REGENERATION OF DURAL DEFECTS

A REVIEW

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The belief that it is necessary to fill every dural defect with some type of membrane has been the basis of much of the experimental work on dural deficiency as well as the surgical treatment of dural defects. On the other hand, there is the opinion, based on clinical experience and some experimental studies, that the dura mater takes good care of its own defects.

In 1924, Trotter observed that if a segment of cerebral dura mater were excised and the overlying subcutaneous tissues of the scalp were left in contact with the brain a neomembrane would form from the scalp which would be indistinguishable from the old dura mater within a few weeks. He was of the opinion, further, that every element of the nervous system should be kept from contact with somatic tissue, either by dura mater or neurilemmal sheaths, and he stressed the insulating function of the dura mater. He reached the same conclusions regarding the regeneration of dura mater as Sayad and Harvey, who based their conclusions on experimental work. Davis compared the regeneration of the dura mater to that of peritoneum and warned against the introduction of foreign materials to fill in dural defects. He believed that the regenerated dura mater was far more protective than any artificial membrane and, also, that it regenerated very rapidly. Penfield in 1942 expressed the opinion that neurosurgeons still needed an ideal membrane which would be absorbable and would disappear, after having prevented cross circulation and formation of adhesions. As recently as 1955, Huertas and Teng and Feigin expressed opposing views regarding the indications for repair of dural defects: Huertas, in a report on a dural substitute stated, "The continuity of the dura mater is a prime necessity;" and Teng and Feigin in a similar report stated, "The chief purpose of using a dural substitute in neurosurgery is to prevent adhesions between the exposed brain and the overlying soft tissues rather than to fill the defect in the severed dura mater."

The dural defect has been dealt with in numerous and varied reports, and the multifority of the therapy described would indicate that an ideal successful therapy has yet to be presented.

A deficiency of the dura mater may result from many causes—cranio-

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cerebral trauma;\textsuperscript{17,39} surgical removal;\textsuperscript{15,20,45,57} neoplastic destruction;\textsuperscript{11,18}
inflammatory destruction;\textsuperscript{2,20} hydrocephalus;\textsuperscript{11,16,58} or congenital absence.

Occasionally dural defects lead to serious sequelae. Probably the most important of these is the frequent complication of meningitis and/or cerebral abscess in association with the dural defects of cranionasal or cranio-otic fistulae.\textsuperscript{11,18,20} These fistulae are usually accompanied by cerebrospinal fluid rhinorrhea or otorrhea. O'Connell\textsuperscript{19} said that the herniation of brain tissue in "cerebral fungus" formation following an injury is caused primarily by a dural defect and that the superficial extent of the "fungus" is determined by the size of the dural defect, not by the size of the cranial defect.

Pneumocephalus\textsuperscript{13} may result from a dural defect associated with a cranionasal or cranio-otic fistula. It is also frequently accompanied by meningitis.

A less serious, though very important, sequela is the development of erosion of the skull in an area corresponding to an underlying dural defect. This condition, aptly termed "craniocerebral erosion"\textsuperscript{44,45} has been known and is still known under a wide variety of terms,\textsuperscript{46,53} though its true nature is still not well understood.

**EXPERIMENTAL WORK**

In 1923 Sayad and Harvey\textsuperscript{61} recorded the first experimental study concerned primarily with the regeneration of the dura mater. In addition to their report, there is an extensive literature on the subject of duraplasty and prevention of meningocerebral adhesions.

Interest in the surgical treatment of dural defects arose originally from a desire to prevent the return of meningocerebral adhesions following excision of the dura mater and the meningocerebral cicatrices in cases of epilepsy (Beach,\textsuperscript{6} 1890). This interest has been confined chiefly to that of finding a dural substitute that closely resembles the normal membrane.

The search for dural substitutes has taken two principal routes: inorganic materials such as metal foils; and animal membranes such as homologous and autologous tissue grafts.

The subject of duraplasty has been reviewed by von Saar\textsuperscript{50} (1910), Buné\textsuperscript{10} (1933), Glaser and Thienes\textsuperscript{25} (1938), and Pudenz and Odom\textsuperscript{47} (1942). The large number of substitutes that have been advocated bears witness to the continued confusion concerning the proper treatment of dural defects.

Abbé\textsuperscript{1,2} (1895) first reported on the use of an artificial membrane for a dural defect. He used rubber tissue in two patients with post-traumatic epilepsy operated on with removal of meningocerebral cicatrices. Prior to this, Beach\textsuperscript{6} had suggested the use of gold foil for the prevention of meningocerebral adhesions. However, he did not report its use until 1897.\textsuperscript{7} McCosh\textsuperscript{26-28} in 1898 reported on the surgical treatment in 14 cases of epilepsy. He used rubber tissue and silver foil in an effort to prevent the postoperative return of meningocerebral adhesions. The use of silver foil was suggested by Ray\textsuperscript{48} (1901) and Harris\textsuperscript{26} (1904). Both rubber tissue and metal-