., and the roots of the other three muscles to the 6th Cerv.; consequently if 25 union had taken place so as to allow the non-paralysed muscles to act, why should the Deltoid not act likewise? if Dr. Heminghame’s statements be correct, Ites’s proof, though not in strict accordance with this case, approach more nearly to it.

In a similar case recorded by Mauvay and Sullving (Am. Jour. of Med. Science, Vol. III. 1874. p. 29) the Brachial Plexus was excised and consequently the communicating branch from the 2nd Cerv. N. must have been divided. Here the anaesthesia extended up the Anterior surface of the Arm to the Shoulder, while the Medial, Deltoid and Posterior surfaces were sensible to touch. Unfortunately no details are published in this case of the Motor paralysis, but contrasting it with the preceding case one would be led to conclude that the skin of the upper half of the Anterior surface of the Arm was supplied by the branch from the 4th Cervical Nerve.

Here is this difficulty to contend with. Mr. Dixon in his recent work on the Surgery of the Spinal Cord gives two cases (Cases 1 and 2) in which the injury to the Plexus was the same as in Dr. Poer’s case, the 4th Cerv. N. being spared, as was confirmed Post Mortem. In both these cases there was complete muscular paralysis and anaesthesia below the level of the junction of the upper and middle thirds of the Deltoid, i.e. sensation was limited to the area supplied by the Descending Cervical Nerves, the area supplied by the Inter.
costo-humeral being also in this case anesthetised.

Looking at these cases collectively, one sees at once that
the results do not agree, and consequently looks for an
explanation, and I think one is to be found.

That the communicating branch from the 4th Cervical
nerve was spared whilst the rest of the Oblius was injured, was
verified in Mr. Thorburn's two cases at the Port Matilda Ex.
Amputation, and the complete muscle paralysis which was
observed is in strict accordance with Dr. Herringham's
and also with Traube's results. For neither of these authors
trace any of the nerves supplying muscles to the
4th Cervical branch. Dr. Ross's diagnosis was not confirmed.
P.M.; but he gives his reasons for it as follows (loc.cit. p.59).

"The absence of paralysis of the mediod and outward rotators
of the Humerus would seem to indicate that the motor
fibres derived from the communicating branch to the
Brachial Plaeus from the 4th Nerve, had remained un-
affected," but Dr. Ross diagnoses rupture of all the other
parts of the Oblius. — I would suggest that in this
case the 5th post. was also intact and then we would
expect the Biceps, Brachialis Anticus, Supinator Longus,
Tilos, Supra- and Infra-Spinatus to be intact (vide
Thorburn loc.cit. Cases 3 and 9.) and we have seen that
most of these muscles were so; with regard to the Biceps,
Tilos, and Supraspinatus, Dr. Ross says (p. 77) "the patient
can perform certain movements at the Shoulder joint with
the muscles that remain active (viz: upper part of Rotaridae
major, ICteral and Internal rotators) which might lead
one to suppose, without careful examination, that the
Deltoid, Siceps and Biceps possess a slight degree of motor power," while I would suggest they did.

Dr. Ross's opinion was confirmed by Professor Alexander Egerton. One naturally feels very reluctant upon expressing an opinion against the diagnosis of two such eminent authorities, but I think the explanation suggested, brings both Anatomical and Pathological facts into harmony.

With regard to the area of anaesthesia in these cases, there is but little help to be got owing (a) to the fact that when some of the nerves to the limb remain intact, the area of anaesthesia soon tends to diminish, a fact which will be more fully referred to later on; and (b) to the fact that in some cases of injury to the Oblique, secondary changes in the Cord supervene so rapidly, and the area of anaesthesia consequently increases, that unless a case is seen and noted at once, it is of much use; for example case 3 in Dr. Dunbar's book, there was paralysis below the 5th costal; the radial side of the forearm and hand and ball of the thumb were alone sensitive, but four days after the injury there was complete anaesthesia.

This case brings out another point of interest; immediately after the injury there was paralysis of all the muscles except the Deltoid, Biceps, Brachialis Anticus and Supinatus Longus (etc.), the Scapular muscles not being examined. Eight days afterwards, the Deltoid became paralysed, which suggests that the Deltoid Nuclei are situated below these for the Biceps, the former having first yielded to the Descending Pyramidalis, which was discovered. Post mortem. I shall not go through the very interesting


series of cases recorded by Mr. Dearborn, involving the various parts of the Phercus, but I have examined them carefully and I find they are in accordance with Dr. Haringham's paper, which thus proves to be of immense value in the diagnosis of lesions in this region.

I shall just refer to Dr. Haringham's first law with regard to sensation, already quoted, viz. that "of two spots on the skin that is nearer the first axillary border tends to be supplied by the higher nerve" and show how it is confirmed by two cases given by Mr. Dearborn (Cases 3 and 14).

In the former the 4th and 5th spots were intact, sensation remaining on the radial side of the forearm and hand only, while in the latter case, the 8th thor. and 1st dorsal spots alone were injured and the resulting anaesthesia was confined to the little finger and inner side of the long finger, the ulnar border of the forearm and the internal and posterior aspects of the arm. In studying these cases one cannot but be struck by the close association of the nerve supply to the skin and that to the subjacent muscles, and moreover, that there is some close association of those in the central nervous system is promised probable by such cases as that of the man Oase (Charcot, Diseases of the Nervous System, New Syden. Soc. Trans. Vol. III 1880, p. 264), who was suffering from Hypertrophic Monoplegia; it is here recorded that "sensibility to touch, pain and cold is completely and absolutely abolished, (in certain areas) and the cutaneous anaesthesia occurs exclusively in the parts of the extremity (upper) where there is motor paralysis and does not at all follo-
the Anatomical Distribution of the Nerves.

Coming now to the division of individual nerves in the arm itself, we see that the distribution of the Median and Radial nerves to the tip of the hand, as usually described, cannot be correct; and moreover, that there must be a much more intimate anastomosis between the terminations of the various nerves, than is usually mentioned in Anatomical works though Zappery draws attention to it (Spalte d'Anatomie 1871. II, p. 43).

Subjoined is a table of 6 cases of injury to the median nerve that I have collected.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Site of Lesion</th>
<th>Area of Analgesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Honecrt. Tribune Medicale.</td>
<td>Median N. at the wrist.</td>
<td>Complete analgesia of the thumb, index, middle, and ring fingers, except at the extremity of the last named finger. The whole of the palm was sensible. Dorsal aspect: Analgesia of index, middle, and ring fingers, but clearly limited to the two terminal phalanges.</td>
</tr>
<tr>
<td>1874-75. III, p. 89.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1866.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authors &amp; References</td>
<td>State of Lesion</td>
<td>Area of Sensitiveness</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>3. Leriche.</td>
<td>Median at the Wrist.</td>
<td>Anesthesia of the 2 last phalanges of the Index &amp; Middle fingers on both aspects. Thumb insensitive on Palmar aspect of Terminal Phalanx.</td>
</tr>
<tr>
<td>4. Pichot.</td>
<td>Median and Ulnar at the Wrist.</td>
<td>Palmar. Slight anesthesia except of Thumb &amp; little finger of the Thomas prominence. Dorsal. Anesthesia of last 2 Phalanges of the Index Middle &amp; Ring fingers, but in the last two it extended more into the 1st Phalanx. The sides of the 1st Phalanx of Index finger were sensible to touch but not to pain.</td>
</tr>
<tr>
<td>5. Richet.</td>
<td>Median at the Wrist.</td>
<td>Palmar. Diminution of Sensation in the outer half of Ring Middle &amp; Index fingers &amp; Thumb. Dorsal. Great diminution of last 2 phalanges of Middle &amp; Index.</td>
</tr>
</tbody>
</table>
### Anatomical Cross References

<table>
<thead>
<tr>
<th>London Hospital</th>
<th>Seal of Lesion</th>
<th>Area of Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1866</td>
<td>of all fingers and metacarpal bones except thumb and index finger.</td>
<td>up to a little beyond the joint between the first and second phalanges.</td>
</tr>
</tbody>
</table>

The number of such cases might be greatly multiplied but these have selected as being so definitely described, and they will suffice to show that the area of anesthesia is not confined to that part of the skin alone, which is usually described as being supplied by the Median N.; but affects also the digital phalanges which are usually described as being supplied by the Radial Nerve. Because, having his conclusions on the study of such cases as those, has described the nerve distributing thus: "Each finger is supplied with two palmar and two dorsal nerves which are derived from the principal nerves trunks to the hand, and run along the ulnar and radial borders of the palm and back of the fingers. The Palmar are much larger than the Dorsal Branches; they run along the inner side of the Palmar Digital Arteries to reach the tips of the fingers and are chiefly distributed to the Palmar surface. Opposite the first Phalangeal joint of each finger, a long branch is given off on each side which passes round the edge of the finger to the back of the second Phalanx, whilst opposite the 2nd Phalangeal joint, a second smaller branch is given off on each side which also passes round the finger to reach the back of the 3rd Phalanx. These branches divide
without forming a network in the skin of the end of the fingers and in that under the nail. The dorsal digital branches reach only as far as the dorsum of the 1st phalanx, where they form loops with the palmar branches; it is only the hand which is distributed to the thumb alone that reaches to the lingual phalanx.

After a study of several cases reported by Dr. Jonathan Hutchinson in the London Hospital Reports 1860, he concludes “that the digital nerve to the thumb reaches only as high as the root of the nail, on the forefinger to the middle of the second phalanx and on the middle and ring fingers not higher than the first phalangeal joint.

The most recent English work on Anatomy, that of Professor Macalister of Cambridge, adopts this description as the diagram subjoined shows.

Fig. 3

From Macalister.
Part II

It will be convenient here to refer briefly to the Physiology of the Sensory nerves, as that is required as a basis for the Third Part of this Essay.

The Sensory Fibres emerge from the Spinal Cord by the Posterior part of the Spinal Nerves and upon these parts are situated the Spinal Ganglia. This condition has been stated above to hold good also in Fishes, but in them the Posterior parts were shown to be purely Sensory, and the Anterior purely Motor.

In the higher animals it is not so. For though the Posterior are purely Sensory, as far as our knowledge at present goes, the Anterior are not purely Motor. Magendie (Journ. de Physiolo. 1822) discovered that the Anterior were also Sensible, and concluded that there was no difference between the two, but Longeot (Comptes rendus de l'Acad. des Sciences, Jan. 1839, p. 884) first stated that the Sensibility of the Anterior parts was derived from the Posterior and disappeared when the latter were divided. Schiff and C. Bonard (Comptes rendus 1847, p. 104) and Liger sur la physiol. du la pattue, du systeme nerveux, Paris 1855, II. p. 337, 349) found that the Sensory Fibres in the Anterior part run in a centrifugal direction, whereas, those of the posterior parts run centrifugally. This is the reason of the so-called "Recurrence Sensibility" and they found that in order to observe this phenomenon it was necessary that the general sensibility should not be impaired. Moreover, they found that if the animal was slowly stretched Recurrent Sensibility disappeared first, then the Sensibility of the Skin and, lastly, that of the Posterior parts. As the effects of the Ether passed off,
Sensations return in an inverse order. This condition is apparently only found in Mammals, as various authorities have failed to discover it in Insects, Reptiles, Fishes or Birds, which explains why I threw attention to the anterior part in Fisher's 'peepee vitta.'

After the junction of the fibers from the two parts, a mixed nerve is formed, and in it the sensory fibers are carried to the skin. The relative positions of the sensory and motor fibers in a mixed nerve have not been made out, but in the Embryo Rabbit it has been shown by L. F. S. (London's Stirling's Physiology, Vol. II, p. 383) by the direct staining with uranine that the motor fibers take on, that in the anterior part the sensory fibers lie in the outer part, the motor in the inner, whilst the reverse is the case in the posterior part.

The terminations of the sensory nerves in the Skin with their numerous forms of touch corpuscles, as those of Reiner and Minot, of Mair and Pacini, Trousset and Merkel are fully described in all text-books of Physiology and will be omitted here, but it will be convenient, with reference to what will follow, to say a few words descriptive of the way in which the sensory nerves terminate in the Skin by the formation of a Placeus. "From sensory nerve fibers terminate in Placeus, they generally branch once or twice on nearing their termination. The sheaths of these fibers successively become lost, first, the perineural sheath, then the medullary sheath, and, lastly, the primitive sheath, the axis cylinder, being alone continued as a bundle of primitive fibers. This bundle then joins with the ramifications of the axis cylinders of neighboring nerve fibers to form a Primary Placeus. From the
Primary Obliquus smaller branches come off and these from a secondary Obliquus near the surface, generally immediately under the epithelium. Finally, from the secondary Obliquus nerve fibres proceed and from a terminal Obliquus parenchyma amongst the epithelial cells, the actual ending of the fibres being generally in little knob-like enlargements. 

(Schäfer's Essentials of Histology, 2nd Ed. p. 83.) We are still ignorant of the molecular mechanism of nerve endings.

It has long been a vexed question amongst Physiologists to determine exactly the point where the sensory fibres in a mixed nerve turn back in a centrifugal direction to give rise to the central Sensibility. Claude Bernard (Loc. cit. II. p. 20) found that after division of a mixed nerve, the anterior part was insensitive and consequently concluded that the presence of the sensory fibres probably take place at the periphery, possibly through such a pleura as that just described.

Functions of the Sensory Fibres. The function of the sensory fibres is to carry sensory impressions from the periphery to the central nervous system. These impressions are of various kinds as Touch, Pain, Pressure, Temperature, Locality, Feeling etc. Due to the mode of transmission of these various impressions, there is much difference of opinion, some authorities affirming the existence of different sets of fibres for the different impressions, whilst others deny it and maintain that all impressions are carried by the same fibres, but that the various stimuli bring about the same molecular changes in the nerve, which are capable of being discriminated by the brain. Let us examine the arguments adduced by the advocates of these two theories, taking the latter first. Dr. W. Mitchell
in his book on "Injuries of War" (p. 39) says "The phenomenon of nerve injuries tend to discern it by negative proofs that injury over the presence from vague states of sensory nerve fibers" and he goes on to say that all the intestinal organs are supplied by sensory fibers of which some must be pain conducting and may perhaps only be passed into activity once in a lifetime; it is difficult to understand how it is rarely used, they can sustain their organic life uninjured and ready to break in into functional activity at any and irregular intervals. "I am unwilling," he says (p. 40) "in view of these facts, to look upon pain as a distinct sense with special nerves peculiar to itself; and when we consider also how sensory impressions, made on nerves of special sense, may rise to the height of being painful, it becomes more and more probable that pain is a central expression of a certain grade of irritation in any contrived or nerve." Again (p. 109) he says "The sense of temperature is lost with that of pain and touch" (as if pain and touch were always lost together) "and usually in a like degree. I have never seen it altered from vera wounds without affection of the pain and last sense. Neither have I met with any case of vera wound which seemed to involve less of muscular sense." But the same author gives two cases in his "Report on Vera Wounds" (Cases 27 and 28) which do not quite bear out what I have quoted above; in the first of these cases, a wound of the arm, there was a great diminution in the sense of pain, with no less touch; and in the second, the loss of the pain sense was so great that the electric wire hand was scarcely felt, and this was accompanied by hyperesthesia.
Again, Mr. Brewley of S. Bartholomew's Hospital, in his treatise on "Phlegmasia and Diseases of Veins" (p. 14) says "There is really no reason why the same nerve fiber should not be capable of conveying various impressions, and can be appreciated by the nerve centers. To know that the contractile muscle can be excited by the application of various irritants to its nerve, and as far as I am aware, no one has yet suggested that each stimulus requires a separate set of fibers to produce that due effect." But I do not see that the analogy holds good; for in the first case each different cause produces the same effect, viz. muscle contraction, but in the case of sensation, each cause produces its own particular effect. If the cases were analogous, the right inference to draw would be, that the various sensory stimuli would all produce one and the same impression in the brain, which is clearly not the case.

In advocates of the opposite theory, viz. separate tracts for the separate stimuli, are much more numerous. In Landrié and Stirling's Physiology (Vol. II p. 1150) it is stated that the nerve trunks contain two functionally different kinds of nerve fibers, (a) those for transmitting painful impressions, and (b) those for tactile impressions which include temperature and pressure impressions; and the facts adduced in support of this are (i) tactile sensations are absent from all internal vessels; pain can alone be discharged from them; (ii) probably the opposite acts discharged by both sets of fibers are under the influence of special central organs; (iii) one sensation may be abolished and the other intensified, even increased under pathological conditions.
and under the action of narcotics; and (iv) the different
levels of the fibers in the Spinal Cord.
Strung as these arguments are, I think the division of the Sen.
ory fibers into two sets only is not enough; and, moreover,
the Temperature sense fibers can hardly be identical with
the tactile, since the impressions of pain and temperature
are transmitted by deeper portions of the Cord than are the
ordinary tactile impressions. (Professor Granger Sturte-
vant, The Nervous System, p. 7.)
The parasites of Oise (Reid, f. Hist. : B. 2, p. 141)
Eulenberg (Reed, f. Hist. : B. 7, p. 44) Horsen and
Goldscheider show that on the cutaneous surface there are
temperature spots, i.e., little areas in which sensations of heat
and cold are more acutely felt than in adjoining areas:
some cold spots, others heat spots; the former are the more
numerous; but are sensible to pressure; irritation does not
produce pain. "No terminal organ for temperature has yet
been discovered" (McIntosh, Text-book of Ophthalmology, p. 638.)
Here we see that the Temperature spots though sensible to
pressure, are not to pain, which is probably due to conductus
by different nerve fibers, though as we have seen above, they
are in the same Spinal Tract. Moreover, Dr. Jones (Diseases
of the Nervous System, Vol. I, p. 8) says that there is strong precedent
for the idea that the Sensibility to heat and cold are subdivided
by different nerves, which is quite in accordance with the
presence of the Cutaneous heat and cold areas.
I have as yet not been able to find any evidence for separate
sets of fibers for the conduction of Temperature and of Pressure,
though they may exist, but the fact of the Temperature spots
Being sensible to pressure, tends rather to disperse it.
Consequently, I would divide the Sensory Glands into:

(i) Tactile.
(ii) Pain.
(iii) Pressure and Temperature { Cold.

There is no evidence of special sense for conducting the impressions of Locality and Touching; the latter is possibly a simple Tactile impression on a somewhat hyposthetic End Organ. The impression of Locality, I believe to be purely a Function of the Brain, because in a young infant, though the functions of the Pain, Tactile and Temperature conducting Glands are all active, as are also the Glands conducting the Special Sense impressions, yet it is some months before the child can tell the direction from which a sound comes and look towards the place; and, again, if you touch a young child's hand, before it has noticed your presence, hardly stimulating its tactile Glands, it will as often as not look for the exciting cause in a wrong direction. Hence, if the other Sensory Glands are functionally active, why are not those of Locality, if they be separate Glands for that particular kind of impression? Having thus classified the Sensory Glands, let us see whether this classification possesses the support of Clinical Observations. and I think it does. We find it borne out by the two cases of Dr. Stur Mitchell already referred to (p. 25) Cases 24 and 25. in his "Report on Nerve Disorders" and also by the case by Reclus and Fourotte. (Case 4) in the table on p. 19 of his "Thesis." In a forthcoming paper by Professor Bloch of Paris on Syringomyelia, he says that in this disease sensibility to Pain, heat and cold are affected, while the Tactile sense is not.
In a very interesting case of Acute Atrophic Spinal Paralysis recorded by Dr. B. (Practitioner, Vol. 29, 1892) we find these different conditions in the different parts of the body: 

**Left extremity.**
- Tactile Sense: Normal.
- Pain: Abolished.
- Dermal: Abolished.

**Right extremity.**
- Tactile: Normal.
- Pain: Hypersensitive.
- Dermal: Diminished.

From the 2nd to the 10th ribs, all these were abolished.

It is only, I think, by the study of such cases as these that one can really settle the question, as a stimulus applied directly to the nerve endings may produce a sensation which cannot with any degree of accuracy be defined by the individual, as a slight dermal impression may produce at the same time a tactile impression, and either may very easily become painful.

During the time that I was Clinical Assistant in the Electro-therapeutical Department at St. Mary's Hospital, under Dr. A. St.silville, I worked at the subject of alterations in the Electrical Excitability of the Cutaneous Nerves in health and Disease, especially in the cases of Lacteal Atonia, of which there were a number for suspension treatment, but even working in the line set down by Dr. Bichat and Dr. Stilville (Brain Vol. II. 1849-50) for concerning variations in the resistance of the skin, owing to the great differences in the excitability in healthy people, but more especially to their inability to define with any exactitude their various sensory impressions, I was quite unable to come to any satisfactory conclusion. 

Some of the subject is afforded by the electrical test.
Part III.
In dealing with the Pathological relations of the Nerves, I
shall not enter into the microscopic changes taking place
in cases of injury and disease of the nerve, as it would in great
part be a mere recapitulation of the results of the researches
of Dr. Waller, which are now so well known, but I shall
confine myself chiefly to the so-called "Subjective Symptoms"
or alterations in the normal Physiological Functions, and
shall begin with one of the most frequent, viz.:—
Anesthesia. This term though literally meaning loss of
Sensation, is more generally understood to mean loss of the
Tactile sense. The cause may be Central, Bilateral, i.e.;
in the nerve terminations, or Intermediate, i.e.; in the course
of the nerve trunks.
Central. This may be either in the Brain or Spinal Cord,
and is then chiefly due to pressure upon the Sensory Center
in the Sensory Conducting Tracks. The pressure may be
due to Tumours, Abscess (though in this case the Anesthesia
is not usually a prominent symptom) or Hemorrhage.
In the last case the Hemorrhage may be preceded by
Alteration of Sensation, probably due to some disturbance
in the Central Circulation. Inflammatory and other
lesions of the Spinal Cord and its membranes may give
rise to this symptom, as is seen in locomotor Ataxia;
there are also, doubtless, due to alterations in the circulation
or to pressure from the Spinal Cord.
But Anesthesia of Central origin may be Physic as in
the recent numerous exhibitions of Hysteria; or, Juncin
also as in Hysteria, in which case the affected site may vary
from time to time. Dr. Savage (Loc. cit. p. 291) states that local anaesthesia is very common in cases of General Paralysis of the Insane; this, he says, is probably of central origin and due to degenerative changes. It may also be caused by drugs, as by the inhalation of chloroform, and in the later stages of the toxic effects of Cannabis Indica. Dr. Panger (Practical It. p. 321) says that there is such complete anaesthesia, that, while standing there is no consciousness of touching the ground.

(ii) Peripheral. May be due to pathological changes in the nerve terminations, as in Herpes Zoster, in which disease the line between the vesicles is often anaesthetic, and according to Bonnet (Jouv., de Dermatologie, T.IV, p. 347), the anaesthetic areas are surrounded by zones of hyperaesthesia; the anaesthesia may persist after the localization of the vesicles. This may probably be due to nutritive changes.

Again, there is a similar condition in Erythematosis Anaesthetica; here, according to Bock and Davidson (Quain's Diet. of Med.) the structure of the cutaneous nerves are thickened and distended with exudative products. It also occurs (Bonnet, Loc. cit. p. 346) in Poriasis Scle-rotica, and is a point in diagnosis; for in this form there is anaesthesia with analgesia; in P. circinata the reverse is the case and in P. guttata (22) there are no functional symptoms.

The peculiar condition, the Anaesthesia Dolorosa of Blumberg, must be mentioned in this connection. Peripheral anaesthesia may be produced by the local action
of various drugs, but we can well separate this condition from Peripheral Analgesia as the agents are used surgically to produce the latter effect.

Carbonic Acid was first mentioned by Ingenhouz (Miscellanea physico-medica, 1794 p. 8) as having local anaesthetic properties. Thomas Beddoes states that having had the skin taken off his finger by a knife, the pain which he felt on exposure to the air was relieved by putting it into CO₂.

(consideration on the medical use and on the production of lacrimation also, by Dr. Beddoes and James Watt, 1795: p. 43) Similar applications of this gas were made by Bouca, Vonsul and Sir James Simpson.

Carbonic Oxide (Cycl. Comp. Med. March 2nd 1857) Ether Acids, Cold all produce local anaesthesia, the joint becoming blanched and anaemic and both anaesthetic and analgesic. Cold probably acts by the intense anaemia it causes; Warmth, on the other hand causes hyperaesthesia. How these substances act is not quite clear, it may be by their chemical properties acting directly on the nerve endings, or by altering the circulation, causing anaemia and consequently lowering the nutrition of the nerve endings and depressing their functional activity.

(iii) Intermediate. In all three cases there is an interruption of the tactile impressions as they pass centrifugally. This interruption may be more or less complete, the whole nerve being divided or only certain strands, as in punctured wounds, or to changes in the substance of the nerve itself, to pressure from within or to contusion.
Cases due to pressure from without are not infrequent; the pressure may be due to tumors of various kinds as ex.
cesses, or to distraction of a bone coming to press on a nerve.

Frank, DeJherm, in his 'Electrization Localisee' places some cases, that being distraction of the head of the humerus causing loss of sensation. The initial loss of sensation was due partially to the pressure preventing the conduction of the nerve impressions to the cortex, but if the distraction be not reduced, the constant press.

sure would cause anaemia and staphy of the vessels and bring about a permanent anaesthesia as far as that nerve was concerned. That this loss of sensation was caused by concussion and compression and not by a laceration of the nerves was proved post mortem; indeed, Malgrange states that he has never been able to produce rupture of the brachial plexus on the dead body, no matter how much traction he put on the upper limb, and he has never seen it post mortem, from distraction of the humerus in any of the cases that he has examined. That such a rupture of the plexus is possible from traction during life is evidenced by the case preceded by Dr. Ross (Brain. Vol. IV. p. 70) to which I have already referred. Compression of a nerve trunk used formerly to be regarded as a means of producing local anaesthesia for surgical purposes.

Vulpian and Barton (Comptes rendus, 1856 p. 1009.) have studied the phenomena of nerve compression, and they divide it into two periods, one of advance and the other of decline, in each of which are four stages.
The 1st stage of the advance period, is marked by somnolence and languidness; the 2nd (intermediate) stage, in which there is a return to the normal; 3rd stage of hyperesthesia, and the 4th of anaesthesia, being accompanied with muscular paralysis. The period of decline has these four stages but is arranged in an inverse order.

A. Wallae (Proc. Roy. Soc. London, May 13th 1862) has verified these results, but in addition has pointed out that when a single nerve has been compressed, the spinal muscular paralysis is not confined to the muscles alone supplied by that nerve, this is in accordance with the clinical researches of Duchenne, Dr. Mitchell and others.

For an explanation of this fact we must look to the conclusions of Romali, Del. Ferrer and others, that the function of the motor cells in the spinal cord depends on the physiological association of muscles in the production of certain movements and not on the mere anatomical fact of their being supplied by the same nerve trunk; and moreover, that a muscle concerned in different sets of movements is connected with correspondingly different sets of nerve cells in the cord, hence compression of a nerve going to a certain muscle may give rise to disturbance in the various sets of nerve cells with which that muscle is connected and this disturbance may radiate to the neighbouring spinal motor cells and consequently affect the muscles over which they preside.

Contractions may also cause anaesthesia, but in these cases from an alteration in the nerve fibres, probably from a breaking up of their axis cylinders.
Cases of anæsthesia from contusion without any apparent
traumatic lesion are on record, one by Dr. Mitchell from a
strain of the wrist (Injuries to the Nervous System. Case 7, p. 96,) and
another by Lamarque (Oeuvres chirurgicales. Vol. II, p. 617.)
in which a blow from a billiard cue, on the shoulder, caused
entire loss of sensation in the arm for fifteen days.

Changes in the nerve trunk. Changes in this position
giving rise to the loss of the tactile sense, are not very com-
mon. Nerveatic areas are found in cases of long contu-
sion.

Neuralgia, but according to Dr. Dugard (Quain's
Dict. of Med.) and to the experience of many, neuralgia,
of not of long duration, is accompanied by hyperæsthesia.

With regard to the Pathology of Neuralgia little is known,
but according to the same authority (loc. cit.) the nerve
trunk is sometimes found swollen and hyperæmic;
and in a later stage it may be atrophied and degenerated,
and the atrophy would be associated with anæmia.

From what has been said it appears that anæsthesia is
caused by anæmia, excluding, of course, all those cases
where there is abolition of continuity in the nerve, or dis-
section of nerve tissue. In all cases due to pressure may
be looked upon as cases of local anæmia of a nerve and
through which the ordinary tactile impressions become
perverted; so also, in Neuralgia we have seen that the
Stage of anæsthesia is associated with an anæmic condi-
tion of the nerve.

In support of this conclusion, there is a certain amount
of experimental evidence. Dr. E. Mitchell (loc. cit.)
applied ice and salt over the arm Ulnar Nerve at the Elbow
in order to signify it; the first effect is an aching pain, but after a time, there is total anaesthesia in the area of distribution of that nerve. Of course, the nerve was not afterwards examined, but we may fairly conclude that the prolonged freezing would cause anemia, as the nerve in this situation is so superficial; had it been deeply seated one might expect an opposite condition.

We now come to cases of sensation due to a solution in the continuity of a nerve trunk; this may be partial or complete, as the nerve is partially or entirely divided.

In cases of loss of the tactile sense, it is here self-evident, but I shall pass to some of the considerations which division of a nerve brings under our notice; they are:

1. Anaesthesia does not supervene immediately, in all cases, after the infliction of the wound.
2. The affected area does not always correspond with the anatomical distribution of the nerve.
3. The area of anaesthesia tends to diminish with lapse of time.
4. Sensation may be but little affected though there be complete muscular paralysis, and it is re-established sooner.

5. When a nerve of mixed function is slightly injured, the first impression is most felt by the sensory fibres, and any motor loss is apt to be due to secondary changes; but, in more severe lesions, motor and sensation are lost at first.

But that the loss of sensation may not supervene directly
after the infliction of an injury and may be preceded by motor paralysis is shown by the case of dislocation of the humerus preceded by Suchomne (Le. cit. Case 29.)

However, some of the cases where loss of sensation has been delayed may possibly not have been most properly examined, especially if the injury has been to a single nerve trunk, as in these cases complete division may take place without causing complete anesthesia in any part of the area of distribution of the sensory branches of that nerve, a fact to the consideration of which we now pass:

(3.) That the affected area does not always correspond with the supposed anatomical distribution of the nerve, may be due to two causes: (i) the anatomical distribution of the nerves may have been imperfectly known and described, as has been shown to have been the case in Part I of this Thesis, with regard to the Cutaneous nerves of the hand; and (ii) the over-lapping, as it were, in the terminal distribution of nerves, so that when one nerve is injured, another is able to carry on the Sensory function over the area principally supplied by the injured nerve.

This is shown clinically to be a fact, by two cases observed by Littre and Traité des Section des Nerfs, Paris 1843, p. 430, of complete division of the ulnar nerve with paralysis of the muscles supplied by it, but the loss of sensation was only complete over a small patch on the ulnar border of the hand, the remaining portion of the finger supplied by that nerve being only incompletely anæsthetic.

This fact is also confirmed by the experiments of Babkin and Eiplsir (Archiv de Physiol. normale et pathologique. –
II. (pp. 33 and 36.) He found that division of one or two of the nerves supplying the digit of a dog or cat, caused but little diminution in the area of sensibility; and that it was only when all four nerves were divided that complete anesthesia resulted. Again, they found in the fifth digit of a dog, which is supplied by branches from the Radial and Ulnar nerves, division of one nerve causes only partial, but division of both, complete, anesthesia. Division of the Ulnar nerve alone, in the cat, causes complete anesthesia of the fifth digit, as it is only supplied by that nerve.

This widespread effect of the nerves is probably brought about through the fine anastomoses between the terminal filaments of neighboring nerves, as I have described above in speaking of other terminations (Part II), possibly by recurrent sensibility, as Asling and Egerius think, acting through these anastomoses.

This leads us to the third consideration: viz.:

(y) The area of anesthesia tends to diminish with lapse of time. This may be due to reunion of the ends of the divided nerves. This union may possibly be "first intention," though it is doubtful, and sensibility restored within a few hours as in a case recorded by Lacaix (Bullet. de la Soc. de chim. Juin 1862.). Dr. Mitchell (loc. cit. p. 239) throws doubt on this case owing to the unsatisfactory way in which the sensibility to touch was tested, and quotes Villain, who says that since this case both Molaison and Verneuil have both used the simple or divided nerves, but without even an approach to the success above recorded.
Though Dr. Richet seems to have no doubt as to the union by first intention and quotes several cases in support of it, (Recherches experimentales et cliniques sur la semiliqueur, Paris, 1877, p. 23,) I am inclined to agree with Erich Mitchell because I doubt whether it is possible to so rapid a re-annulation of function, and secondly, even if properly tested, as I have said, division of a single nerve trunk does not cause complete anesthesis of the part it supplies, as is shown by a case quoted by A. Richet (Clinique medicale, 1867, Ter. p. 270,) where the median nerve was divided and the sensibility of the parts supplied by it was intact, and similar cases are recorded with regard to the ulnar nerve by Pringle (Military Surgery, p. 377.)

That a restoration of function is ultimately brought about and it may be hastened by suture is within the experience of most surgeons, even after the division has taken place for 16 months or longer. In all these cases motion is not restored until after sensation has for some time returned. Here we are brought to a point much debated upon by physiologists. There is no doubt that motor nerves will unite with motor and sensory into sensory into restored junctions, but will sensory unite with motor nerves? Paul Bert made the following experiment: he stitched the tail of a rat into the animals back and after union had taken place, he cut the Tail from the body at the root, so that the tail, as it were, grew out of the animals back, head end uppermost. In stimulating the end of the tail, which was formerly the root, the animal gave signs of pain. This experiment shows that motor fibers can conduct impulses.
in both directions. One of two things must have occurred: either the motor fibres which normally carry impulses down the tail, now convey them in the opposite direction, and convey them to sensory fibres with which they had united, or the sensory fibres must have united with sensory only and convey impulses in an opposite direction to normal. Bichat asserts that he has succeeded in uniting the hypoglossal with the vagus nerve in the dog. (London and Stirling's Physiology. 2nd Ed. Vol. II. p. 787.)

That the area of sensibility may diminish without any such union is seen frequently clinically, and is, I think, due to neighboring nerve terminations taking an increased influence, what may be termed a function of compensation analogous to what is observed in the opening up of a collateral circulation.

(19) That sensation may be but little affected though there be complete muscle paralysis, is shown by the case given by A. Bichat, quoted above, in which there was paralysis of all the muscles supplied by the median, and only a very homonymous loss of sensation, and also by other cases recorded by Dr. Mitchell (Loc. cit. Cases 35 and 36. pp. 207 and 209).

This is also explained either by the function of compensation, or by Recurrent Sensibility, or by both factors acting together. That sensation is preserved before motion is, I think, acknowledged generally, at any rate, we have the authority of Priestley and Dr. Mitchell, and in explanation of this fact I cannot do better than quote the latter authority: + (1950)

"When a junction is partially paralyzed, its continued exercise is one of the conditions of its ultimate return to
Full activity so soon as the neural injury has become repaired. The sense of touch is in constant automatic use, every contact being a continued stimulus to its activity, and the very fact of deficient feeling subjects the part to rough and unusual irritations. But when muscles are partially paralysed an effort of will, greater than common, is demanded to take them into action. The early inflammatory conditions make motion painful. The effort to unusually assume, and there is no movable and constant stimulus, such as exists in regard to touch. Hence, perhaps it is that motility is regained less easily than sensibility.

I now pass to the consideration of the opposite condition, viz.: Hypoesthesia or increase in the tactile sensibility, and in discussing this symptom it is almost impossible not to include in this term, such other conditions as hypalgesia, as in Hypoaesthetic conditions the slightest touch may give rise to pain. Dr. Buggard thinks it is doubtful whether the sense of touch, or the power of tactile discrimination, is ever markedly increased except possibly in certain cases of Hysteria and mental disorders, and moreover that it is rarely detected clinically and is of but little clinical importance.

Cause it may be
1. Central as in Hysteria; in mental disorders it is less frequently being most common in General Paralysis, and even in this disease it is far less common than anaesthesia.
2. (Dr. Savage. "Insanity," p. 291).
It is also sometimes seen in the early stages of tubercular conditions and in inflammatory affections of the central nervous
System. At the upper limit of an inflammatory lesion in the cord, either traumatic or idiopathic, there is often a zone of hyperesthesia; the cause being probably due to a congested and irritated condition of the neighbouring root of sensory cells in the cord. This grinding of sensory cells in the cord, and to which certain curious phenomena, such as the pain, in Longma Oelais, in the left arm, may possibly be due, is discussed at length in a most interesting paper by Dr. Slades on "The Phenomena of Longma Oelais, and their bearing upon the Theory of Counter-Impression." (Brain, Vol. II, p. 472.)

Sensations. Here the cause of hyperesthesia frequently lies in the various forms of inflammation of the skin. I have seen plenty of cellulitis in the lower third of the thigh.

According to Dr. Pigor, in the early stages of the toxic effects of Cannabis indica, pressure on the skin may cause a sense of burning, which may be looked upon as a form of hyperesthesia.

Intermediate. Some of these causes have already been incidentally mentioned. It has been seen that Bulpian and Pardon state that hyperesthesia is the characteristic of the 3rd stage of spinal compression; it is also frequent in the early stages of neuralgia, coincident with a swollen and hyperemic condition of the nerve.

This subject cannot be further considered apart from the subject of Pain, with which it is so intimately associated, but I have, I think, said sufficient to show that the diazoe of the nerve tissue to be the immediate cause of...
Anesthesia, be it Central, Peripheral or Intermediate, and that Hyperesthesia is caused by a congested condition of the nerve plexus in some part of its course.

Pain is the most common symptom of nervous lesions of all descriptions. As nerves vary in their excitability, so different beings vary in their susceptibility to pain. Ségard has noticed that men and animals of the New World bear pain better than those of the Old World; so also the more uncivilized bear pain better than the man civilized. If we have all heard of the African woman, falling out of the hands of a slave gang, being confined alone by a secluded stream, in which to wash the infant, and then immediately joining the gang and continuing the march. So also in every day experience, we notice that in the lower ranks of life, women seem to suffer less at such a time, than those in the higher walks of life; this, I think, must surely be from a difference in nerve sensibility, probably due to a higher development of the Sensory centres in the brain.

Of course, in Man, the will plays an important part, and due allowance must be made, but there must be something apart from this. For physiologists tell us that all flags do not bear the same sensory excitations in the same way, and that in winter, sensation in flags is so dulled that one can practice on them all kinds of vivisection which it would be impossible to do in warmer weather (E. Chev. Orphel. Soc. at p. 238.) Thus we see that...
in fogs at least, the irritability of a nerve is not always the same and consequently we are led to think that the state of the nerve plays an important part in the aetiology of the pain which a certain impression may produce, and this there is both clinical and experimental confirmation. for we all know how exceedingly sensitive inflamed structures are, as for example, and, moreover how much more painful is an incision into inflamed skin than on into healthy skin: a still more curious fact is, that sensibility may return in an anaesthetic area if it become inflamed, as is seen sometimes in cases of laparotomy (Gayon. Comptes rend. T. 69. 1856, p. 90.) it has been shown by Keller and Fleury (Ker. sur la nature des parties sensibles st iritables. I. p. 156. and Comptes rend. T. 43. p. 642 and T. 44. p. 804.) that the healthy sura nerve is insensible but if inflamed is very sensitive, and with regard to the reflex action of pain, Sacharoff (Gazette médicale. 1875.) has shown that whilst it is not possible easily to arrest the heart's action by exciting the memory of a jog, it is possible when that membrane is inflamed by exposure to the air for some time.

Another example, is one of every day experience, I mean the pain of joint and ligament injuries, sprains and inflammatory conditions of the tendons, all of which tissues were at one time supposed to be practically extra-neural. As the seat of origin of the pain, it may be, is central, this requires no mention, but there are two curious forms of pain, seen in cases of Decerebro Ataxia, which
across a passing mention, they are the lightning and girdle pains. Of the former, I am able to offer no attempt at an explanation; the latter are probably due to gradual contraction of the sclerotic fibrous tissue which surrounds the point of entrance of the posterior sensory roots into the spinal cord.

The pain which is sometimes due to shock is also of central origin. In many cases where the pain is undoubtedly of central origin, it is often referred to the periphery, as in these girdle pains, and in the aura of epilepsy, in which a spontaneous disturbance begins in the sensory part of the cerebral cortex, and yet various sensations are felt at the periphery in the absence of any outward disturbance to correspond with them.

Peripheral Pain may be produced peripherally by various inflammatory affections of the spine involving the nerve terminations, or the nerve terminations themselves may be primarily affected as in Peripheral Paralysis, or by an excessive stimulation as by stinging, or intermediate. There may or may not be any solution of continuity in the nerve trunk, as in puncture or division of the nerve, or where there is contusion, congestion or inflammation of a nerve.

Pain may be of various kinds as aching, tearing, burning burning etc. but there seems to be no relationship between the character of the pain and the nature of the wound; but where there is no solution of continuity of the nerve, the pain is more usually of the aching and trenching kind, unless secondary changes take place give rise to the pain of Paralysis.
There is a peculiar intense burning pain which is very frequently associated with a glossy condition of the skin to which Dr. W. Mitchell has given the name, causalgia; it rarely arises at the moment of wounding but almost always during the healing of the wound. The cause is unknown but it sometimes follows the transfer of pathological changes from a wounded nerve to an unwounded nerve and has been felt in their distribution. It most frequently attacks the arms and legs, rarely the hands and feet, never the trunk.

Pain is often not felt at the moment of infliction of a nerve injury and if it does it rarely persists. In 91 cases of nerve injury collected by Dr. W. Mitchell, pain followed immediately in rather less than two-thirds of the cases, and in only one of these did it persist; in the remainder it passed off leaving a sensation of tingling and numbness. Pain may be caused by simple pressure, but is apt to be more severe if the pressure varies; acute pain due to pressure is frequent in cases of aneurism. In many punctured wounds this may be pain and hyperesthesia, which may grow worse if congestion of the wound, and hyperplasia of the inter-neural connective tissue supervene.

Pain from nerve injury, may be constant or intermittent. “The neuralgias common to all nerve injuries are apt to assume a quotidian type, and, as a rule, occupy the later rather than the earlier hours of the day,” thus differing from causalgia (Dr. Mitchell, loc. cit. p. 195) and may probably be due to stimulation of the circulation from exercise. A curious case, related by Mr. Swan, and referred to
By Dr. Eric Mitchell, of an ulcer over the Choroidal nerve, occasioned a pain which prevailed daily at the same hour. Pain is usually, as has been said, referred to the termination of the injured nerve, a pain can be referred to remote parts, without any pain at the point of injury, a condition known as Allosthesia. After an amputation pain is commonly referred for some time to the limb that has been removed. Injury to the Sciatic nerve may cause pain and paresthesia of the foot, and Dr. Eric Mitchell says that in many cases of wick wounds great pain has been felt at the motion of the deltoid muscles, and he suggests that it may be due to spasm, but spasm would not account for a case, such as the one given by Professor Anandale (Malignant of Angina and Miscellaneous, Case 35) in which the pain was felt in the right hand and in the sides of the foot, though the injury was to the ring finger of the left hand.

Possibly some explanation may be found for it in the physiological grouping of sensory cells in the cord, similar to that for the motor cells, and when one group of cells becomes irritated through fibers from the periphery, the irritation radiates to neighboring groups of cells, which themselves becoming irritated, propel the irritation to the periphery of the nerves over which they pass.

Pain may cause reflex muscular contractions especially in the muscles innervated by the facial nerve. Simulation of the centrally or a sensory nerve causes elevation of the blood pressure and a lowering of the pulse rate (Ch. Michels. 1867: at. P. 119). The effects of pain may also become evi-
Work by alterations in the intellect, it may be in some cases by permanent loss of reason.

In speaking of the disorder of the tactile sensibility, I spoke of the condition known as anosodia, that is, the condition in which the sensation is felt on the opposite side of the body to the one touched and I referred to a case of Professor Annandale in which this symptom occurred, but I omitted to mention the two conditions known as algaeesthesia and dysalgaeesthesia.

In algaeesthesia, a single impression is felt as two or three, and Professor Granger Stewart gives a good example of it (Soc. at. J. 69). These multiple impressions according to Dr. Gowres, are usually all felt in the same limb.

Dysalgaeesthesia, or Baralgaeesthesia, was first described by Charcot. In this condition a touch may give rise to pain, or both tactile and painful impressions may produce sensations abnormal in character, as tickling, tingling, etc., in the limb touched.

These conditions are of very rare occurrence, and as so little is known of them, I will not dwell upon them any longer.

Temperature Sense. On this subject I have little to add to what has already been said in Part II. Sensibility to temperature is usually affected with that of pain, but often not in the same degree, as one may be affected without the other. There may be absolute
inability to recognize heat and cold, as such, or only when there is a wide range between them; it is any difference, for instance, or, again, heat may be felt as cold, and cold as heat. The sense of temperature is always slightly delayed, even in health, owing to the time having to be heated or cooled, before the nerve terminations commence to receive the impression. Then perception of pain is delayed, that of temperature may be much delayed also.

Retardation in the Conduction of Impressions. In various conditions the impressions may be delayed, any or all being affected. I shall not say more on this subject, as it occurs solely in lesions of the Central Nervous System. Dr. Gris Mitchell says (Loc. cit. p. 225.) that "even in the greatest degree of nerve trunks, if a touch were felt at all, it was felt not as remarkable delay."

Leaving now the subject of alterations in the Tactile Sensibility, I pass next to the Muscular Sense which is due to the Sensory Nerves uniting with muscles in such a manner that there is an abundant supply of nerve fibers, so that there is auyer and which end, according to Tschirn (Archiv für Psychiatrie, Bd. VIII, Heft 3.) in the interstitial tissue between the muscular fibers. This sense may be impaired or diminished. It is conceivable that loss of muscular sense may result from lesions of the nerves, but I have not yet seen part of this." (Granger: Loc. cit. p. 72.)

In every case that alteration of this sense has been observed of which I have been able to find any account, there has
from some central lesion, as Locomotor Ataxia, consequently I shall not touch further on this subject.

Paradoxical Muscular contraction. Under this name Bostabel has described a curious condition, sometimes, though rarely seen in man, sometimes in a slow tonic contraction in a muscle when suddenly relaxed, or its course suddenly shortened. The mechanism is uncertain, and it is but rarely seen in the arm.

I now pass to say a few words on some of the more remote symptoms sometimes seen in lesions of the roots of the Upper Extremity, and I shall commence with the Ischaemic Changes in the Skin and its Appendages.

1. Hoars Lick. Blisters and Bullae may occur arranged in groups, which may occur in successive crops, along the course of the nerve. In the British Medical Journal (April 26, 1890, p. 963) Dr. Thomson relates a case of Hoars in a girl aged 9, involving the area of skin supplied by the Internal Cutaneous Nerve of the right arm; there were also two groups of vesicles in the palm of the hand. The eruption was preceded for a day or two by severe pain in the affected region, probably neuritis, but there was no traumatic cause. The eruption appeared in crops which broke out successively in the upper arm, forearm and palm. Dr. Thomson discussed the early of the condition, in prospect of the distal distribution and the youthfulness of the patient; and also of the involvement of the skin of the palm, usually supplied
by the median nerve, viz. a lesion dependent mainly or entirely on injuries of the internal cutaneous nerve. This eruption is often seen after injuries to the nerves, and Charles has given it the name of "Zona traumatica." It usually appears about the fourth day or later after the injury, but Mr. Tanson reports a case (Med. Times Gaz. Dec. 30, 1871) in which he saw it unusually early, namely the second day.

(i) Erythema, may occur and according to Willis Mitchell is a very constant feature with glossy skin.

(ii) Porphyria bullae occur in crops on the skin supplied by the injured nerve. They leave indelible scars. (Charles)

(iii) Erythema. A cutaneous condition resembling Erythema Multiforme, in which there is hyperaemia of the skin and subcutaneous cellular tissue simulating Polyanion.

(iv) Liikens and an Ichthyoid thickening of the skin may, according to Bessisa Groainger Stewart, occur, but I have not been able to find any cases of it.

(v) Gangrene may supervene and the fingers drop off, or a slough may come away as in a case of Gangrene of the Ulnar side of the hand following an injury to the Ulnar Nerve, recorded by Pett (N.Y. Med. Record. 1882, p. 576.)

(vi) Glossy Skin. This condition was first described by Dr. (now Sir James) Paget (Med. Times Gaz. March 26, 1869). The skin has a peculiar, shining, glossy appearance. The fingers are usually tapering, smooth, hairless, almost void of wrinkles, glossy, pink or reddish or blistered as if with permanent chillblains. The
Description given by Dr. Machouse, Kern and Dr. Mitchell of this condition only differs from the preceding in that they add that "the epidermis appeared to have been partially lost, so that the cutis was exposed in places." (Loc. cit. p. 158.)

Many cases of this condition are preceded, not the least interesting being Dr. J. Amundson's already referred to. This case, like nearly all the others, was accompanied with severe pain. Paget says it is "the accompanying symptom of certain irritable Neuralgias," and D. Mitchell says (p. 156) that it is "deeply present without burning pain." This, though true of the great majority of cases, is not invariable. For Mr. Bowley (Loc. cit. p. 142) gives two cases of Glossy Skin without any pain.

As to the duration of this condition, D. Mitchell says it varies from a few weeks to years, "but in all cases I have been able to follow, it has either been cured or gradually disappeared." That it may be of very long standing, is shown by one of Mr. Bowley's cases which was of more than 12 years standing and which showed no signs of improvement.

Some cases are preceded in which the condition comes and goes. It is probably due to an atrophic condition of the Skin.

_Sweat Glands and their Secretion._ In Glossy Skin there may be atrophy of these glands with diminution in the amount of secretion, and it may also in some cases where there is no Glossy condition of the Skin. In a number of D. Mitchell's cases of Glossy Skin accompanied with Neuralgia the Sweat was excessive in amount, very acid and with an intensely
Hair on the Skin may be altered; it may be split, short and course or absent altogether from atrophy of the roots as in Glycyrriza.

Levita relates a case, quoted by Morecot (vide infra) of traumatic neuralgia in which the hair was large, hard and with a great tendency to stand erect. This condition has also been seen in hair growing from hyperaesthetic skin, and Dr. Mitchell refers to a case in which a lancet wound was followed by hemorrhagic symptoms, probably due to irritation of the skin from atrophy of the roots. The case became highly covered with hair. Section of the root gave partial relief and finally a cure was obtained after an attack of pneumonia in which the patient was salubrised.

Loss of hair after nerve sections is occasionally met with in animals, especially rabbits, and is sometimes produced without separation of the roots having taken place.

The Nails may crack and curve, become smooth, shiny and vitreous, as in cases recorded by J. Hutchinson (Sec. et al.) and Mr. Bouldy. Dr. Mitchell records a case in which the Muscular Nervus was injured and the nails became quite black from blood supplied under them, and their growth, although not entirely arrested, was for a time, retarded. They may become fragile and broken, sometimes thickened,


Locomotory System.

Joints. The symptoms here may be very like those of Subacute Arterial Atheromatous. The cartilage may lose, the ligaments cedify, and the heads of the bones atrophy. One may be irregular honeycombed in the neighbourhood of the Joints. In the arm changes these changes occur chiefly in the Elbow, but the fingers have been known to suffer. In Oedematous case all the joints of the arm were stiff and painful. The condition usually terminates in Osteosclerosis.

Bones often suffer from Osteitis followed by Acroasis, with atrophy at their ends as mentioned above. They may become brittle and fracture spontaneously. Union is attended with the formation of a large amount of Callus. Sometimes there is ossification in the adjacent tissues.

Muscles may quickly atrophy, as in Mayo and Dukin's case (supra), the Deltoide atrophied rapidly and lost an
extent, that the humerus fell out rich from the glenoid cavity. This case, I may mention, contained most of the symptoms about which I have been writing. Styes, and desquamation of the skin; marked incrustation of the nails; skin of the hands, especially about the knuckles, and smooth with desquamation of the epidermis. There was also marked general oedema of the limb which is so common in all nerve injuries.

Muscular atrophy may to some slight extent be due to the paralysis, but never irritation alone is capable of determining rapid and early atrophy of the muscles, preceded by decrease or disappearance of faradic contractility. Complete nerve division does not induce atrophy and loss of electrical reaction until after an incomparably greater lapse of time, as in cases of prolonged inaction. Muscular and cutaneous sensibility are often preserved nearly normal in cases of lesions of mixed nerves, even when rapid establishment of the electrical contractility and consequent muscular atrophy are carried very far. After a traumatic lesion in the course of a nerve the power of motion sometimes remains and only becomes disappeared when trophic lesions have supponced in the muscle.

With regard to the electrical reactions of an affected muscle, faradisation shows at once a diminution and then in intense cases total abolition of contractility. With the galvanic current, there is at first but a very slight or establishment; but after the second week it is followed by excitation which persists during the whole period of faradic depression and which disappears in its turn when faradica-
him presume its power. According to Buckenm (De: cit.) the electrical conductivity of muscles may be diminished from the fifth day in cases of compression, contusion and concussion of a mixed nerve.

Histologically, the muscular atrophy in such cases, partakes more of the nature of an inflammatory process, than of a passive one. There is hyperplasia of the interstitial connective tissue and multiplication of the nuclei of the sarclemma; the fibres possess their striated appearance, but decrease in their transverse diameter (Cf. Deutsc.: Archiv: Bd. I. 1866, p. 44.)

This muscular atrophy may be accompanied by aches, pains or abnormal sensations, and is very frequently followed by contracture. As to the cause of this contracture, I cannot do better than quote Mr. Bowley's words, (De: cit.: p. 44), he says it is probably due to the fact that "the muscle shrinks only so long as it is unopposed; if, therefore, its origin and insertion be unduly approximated during the process of atrophy, they will remain in such a condition when the trophic changes have ceased, not because they have been drawn together by such changes, but that the atrophy found them in a certain position and fixed them there. For instance, after Section of the Median Nerve in the upper arm, it is very common for permanent flexion of the digits to ensue, but the reverse is not the case after division of the Musculospinal, the fingers and wrist are not then extended, but on the contrary, are flexed." The explanation is, "when the hand is paralyzed, or when it is simply not in use, the
Singers naturally lie in a position of flexion, and in that position they are gradually eased by the normal changes.

Speaking of these symptoms more in general, we find that they are almost always preceded or accompanied by burning pains. Anæsthesia is, as a rule, absent. They may or may not occur in cases of Puncture, laceration, or Incision. Section of the nerve, but are more found in Complete Section, but only in those conditions producing Neuritis. That they are all probably due to inflammatory changes in the nerve, is strengthened by the fact that all these Symptoms occur in Lepræ, due, according to Wierus to a Lepræous Perineuritis, with at first hyperæsthesia and afterwards anæsthesia. In this disease the limbs may drop off painlessly due to the Necrosis of the bone occurring in the later anaesthetic stages.

In diagnosing these symptoms, it behoves us to be careful. Just how much we attribute to the nerve lesion itself. For example, in one of Sir James Paget's cases (loc. cit.) though there was some sensation, the Temperature Sense was entirely gone; 2 ulcers were present in the free-finger and thumb, but these were found to have been caused by being held too near the fire. To a careless observer, such ulcers might have been taken for one of those resulting from a Subcutaneous Whitlow to which Dr. Jonathan Hutchinson has drawn attention in his report on such cases occurring in the London Hospital (loc. cit.) and might erroneously have been considered as due to the actual nerve lesion itself.
There are just two more points to which I wish to draw attention before leaving this subject to a close: the first of these is the Temperature of the Part supplied by the injured Nerve.

Soon after section or compression of a Nerve trunk, the Temperature of the part supplied by that Nerve, falls: this is due probably to Vasomotor influence, as it has been shown not to occur if a tourniquet be previously placed over the Brachial Artery. Some weeks after complete division of a nerve the Temperature of the affected part is considerably lowered, possibly due to the slowness of the circulation and of the trophy functions. This lowering in Dr. Mitchell's cases varied from 2° to 15° Fahr. in Mr. Jonathan Hutchinson's cases from 6° to 10° Fahr.

When a nerve is not divided but merely injured the lowering of the temperature varies from about 2° to 3°. But if there be any irritation lesion the temperature of the part may be normal or more generally raised. In cases of glossy skin, while the affected part may be raised 2° or 3° Fahr., the skin just above the burning part may be a degree or two below that of the healthy limb. "This slight loss of temperature above the wound is not uncommon in any nerve lesion, and may be due in part to the long and constant disuse of the limb." (W. Mitchell.)

The last Symptom to which I shall refer are the Eye Symptoms. Sir James Paget has drawn attention...
In cases of injury to the Brachial Plexus, he says that the Pupil on the paralyzed side is always smaller than the other, both pinn. act fast. There is no afferent in the right. Dr. Anghelina Jackson suggests that it is due to the relations of the Brachial Plexus with the Clic-Spinal portion of the Sympathetic Cord.

Malle: A. Humphreys has written a very interesting paper on this subject (Proc. de Medicine. 1885. Iv. p. 591.) in which he has collected a number of cases of injuries to the Brachial Plexus in which there are eye symptoms. The other symptoms were described as Pyrosis, narrowing a straightening of the Pulmonary slit, retraction of the Glege, and in some cases flattening of the Corch. Section of the nerves of the Brachial Plexus is only accompanied by pupil-pupillary phenomena when the communicating branch from the 7th Dorsal Nerve is involved; they always exist alone and are never accompanied with palsy-motor disturbance of the face. This shows the presence of pinn. dilatator fibers in the 1st Dorsal Nerve. As the Pinn. motor nerves for the face are connected with the 3rd, 4th, 5th, and 6th Dorsal Nerve. (Humphreys, Soc. cit. p. 789.)

The subject of the existence of pinn. dilatator fibers has been most ably worked out in a recent and to use a German expression, speech-making paper by Dr. Gaskell in the Proceedings of the Royal Society of London.
Such then are the more important considerations in connection with the morphological and pathological relations of the various supply of the upper extremity. In a subject so wide, it is exceedingly difficult to prevent oneself from being irresistibly drawn in the consideration of many and very interesting side issues. I have tried as much as possible to circulate my remarks and to weed out all irrelevant matter, to bring the thesis within practicable limits. That it is still open to much improvement in this direction, I am fully aware, but this does not permit of any more precision, so I must leave it, with all its many imperfections, in the knowledge that it is "something attempted, something done."

S.S. Marshall Stone

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