

CUNNINGHAM'S
TEXTBOOK OF
ANATOMY

ELEVENTH EDITION

EDITED BY

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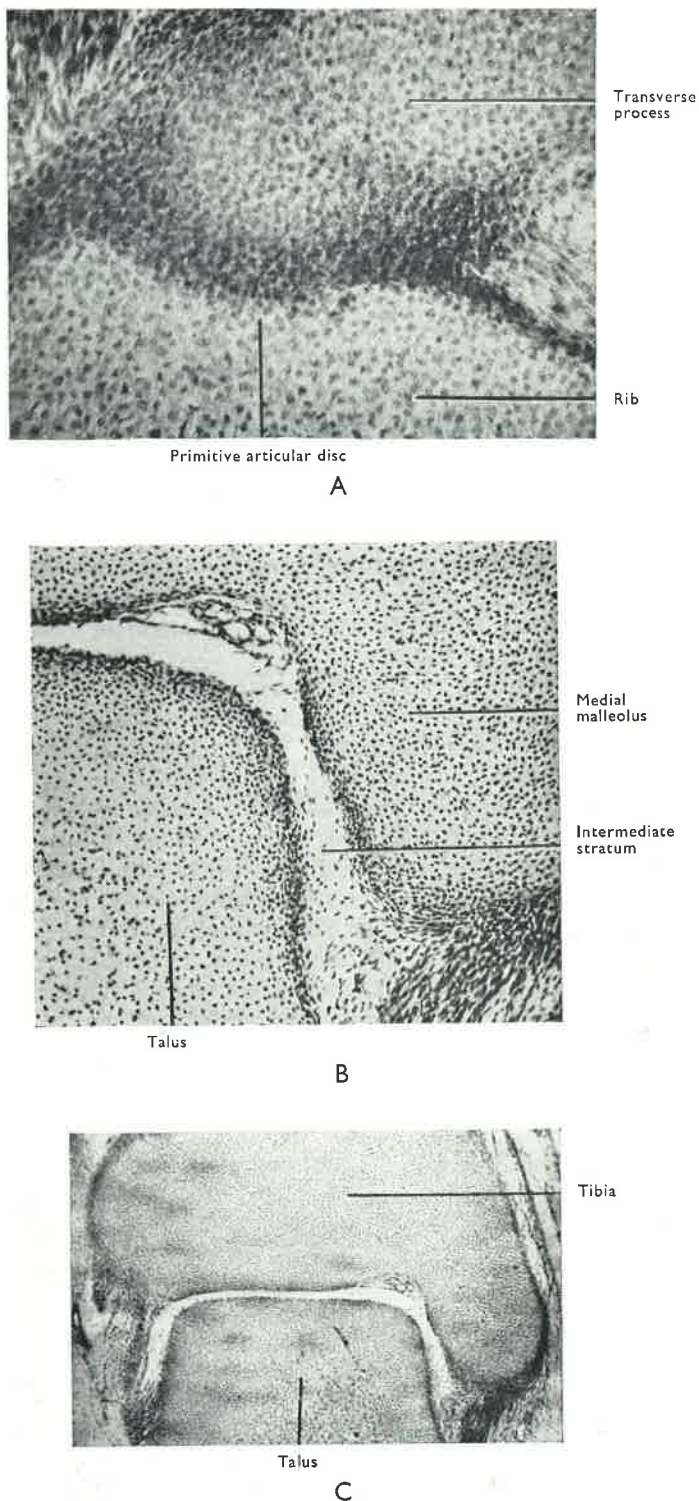


FIG. 282 Photomicrographs to illustrate the development of synovial joints.

A, costotransverse joint of 20-mm. human foetus. $\times 100$.

At this stage the primitive articular disc is very cellular and not sharply demarcated from the adjoining cartilages.

B, ankle joint of 45-mm. human foetus. $\times 75$.

There is an intermediate stratum of loose tissue between the medial malleolus and the talus, but between upper surface of talus and tibia this tissue has been absorbed.

C, ankle joint of 45-mm. human foetus. $\times 25$.

The same specimen as in Fig. 282 B, to show the extent of the joint cavity in relation to upper surface of talus.

behind the flexor retinaculum at the wrist, and the flexor tendons lying on the front of the fingers. The synovial layer lines the tunnel and is also reflected round the tendon that lies within it.

Development of a Synovial Joint. After the cartilaginous precursors of the bones have been formed, their ends are separated from each other by a disc of very cellular mesenchyme that is called the **primitive articular disc** [FIG. 282]. There are no sharp lines of demarcation between the ends of the cartilages and the articular disc, and indeed the cells of a disc that are adjacent to cartilage form a chondrogenetic zone that is associated with the growth in length of the cartilage (Haines, 1947). As development proceeds, a process of differentiation occurs within the disc and the two chondrogenetic layers become separated from each other by an intermediate stratum of loose tissue in which the cells are relatively scanty [FIG. 282]. The intermediate stratum of loose tissue later undergoes liquefaction so that a joint cavity appears between the ends of the cartilages [FIG. 282]. The cartilages in turn lose the chondrogenetic layers over the articular surfaces though a thin fibrillar layer may persist over them until birth. The mesenchymatous tissue that surrounds the primitive articular disc differentiates into a dense outer layer that forms the **fibrous capsule**, and an inner loose layer that forms the **synovial membrane**. The synovial layer is invaded by extensions of the joint cavity so that the typical relationship of cavity to synovial membrane is established. **Intra-articular ligaments and fibrocartilages** arise from thickenings that project inwards from the wall of the primitive articular cavity. A complete **articular disc** arises from a transverse mesenchymatous septum between double cavities which appear in the primitive articular disc.

Blood and Lymph Vessels. A synovial joint is freely supplied by branches of the main arteries that are adjacent to it. These branches perforate the fibrous capsule and break up within the synovial membrane into capillaries which form a rich and intricate network. Many of the capillaries are extremely close to the free surface of the synovial membrane [FIG. 283] and this accounts for the frequency with which haemorrhage occurs into the articular cavity after even minor trauma (Davies, 1945). Adjacent to the peripheral margin of the articular cartilage the larger vessels of the synovial membrane branch and anastomose to form a vascular circle, the **circulus articulari vasculosus** of William Hunter (1743), and it is the terminal branches of this circle that overlie the margin of the cartilage and provide it with nourishment [p. 210]. Arteriovenous anastomoses occur in the articular vessels as they do in so many other places in the body.

The **lymph vessels** form a plexus within the synovial membrane, and from it efferent vessels pass towards the flexor aspect of the joint.

Nerve Supply. The fibrous capsule and, to a lesser extent, the synovial membrane are both supplied with nerves. The correlation that exists between the nerves of a joint and the nerves to the overlying tissues is expressed in **Hilton's Law** (John Hilton, 1863): 'The same trunks of nerves, whose branches supply the groups of muscles moving a joint, furnish also a distribution of nerves to the skin over the insertions of the same muscles; and the interior of the joint receives its nerves from the same source.' Some of the nerves in the fibrous capsule have encapsulated nerve endings and others

Hilton's law expounded by John Hilton in a series of medical lectures given in 1860-1862, is the observation that in the study of anatomy, one often finds that a nerve that innervates a joint also tends to innervate the muscles that move the joint and the skin that covers the distal attachments of those muscles.^[1]

For example, the musculocutaneous nerve supplies the elbow joint of humans with pain and proprioception fibres. It also supplies biceps brachii, brachialis, and the forearm skin close to the insertion of each of those muscles.

Hilton's law arises as a result of the embryological development of humans (or indeed other animals). Hilton based his law upon his extensive anatomical knowledge and clinical experiences. As with most British surgeons of his day [1805-1878] he intensely studied anatomy.

Proprioception (pronounced / prɒpɪ.ə'sepʃən / PRO-pree-o-sep-shən), from Latin proprius, meaning "one's own" and perception, is the sense of the relative position of neighbouring parts of the body and strength of effort being employed in movement.^[1] It is distinguished from exteroception, by which we perceive the outside world, and interoception, by which we perceive pain, hunger, etc., and the movement of internal organs.

The musculocutaneous nerve arises from the lateral cord of the brachial plexus, opposite the lower border of the Pectoralis major, its fibers being derived from C5, C6 and C7.

It penetrates the Coracobrachialis muscle and passes obliquely between the Biceps brachii and the Brachialis, to the lateral side of the arm; a little above the elbow it pierces the deep fascia lateral to the tendon of the Biceps brachii and is continued into the forearm as the lateral cutaneous nerve of the forearm.

In its course through the arm it innervates the Coracobrachialis, Biceps brachii, and the greater part of the Brachialis.

- The *branch to the Coracobrachialis* is given off from the nerve close to its origin, and in some instances as a separate filament from the lateral cord of the plexus; it is derived from the seventh, cervical nerve.
- The *branches to the Biceps brachii and Brachialis* are given off after the musculocutaneous has pierced the Coracobrachialis; that supplying the Brachialis gives a filament to the elbow-joint.
- The nerve also sends a small *branch to the bone*, which enters the nutrient foramen with the accompanying artery.
- The musculocutaneous nerve presents frequent irregularities.
- It may adhere for some distance to the median and then pass outward, beneath the Biceps brachii, instead of through the Coracobrachialis.
- Some of the fibers of the median may run for some distance in the musculocutaneous and then leave it to join their proper trunk; less frequently the reverse is the case, and the median sends a branch to join the musculocutaneous.
- The nerve may pass under the Coracobrachialis or through the Biceps brachii.
- Occasionally it gives a filament to the Pronator teres, and it supplies the dorsal surface of the thumb when the superficial branch of the radial nerve is absent.

The musculocutaneous n. can be affected through compression due to hypertrophy or entrapment between the biceps aponeurosis and brachialis fascia or it may be injured through stretch as occurs in dislocations and sometimes in surgery.

Practical Applications of Hilton's Law in Physiology and Clinical Practice

Understanding the Utility of Hilton's Law and Sensory Corpuscles in Diagnosis, Treatment, and Research

Introduction to Hilton's Law

Hilton's law, a foundational principle in anatomical physiology, was articulated by the eminent British surgeon John Hilton (1804–1878). The law states: "A nerve supplying a joint also supplies the muscles that move the joint and the skin covering the insertion of those muscles." This coordinated innervation, which also encompasses specialized sensory structures, has profound implications for understanding the body's organization and clinical practice.[1][2]

Sensory Corpuscles and Their Relationship to Hilton's Law

The skin and joints supplied by nerves according to Hilton's law are rich in specialized sensory receptors, known as corpuscles, that contribute to proprioception, touch, and pain perception. The major types relevant to musculoskeletal physiology include:

- **Meissner's corpuscles:** Located primarily in the dermal papillae of the skin, especially in areas of fine touch (e.g., fingertips), these corpuscles are responsible for sensitivity to light touch and texture.[13]
- **Pacinian corpuscles:** Found deep in the dermis and around joints, tendons, and periosteum, Pacinian corpuscles detect deep pressure and high-frequency vibration, contributing to the sensation of joint movement and acceleration.[13][14]
- **Ruffini endings (corpuscles):** Located in both the dermis and joint capsules, they respond to sustained pressure and stretch, playing a vital role in detecting joint position and movement (proprioception).[13][15]

These corpuscles are innervated by the same nerves that fulfill Hilton's law. Thus, the nerve that supplies a joint not only serves the muscles and overlying skin but also carries afferent (sensory) signals from these mechanoreceptors. This integration underlies the body's sophisticated ability to coordinate movement, perceive joint position, and adapt to external stimuli.[2][14][15]

Effects of Sensory Corpuscles on Hilton's Law in Clinical Practice

- **Proprioception and Joint Integrity:** The presence of Ruffini and Pacinian corpuscles within joint capsules enhances proprioceptive feedback, allowing for precise control of joint position and movement. Disruption of the nerve supply (as described by Hilton's law) can lead to impaired proprioception and joint instability.[14][15]
- **Pain and Injury Localization:** Meissner's and Pacinian corpuscles, along with free nerve endings, contribute to tactile sensation and pain localization. When a nerve is damaged, symptoms such as loss of touch, abnormal vibration sense, or altered pain perception can be anticipated in the joint, associated muscles, and skin area supplied by that nerve.[4][13]
- **Therapeutic Interventions:** Understanding the distribution of these corpuscles allows clinicians to better assess sensory deficits and target rehabilitation strategies. For example, after joint injury or surgery, therapies stimulating these receptors can help restore normal sensation and proprioceptive function.[8][15]
- **Nerve Blocks and Anesthesia:** Effective regional anesthesia must account for the afferent pathways from these corpuscles, ensuring comprehensive loss of sensation in the targeted joint, its movers, and overlying skin.[6][7][13]

Conclusion

Hilton's law not only maps the motor and cutaneous nerve supply to joints but is also intimately connected with the sensory input provided by Meissner's, Pacinian, and Ruffini's corpuscles. This integrated neuroanatomy is fundamental for movement, proprioception, pain perception, and effective clinical intervention. Recognizing the interplay between these specialized corpuscles and Hilton's law enhances the clinician's ability to diagnose, treat, and rehabilitate musculoskeletal conditions.[1][2][13][14][15]

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