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Beneath the Surgeon's Touch

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Abstract

The "surgeon's touch" technique embodies the exquisite manual dexterity and heightened tactile sensitivity that surgeons cultivate through years of rigorous training and experience. This remarkable skill allows them to navigate intricate surgical landscapes with precision, deftly manipulating instruments and tissues to achieve optimal outcomes during procedures. It is a blend of art and science, where every subtle movement is guided by an intuitive understanding of human anatomy and the delicate interplay of bodily structures. This concept goes beyond simple mechanical manipulation, representing a sophisticated blend of sensory perception, precision, and experience. A surgeon's expertise allows for the differentiation of tissues, the identification of pathologies, and the careful handling of anatomical structures, which are essential for reducing intraoperative trauma and enhancing patient outcomes. Mastering this technique is not innate; it is acquired through years of deliberate practice, observation, and adaptation in various surgical environments.

In contemporary surgical practice, particularly with the emergence of minimally invasive and robotic procedures, the preservation and training of tactile sensitivity have gained significant importance. The lack of direct contact with tissue in these procedures poses a distinct challenge, necessitating alternative methods to replicate and sustain the intuitive feedback previously received through direct touch. Innovative haptic technologies, surgical simulations, and tactile enhancement tools are being developed to bridge this gap.

This article emphasises how important a surgeon's touch is in both open and minimally invasive surgeries. This touch helps improve surgical precision, protect tissue, and ensure patient safety. A surgeon's skill is essential for providing excellent care, as they mix both art and science to heal patients with compassion.

Introduction

A surgeon must have 'the heart of a lion and the hands of a lady Lord Berkley Moynihan regarded his hands as the handsome servants of his controlling brain Infinite gentleness, scrupulous care, light handling and purposeful, effective, quiet movements which are no more than a caress, are all necessary if an operation is to be the work of an artist and not merely of a hewer of flesh.

Surgical instruments need to be considered an extension of the fingers. It is the application of the fingers and the grip that will determine whether you can feel the tissues.

The appreciation of the grip is well recognised and taught in many sports [1,2] Golf for example has what initially feels like awkward grip and the beginner applies the hands with force. On the contrary the hands need to be applied with the delicacy of holding a toothpaste tube with the cap off i.e. if you squeeze, toothpaste will be extruded. The same applies to holding a katana, a similar two-handed grip that need to be applied with the lightest of touches and the 'tenuchi', a wringing motion, is completed at the end of a downstroke that stops the blade at the naval. An expert Sensei can see whether the blade is being held too tightly by the direction of the swing and the bouncing of the blade at the end of a down stroke. The cutting action needs to be precise, but this sort of instruction or fidelity is rarely described or taught in the discipline of surgery.

The human hand is unique in structure and function [3] and the fact the eighty five percent of the population is right hand dominant independent of ethnicity or gender [4]. The latter is problematic for the left-handed surgeon as surgical instrument have been designed for right-handed people and by males thus ignoring the radial size of the digits in the rings. These are the last 'isms' of surgery that need attention.

The intrinsic muscles of the hand especially the lumbricals, extend the distal interphalangeal

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joints without interruption by the long flexor muscles of the forearm, which together with the opponens policis enable the pulps of the fingers to be opposed, thereby exercising the lightest of touches and resulting in the caress of tissues described by Lord Berkley Moynihan.

The detail of instrument handling is poorly taught, and it is clear from photographs that many trainees lack instruction on how to hold the surgical instrument properly. This was particularly true of forceps. The flexor digitorum profundus and flexor pollicis longus, in the deep flexor compartment, are the two biggest muscles of the forearm. The pinch force, generated by these long flexors as they flex the distal interphalangeal joints is between 25 N and 50 N [5]. If the surface area of the end of a pair of forceps is assumed to be 5 mm^2 (5×10 -6 m^2), the pressure exerted on tissue by pinching the forceps is more than 5 million Nm2 (Pressure = Force (N) / Area (m2) or the equivalent of 725 psi. Tissue damage is inevitable if it is above 15 N [6] and can result in stenosis of blood vessels [7,8]. The extension of the PIP DIP joints and flexion of the MCP joints together with the opponens policis maximises the contact area of the pulp of the fingers and the thumb and characterises the precision grip using the first three digits [9]. The lumbrical has evolved into a highly specialized structure that modulates the tension between the extensor and flexor system during fine pinch that and is identified with a human's adaptability in using tools, especially surgeons [10]. The tactile and visual elements of precision feel [11] does mean that the surgical instrument becomes an extension of the fingers.

We unconsciously chose the part of the fingertip to perform daily function like picking up an object, turning a page or stroking a surface [12]. The fingertip enables checking of hardness and temperature. Human fingertips can discriminate between tones from differences in their harmonic components for a contact load of 1N, two types of vibratory stimuli having different phase differences between their fundamental and second harmonic components can be discriminated at a fundamental frequency of 40Hz [13]. A lot of research is going into this area called Tribology to improve haptics of robotic arm and patients with neurological deficits. The science of sensation is more complex that it first appears [14].

A human fingertip consists of skin (epidermis, dermis and subcutaneous), a phalanx, a nail, and sensory receptors. There are many various kinds of tactile receptors i.e., the Meissner corpuscle (vibration sensations of 10 Hz), the Merkel disk (touch and pressure sensations), the Ruffini ending (touch sensations), the Pacinian corpuscle (vibration sensations of 250 Hz) and free nerve endings (temperature and pain sensations). These area densities are 1500pcs/cm2 for the Meissner corpuscle, 750 pcs/cm2 for the Merkel disk and 75pcs/cm2 for the Pacinian corpuscle and Ruffini endings that a are higher in humans [15]. The surface resolution for the sensation of touch, or "the two-point threshold" (the threshold can be divided into two points of "touch" sensations) in a human fingertip is approximately 2 mm. The brain recognizes the details of the contact information with many tactile receptors (5000 pcs/cm2) found in the human [16] and the size and surface are of the finger is important [17].

The Meissner corpuscle structure is found in higher density in humans, equal in both hands, [15] but in higher distribution in the finger tips [18] and varying the lamella structure [19]. The special innervation is well described but it has been shown that that two homotypical tiled but heterotopically offset. Ab mechanosensory neurons with distinct molecular, physiological, and ultrastructural properties are responsible for the perception of, and behavioural responses to, the gentlest detectable forces [20]. They share an endoneural origin with Pacinian corpuscles [21]. The distribution of Meissner corpuscles across the fingers is similar for individuals but concentrated at the tips [22].

The human skin fibroelastic and the fictional coefficients and contact pressures, as well as lubrication, affect sensation. The contours of the finger prints, deformation of the finger pad with forces, pulling and pushing the finger affect sensation over dry and wet glass surfaces [23].

The brain relies on predictive forward models; the surgical instrument can be considered an extension of the fingers, and with the appropriate application of the fingers and touch, becomes predicted, based on the anticipated position of the current effector i.e., the tip of the tool rather than the body part per se. Under controlled conditions touch with a tool was observed to be akin to touching with fingers [24]. The complex high-fidelity sensation of the fingers is helped in surgery with an extended index finger that affords direction and proprioception to the movement, [25]. Practice and being aware of sensations helps in the process of learning musical instruments [26] and can be translated into learning surgery. It begins with the lightest of touches and a feel of the tissues. When holding a surgical instrument, it is important to maximise the surface area of the pads of the fingers on the instrument and use a gentle touch.

The gloved finger does effect sensibility of the fingers, with thinner gloves offering more fidelity but this is mitigated by increased awareness of haptics [27].

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