Evaluation of antibiotic-impregnated shunt catheters in prevention of shunt infections: a systematic review

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بسم الله الرحمن الرحيم
قالوا
سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم
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List of Contents

Subject	*Page No.*
List of Abbreviations	**i**
List of Tables	**ii**
List of Figures	**vii**
Introduction	**1**
Aim of the Work	**2**
Review of Literature	
Anatomy of ventricular system	**3**
Hydrocephalus	**20**
Systematic review	**30**
Discussion	**40**
Conclusion	**46**
References	**47**
Arabic Summary	**—**

List of Abbreviations

Abbr.	Full-term
AI	Antibiotic-impregnated
AIC	Antibiotic-impregnated catheter
CC.................	conventional catheter
CoNS	Coagulase-negative streptococci
CSF...............	Cerebrospinal fluid
ETV	Endoscopic third ventriculostomy
GNB.	Gram negative bacilli
HCC	Hydrogel-coated catheter
HOQ	Hydrocephalus outcome Questionnaire
LOS	Length of stay
MRSA	Methicillin-resistant Staphylococcus aureus
NPH	Normal pressure hydrocephalus
QOL	Quality of life
RCT	Randomized controlled trial
SCC	Silver-coated catheter
VP	Ventriculoperitoneal

List of Tables

Table No.	Title	Page No.

Table (1): Etiology of hydrocephalus................................ 21

Table (2): Types and incidence of shunt complications.. 24

Table (3): Symptoms and signs of shunt malfunction in infants 25

Table (4): Signs and symptoms of shunt malfunction in older children and adults 26

Table (5): Characteristics of studies included:.................. 36

List of Figures

Table No.	Title	Page No.

Figure (1): The ventricular system. 4

Figure (2): Horizontal section of the cerebrum dissected to remove the roofs of the lateral ventricles 7

Figure (3): The inferior horn of the lateral ventricle, coronal section 8

Figure (4): The lateral and third ventricles, coronal section 10

Figure (5): The floor of the fourth ventricle, dorsal aspect of the brain stem 13

Figure (6): Lateral aspect of the 4th ventricle and surrounding posteriorfossa structures 14

Figure (7): The pathway of cerebrospinal fluid flow from the choroid plexuses in the lateral ventricles to the arachnoidal villi protruding into the dural sinuses.................. 17

Figure (8): Choroid plesus diagram 18

Figure (9): Arachnoid granulation 19

Figure (10): Steps of shunt infection reduction protocol.[71] 44

Abstract

Background: Cerebrospinal fluid (CSF) shunts remain among the most failure-prone life-sustaining medical devices implanted in modern medical practice, with failure rates of 30–40% at 1 year and approximately 50% at 2 years in pediatric patients. **Aim of the Work:** To study the effectiveness of antimicrobial impregnated catheters in preventing shunt and EVD infections and the impact of antibiotic impregnated catheters on mortality, and prevention colonization. **Methods:** The PubMed and Scopus databases were searched. Catheter implantation was classified as either shunting (mainly ventriculoperitoneal shunting) or ventricular drainage (mainly external [EVD]). Studies evaluating antibioticimpregnated catheters (AICs), silver-coated catheters (SCCs), and hydrogel-coated catheters (HCCs) were included. A random effects model meta-analysis was performed. **Results:** Thirty-six studies (7 randomized and 29 nonrandomized, 16,796 procedures) were included. The majority of data derive from studies on the effectiveness of AICs, followed by studies on the effectiveness of SCCs. Statistical heterogeneity was observed in several analyses. Antimicrobial shunt catheters (AICs, SCCs) were associated with lower risk for CSF catheter-associated infections than conventional catheters (CCs) (RR 0.44, 95% CI 0.35-0.56). Fewer infections developed in the patients treated with antimicrobial catheters regardless of randomization, number of participating centers, funding, shunting or ventricular drainage, definition of infections, de novo implantation, and rate of infections in the study. There was no difference regarding gram-positive bacteria, all staphylococci, coagulase-negative streptococci, and Staphylococcus aureus, when analyzed separately. On the contrary, the risk for methicillin-resistant S. aureus (MRSA, RR 2.64, 95% CI 1.26-5.51), nonstaphylococcal (RR 1.75, 95% CI 1.22-2.52), and gram-negative bacterial (RR 2.13, 95% CI 1.33-3.43) infections increased with antimicrobial shunt catheters. **Conclusion:** The use of antimicrobial shunt catheters reduces the risk for CSF infections in patients with hydrocephalus. Several subgroup analyses showed that factors related to study design, type of catheter, duration of catheter placement, and whether the procedure is a de novo implantation or a revision may affect this risk. Publication bias in the region of small negative trials was also observed.

Key words: antibiotic-impregnated shunt catheters, shunt infections

Introduction

Cerebrospinal fluid shunting procedures are among the most common procedures neurosurgery, it has been used since 1950s and continued to be the procedure of choice in the majority of cases even after the introduction of the endoscope in the management of hydrocephalus. Despite its rule in saving thousands of lives it is criticized for having a very high rate of complications making many shunt treated patients life a series of miseries. Infection is a serious complication of the shunt operation with an incidence of about 5-15% [1,24,27,28], it is more common in young children below 6 month age and prematures. Other risk factors include postoperative CSF leak, the etiology of hydrocephalus also plays a rule in this aspect as neoplastic, infection and hemorrhagic causes are associated with higher risk of infection. [27,28] Furthermore patients with infected shunts have twice the mortality of those without infection. [8]

The introduction of antibiotic impregnated catheters in CSF shunting systems about 20 years ago was a step in the battle against shunt infection. [7] many studies in the literature have discussed this alleged effect; some of which have been included in our review to assess the effect of these devices to prevent shunt infection.

Aim of the Work

This study was conducted to assess the rule of antibiotic impregnated shunt in preventing shunt infection through systematic reviewing of the studies found matching our inclusion criteria, analyzing their results and discussing some of these studies that have discussed important aspects of our topic, aiming to give better guidelines in the usage of this shunt systems in dealing with this challenging problem.

Anatomy of ventricular system

The ventricular system consists of series of channels and spaces connected to each other, The embryologic origin is from the central lumen of embryonic neural tube. Each cerebral hemisphere contains a large lateral ventricle that communicates near its rostral end with the third ventricle via the inter-ventricular foramen (foramen of Monro). The third ventricle is a midline, slit-like cavity lying between the two thalami and hypothalami. Caudally, the third ventricle is continuous with the aqueduct of Sylvius, a narrow tube that passes through the midbrain, and which is continuous in turn with the fourth ventricle, a wide tent-like cavity lying between the brain stem and cerebellum. The fourth ventricle communicates with the subarachnoid space of the cisterna magna though the foramen of Magendie, and of the cerebellopontine angle through the foramina of Luschka; caudally it is continuous with the central canal of the spinal cord.[9]

The ventricular system contains the cerebrospinal fluid (CSF), which is secreted mostly by the choroid plexuses located in the lateral, third and fourth ventricles. The CSF flows from the lateral to the third ventricle, then the fourth ventricle, then from the fourth ventricle through the foramen of Magendie and the foramina of Luschka to the subarachnoid spaces.[9]

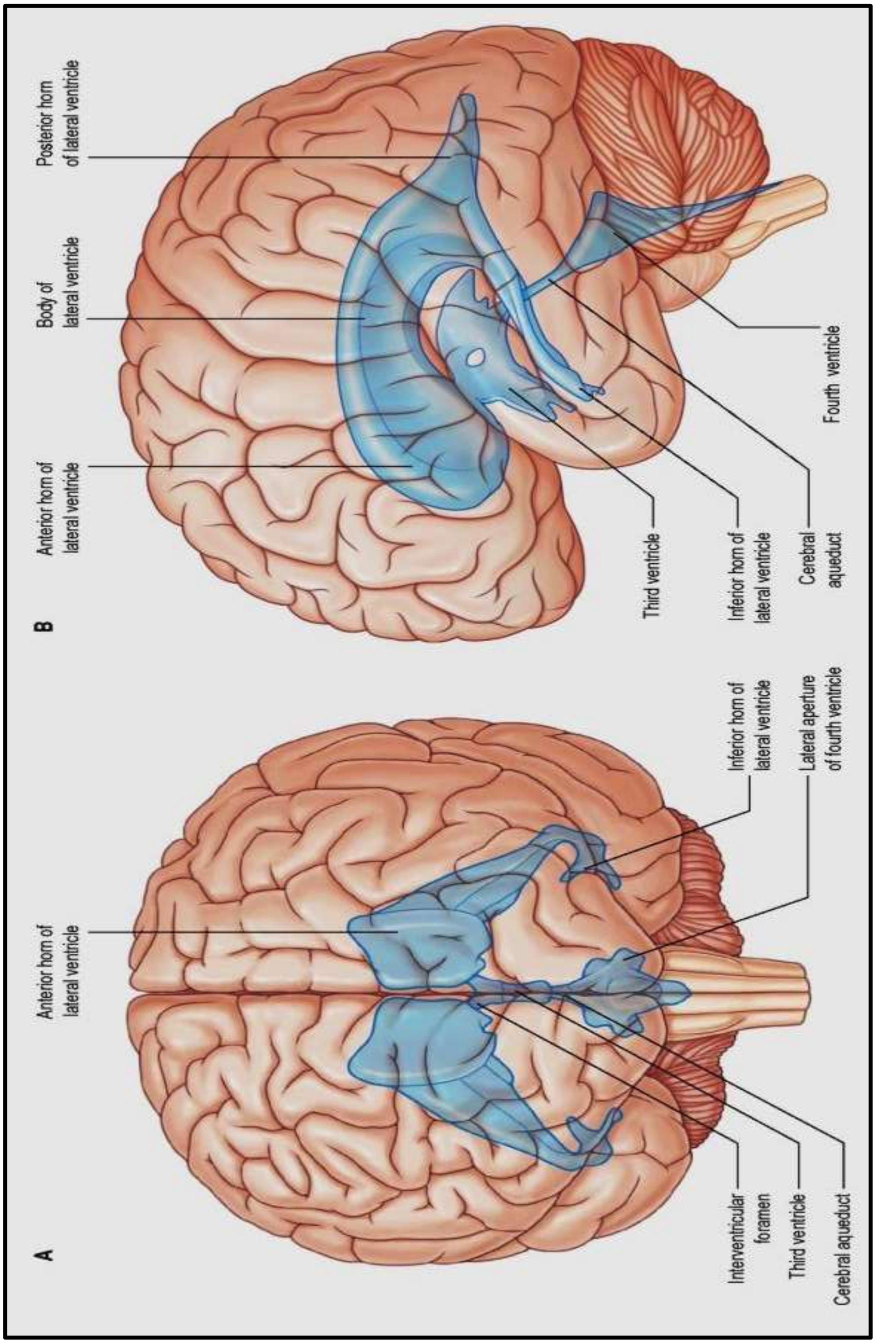

Figure (1): The ventricular system. A, Anterior view; B, left lateral view
[Gray's anatomy 40th edition]]

LATERAL VENTRICLES

From the lateral aspect, the lateral ventricle is C-shaped cavity which is formed by the expansion of the neural tube in the frontal, parietal and occipital lobes of the hemisphere during development, and the temporal lobe inferiorly and anteriorly. [9]

The lateral ventricles are divided into body, anterior (frontal), posterior (occipital) and inferior (temporal) horns. The anterior horn lies in the frontal lobe, and bounded anteriorly by the posterior aspect of the genu and rostrum of corpus callosum, and its roof is formed by the anterior part of the body of the corpus callosum. Both anterior horns of the ventricles are separated from each other by the septum pellucidum, in a coronal cut the anterior horn has the shape of a flat triangle in which the head of the cauda the nucleus forms the lateral wall and floor. The anterior horn extends to the inter-ventricular foramen. The body lies in the frontal and parietal lobes and extends from the inter-ventricular foramen to the splenium of the corpus callosum. The septum pellucidum, contains the columns of the fornices in the lower edge. The lateral wall of the body of the ventricle is formed by caudate nucleus superiorly and thalamus inferiorly. The bodies of the lateral ventricles widen posteriorly to be in continuation with the posterior and inferior horns at the trigone or atrium. The posterior horns curve postero-medially into the occipital lobes. The body of the lateral ventricle is usually diamond-shape or square. The inferior horns are the largest parts of the lateral ventricles and extends forwards into the temporal lobes. They curve round the posterior aspect of the thalami (pulvinar), then pass downwards and postero-laterally and then turn anteriorly to end 2.5 cm off the temporal pole, near the uncus. It corresponds to the superior temporal sulcus on the surface. The roof of the inferior horns are formed mainly by the tapetum of the corpus callosum, but also by the tail of the caudate nucleus and stria terminalis. The floor of the ventricles consist of the hippocampus medially and collateral eminence which is formed by the infolding of the collateral sulcus, laterally.[9]

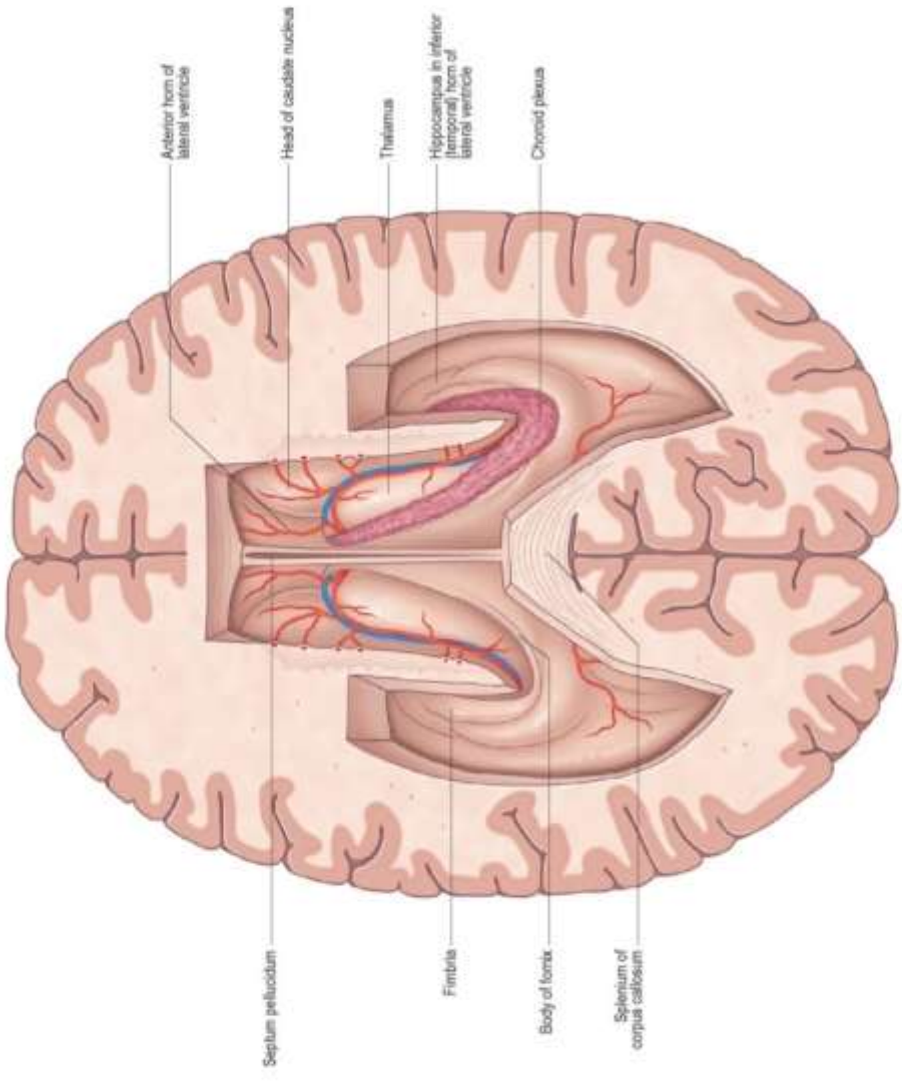

Figure (2): Horizontal section of the cerebrum dissected to remove the roofs of the lateral ventricles. [Gray's anatomy 40th edition]