-Lecture 4 - notes
CAPD: The role of interhemispheric function – A commentary, Frank E. Musiek

Interhemispheric connections: The corpus callosum.

The corpus callosum (CC), which is located at the base of the longitudinal fissure, is the primary connection between the left and right hemispheres. The CC is covered by the cingulate gyri and forms most of the roof of the lateral ventricles .It consists of long, heavily myelinated axons and is the largest fiber tract in the primate brain. In an adult, the CC is approximately 6.5 cm long from the anterior genu to the posterior splenium, and is approximately 0.5 to 1 cm thick The CC seems to be larger in left-handed than in right-handed people, but it has significant morphological variability
The CC is not exclusively a midline structure as it essentially connects the two cortices and thereby must span much of the intercortical space above the basal ganglia and lateral ventricles. Because it encompasses such a large portion of the cerebrum, it is probable that in many "cortical" lesions some region of the CC is involved.
Homolateral fibers (those which connect to the same locus in each hemisphere) are the primary fibers in the CC. The CC also contains heterolateral fibers, which are those connecting to different loci on each hemisphere. Heterolateral fibers frequently have a longer and less direct route to the opposite side, which may necessitate a longer transfer time than required by their homolateral counterparts. The latency of an evoked potential recorded from one point on the cortex following stimulation of the homolateral point on the other hemisphere is referred to as the trans callosal transfer time (TCTT). The TCTT in humans decreases with age, and minimum values are achieved during teenage years These findings are consistent with increased myelination of the CC axons . The TCTT varies significantly, from a minimum of 3 to 6 msec to a maximum of 100 msec, in primates and humans. The concept of inhibitory and excitatory neurons in the CC may be substantiated by this variability.
The anatomy of the CC subserves, and the neural connections correspond to, various regions of the cortex. The genu, or anterior region of the CC, contains fibers leading from the anterior insula and the olfactory fibers. The trunk comprises the middle section of the CC, where the frontal and temporal lobes are also represented. The posterior half of the trunk, called the sulcus, is thinner and contains most of the auditory fibers from the temporal lobe and insula. The splenium is the most posterior portion of the CC and contains mostly visual fibers that connect with the occipital cortex .Just anterior to the splenium in the posterior half of the CC is the auditory area of the CC at the midline. Although this information was obtained through primate research, data on humans helped localize the auditory areas of the CC. Baran et al. found little or no change in tasks requiring interhemispheric transfer (i.e., dichotic listening or pattern perception) after the sectioning of the anterior half of the CC. However, markedly poorer performance on these auditory tasks was shown in patients with a complete section of the CC . Lesions along the transcallosal auditory pathway may bring about interhemispheric transfer degradation. Although we have much information about the anatomy of the CC at midline, we know little about the course of the transcallosal auditory pathway. It is thought to begin at the auditory cortex and course posteriorly and superiorly around the lateral ventricles. It then crosses a periventricular area known as the trigone, and courses

medially and inferiorly into the CC proper. This information about the transcallosal auditory pathway comes from anatomic and clinical studies.
A recent study demonstrated size differences in the CC for children with attention deficits, as compared to control subjects. The auditory and the genu areas of the CC in the experimental group were smaller than those of the control group
The vascular anatomy of the CC is simple. The splenium, or posterior fifth, is supplied by branches of the posterior cerebral artery .The remainder of the CC is supplied by the pericallosal artery, a branch of the anterior cerebral artery .

The "paradoxical left-ear deficit" is a pattern that becomes evident when the corpus callosum fibers in the left hemisphere are affected. In this situation, a lesion in the left hemisphere will result in a left-ear or ipsilateral deficit, but only on dichotic speech tasks. In fact, a left-ear deficit on dichotic speech tasks will result if there is a lesion anyplace along the transcallosal auditory pathway, which extends from the left to right cortex. This finding is related to the concept that during dichotic listening the ipsilateral auditory pathway is suppressed in favor of the stronger contralateral pathway. If a verbal report is required of a subject with corpus collosum involvement, the patient has no difficulty complying because the right-ear pathway has easy access to the speech, or left, hemisphere. Impulses from the left-ear stimuli, however, go to the right hemisphere and must be transferred across the corpus callosum to the left hemisphere for speech coding and a verbal report. When the corpus callosum is involved, this transfer either cannot happen or the integrity of this transfer is degraded and a left-ear deficit results. A patient who has involvement of the corpus callosum and left auditory cortex will show a bilateral deficit on dichotic speech tasks.
This outcome is seen because the classical contralateral deficit results will evolve from the left cortex lesion (right-ear deficit), and due to the collosum involvement a left-ear deficit will also result .

Another interesting trend in behavioral tests is presented by the use of the monaurally presented frequency and/or duration pattern perception tests. These tests seem to require interaction of both hemispheres to decode the stimuli for a verbal report. For both hemispheres to interact the corpus callosum must be functional. Therefore, dysfunction in either hemisphere or the corpus callosum results in bilateral ear deficits on pattern perception tasks. It is theorized that the right hemisphere is needed to decode the acoustic contour of the pattern and that the left hemisphere is needed to linguistically label the pattern elements. Although monaural deficits have been noted on pattern perception tests, this finding is not common in patients with lesions of the cortex or subcortex. Because deficits in either hemisphere or the corpus callosum can result in bilateral deficits on pattern tests, these procedures cannot provide laterality information. However, by requiring the subject to hum his or her response, one can check right-hemisphere integrity. If a patient can hum the response but cannot verbally state it correctly, the problem may be in the corpus callosum (transfer) or in the left hemisphere (linguistic labeling). If the result on humming patterns is poor, the right hemisphere may be involved. Therefore, the corpus callosum or left hemisphere cannot be evaluated with pattern tests, and other procedures will be needed .

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The corpus callosum, in the human, requires 12- 14 years to mature. Young children show a left ear deficit on dichotic listening that improves as they become older. The elderly also show left ear deficits in dichotic listening probably secondary to demyelination of the corpus callosum. Studies indicate the left ear deficit becomes greater as they become older. There is evidence that at age 55 years the interhemispheric transfer becomes poorer (via dichotic tests). Anatomical correlates are logical given these findings.

Key References:

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