A Systematic Review on Management of Iatrogenic Dural Tears

Submitted for Partial Fulfillment of Master Degree in Orthopedic Surgery

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

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List of Abbreviations

Abb.	Full term
CSF	Cerebro spinal fluid
DT	Dural tear
FSP	Fibrin selant patch
ICP	Intra cranial pressure
ID	Incidental durotomy
JP drainage	Jackson-pratt drainage
L.P	Lumbar puncture
LDH	Lumbar disc herniation
M.R.I	Magnetic resonance image
MISS	Minimal invasive spine surgery
OPLL	Ossification of posterior longitudinal ligament
P.D.P.H	Post dural puncture headache
PGA	Polyglycolic acid
PLIF	Posterior lumbar interbody fusion
Post.op	Postoperative
Pre.op	Preoperative
RSS	Retrospective study
TLIF	Transforaminal lumbar interbody fusion
TTT	Treatment

Introduction

Anatomy and Physiology of the Dura Mater:

The meninges that cover the brain and spinal cord consist of the dura, arachnoid, and pia mater. The dura mater has three distinct layers: a cellular inner layer, a fibrous middle layer, and a fibroelastic outer layer[1].

Dura mater, arachnoid, and pia mater are the membranes covering the spinal cord from the most superficial layer to that closest to the spinal cord, respectively. The outer of the 2 cranial dural layers serves as the cranial periosteum and at the foramen magnum the inner layer separates to descend as the dural sleeve of the spinal cord. The epidural space separates dura from the vertebral canal and contains a layer of fat that can be useful as a magnetic resonance imaging landmark. A network of epidural veins called Batson's plexus is also in the epidural space and is believed to be relevant to the spread of infection or metastatic cancer. The subdural space is a potential space between the dura mater and the arachnoid space. The subarachnoid space is a clinically important and relatively wide space filled with cerebrospinal fluid separating the arachnoid from the pia mater [2].

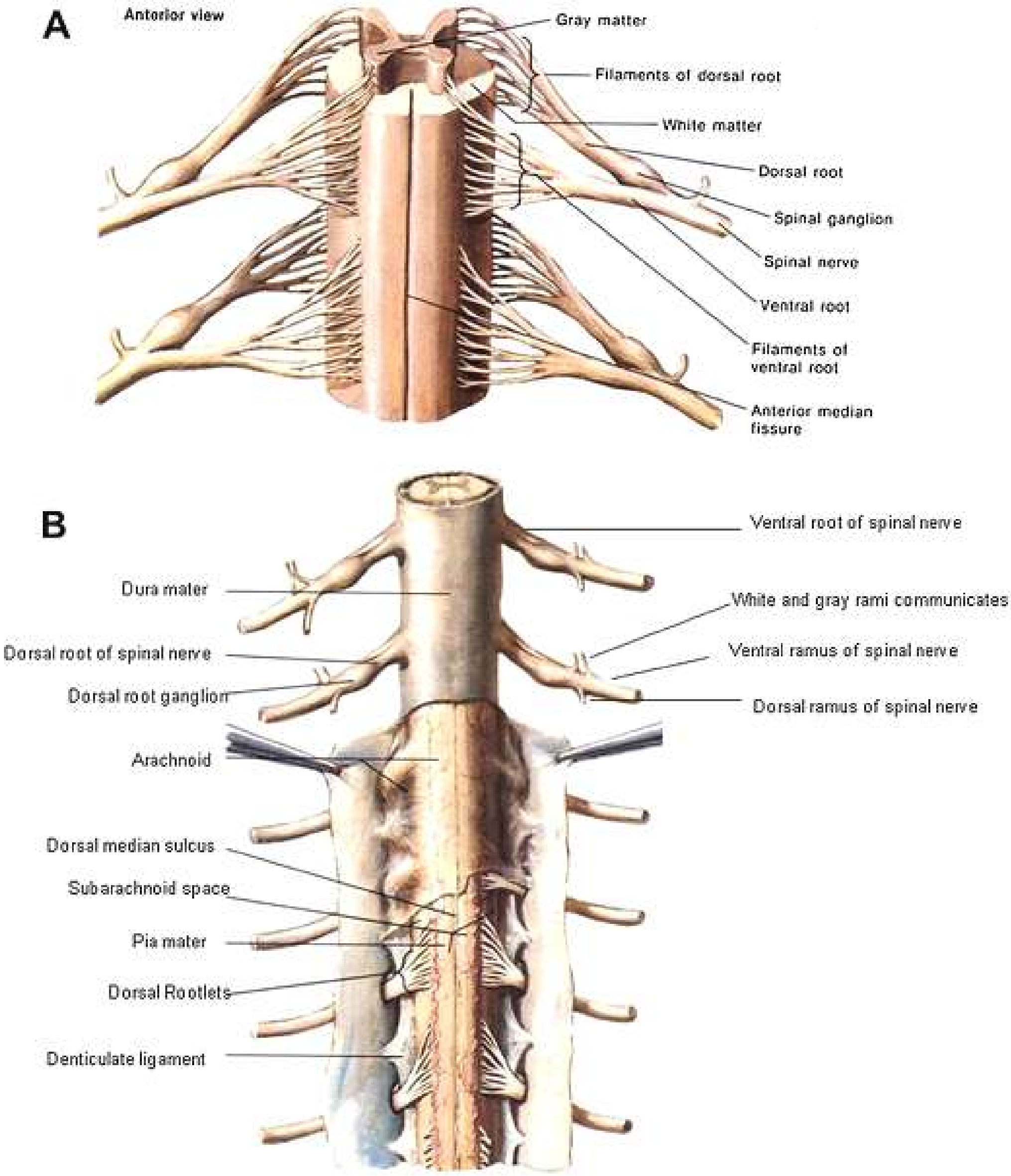

Figure (1): (A) Anterior view of the cord showing dorsal and ventral roots of the spinal cord and formation of the spinal nerves and their dorsal and ventral rami as well as the rami communicantes. (B) Posterior view of the cord indicating the meningeal layers, denticulate ligaments, and dorsal root ganglia.[3]

Cerebrospinal fluid production & secretion:

CSF secretion in adults varies between 400 to 600 ml per day, depending on the subject and the method used to study CSF secretion. Sixty to seventy-five percent of CSF is produced by the choroid plexuses of the lateral ventricles and the tela choroidea of the third and fourth ventricles. The choroid plexuses consist of granular meningeal protrusions into the ventricular lumen, the epithelial surface of which is continuous with the ependyma. They comprise a tuft of fenestrated capillaries. Choroidal cells present microvilli at their apical pole and are interconnected by tight junctions with a variable distribution according to the site on the ventricular wall [(4)].

Choroidal secretion of cerebrospinal fluid comprises two steps; The first step consists of passive filtration of plasma from choroidal capillaries to the choroidal interstitial compartment according to a pressure gradient. The second step consists of active transport from the interstitial compartment to the ventricular lumen across the choroidal epithelium [(5)].

Extrachoroidal secretion is derived from extracellular fluid and cerebral capillaries across the blood-brain barrier. This pathway appears to play a minimal role under physiological conditions [(6)].

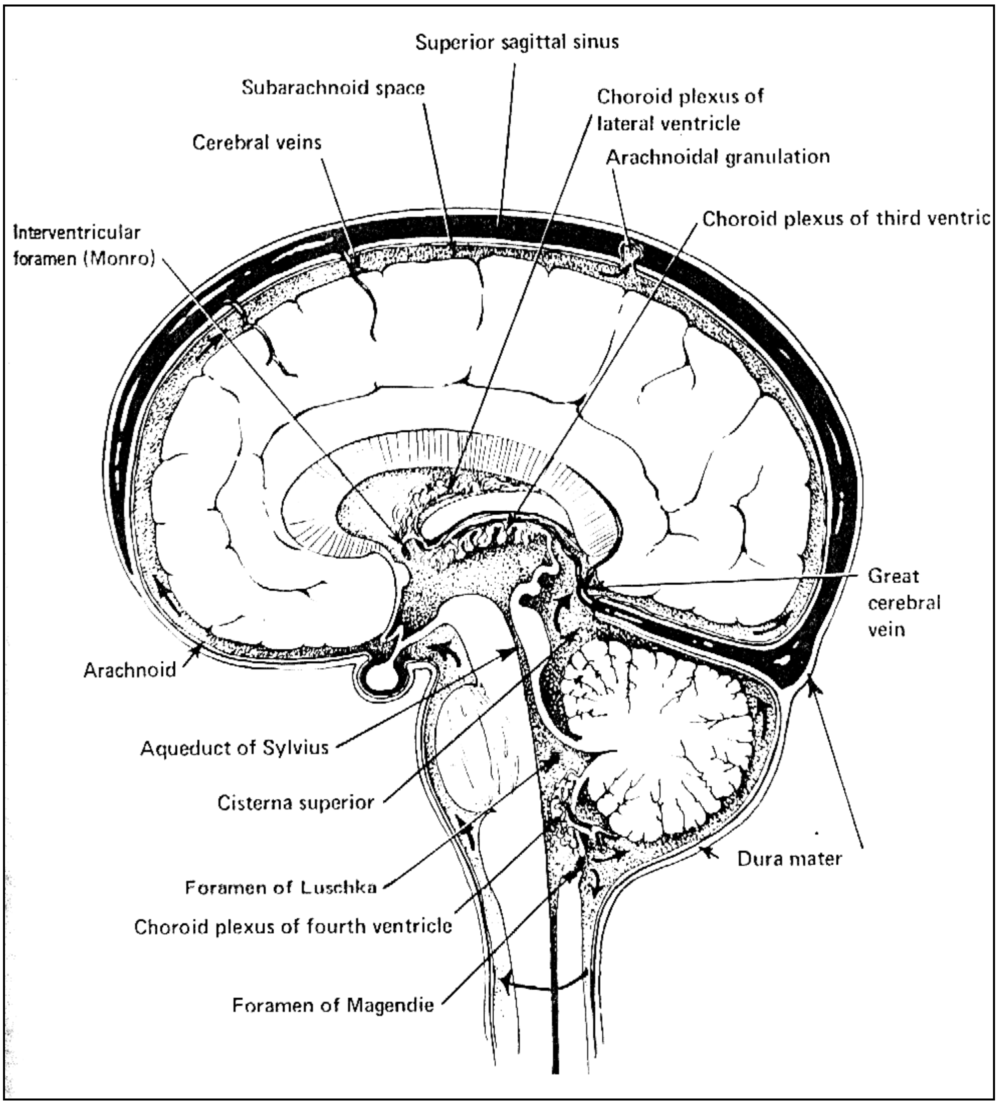

Figure (2): Formation of CSF. [7]

Cerebrospinal fluid circulation

CSF circulation is a dynamic phenomenon and regulation of CSF circulation is responsible for cerebral homeostasis. CSF circulates from the sites of secretion to the sites of absorption according to a unidirectional rostrocaudal flow in ventricular cavities and a multidirectional flow in subarachnoid spaces. CSF flow is pulsatile, corresponding to the systolic pulse wave in choroidal arteries. CSF produced by the choroid plexuses in the lateral ventricles travels through interventricular foramina to the third ventricle, and then the fourth ventricle via the cerebral aqueduct and finally to the subarachnoid spaces via the median aperture (foramen of Magendie) of the fourth ventricle. In the cranial sub-arachnoid space, CSF circulates rostrally to the villous sites of absorption or caudally to the spinal subarachnoid space [(7)].

Cerebrospinal fluid absorption:

Cerebrospinal fluid is essentially absorbed into the internal jugular system via cranial arachnoid granulations. Arachnoid villi are finger like endothelium lined protrusions of the arachnoid outer layer through the dura mater in the lumen of venous sinuses [(8)]. The pressure gradient between subarachnoid spaces and the venous sinus necessary to ensure CSF drainage is between 3 and 5 mmHg [(9)]. Spinal arachnoid villi in contact with the epidural venous plexus represent a pathway of CSF absorption especially during effort. In man, arachnoid villi in lumbosacral nerve roots increase CSF absorption in the upright position in response to gravity, and the absorbed CSF then enters the lymphatic system [(10)].

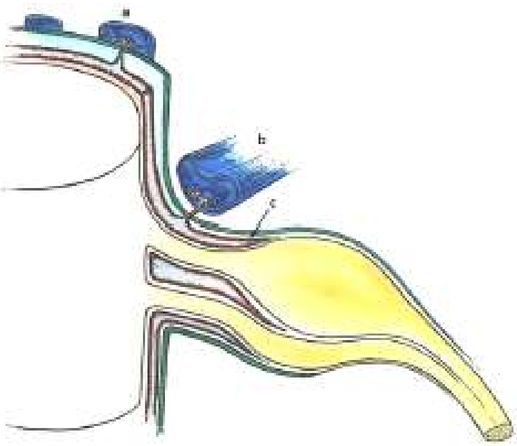

Figure (3): Cerebrospinal fluid absorption by spinal arachnoid villi and meningeal sheaths of spinal nerves. Spinal arachnoid villi in contact with the epidural venous plexus (a) and adjacent to spinal nerve roots (b). Absorption surfaces in the meningeal recess of spinal nerve roots (c) [6].

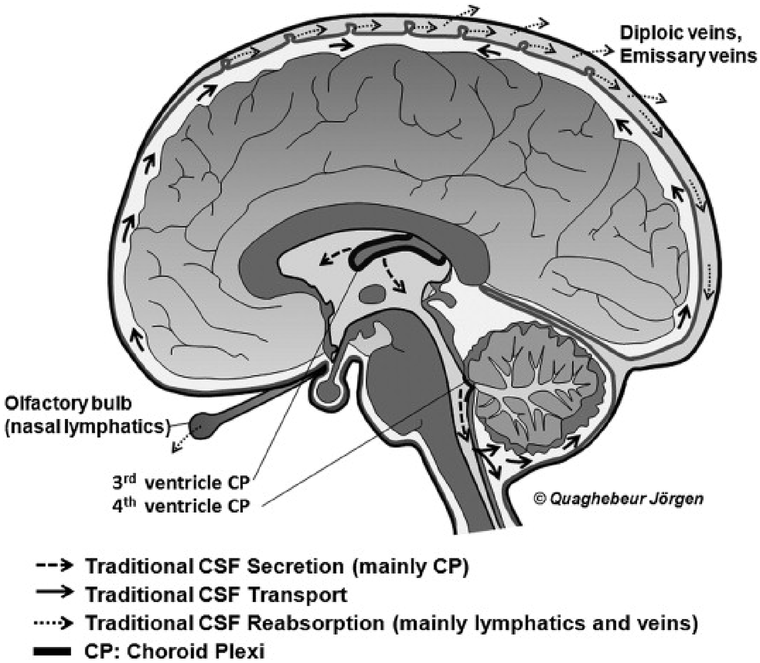

Figure (4): The traditional model of cerebrospinal fluid (CSF) hydrodynamics [11].

AIM OF THE WORK

The aim of this study is to do a systematic review on management of iatrogenic dural tears mentioned in literature and to evaluate and compare each of them in terms of success rate based on short and long term in patients who have undergone surgical treatment for spine pathologies.