

Relationship between Dental Procedures and Shunt Infections in Hydrocephalic Patients: A Narrative Review

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Oral physicians frequently encounter medically compromised patients in their everyday practice and a sizable number of these patients are in urgent need of specialized care. One such medically specialized category is that of patients suffering from hydrocephalus. A large number of medical reports and citations in support of surgical care of the hydrocephalic disorder are available in literature. However, reports on dental studies offer contradictory statements on the relationship between hydrocephalic shunts and oral manoeuvres. The present narrative review aims to delineate the historical journey of the association between shunt infections and dental procedures, decode the existing controversies and provide updated information on antibiotic prophylaxis prior dental treatment for hydrocephalic patients.

Key Words: Antibiotics, bacteremia, dental clinic, hydrocephalus, ventriculo-peritoneal

INTRODUCTION

In recent times, multidisciplinary interventions have garnered a great deal of attention and health care professionals have to adapt and improvise so as to best serve the need of ‘special-case’ patients. Dental disciplines are no exception to this phenomenon. Nowadays, as a matter of routine, oral physicians are encountering medically compromised patients in their everyday practice and a sizable number of these patients are in urgent need of specialized care. One such medically specialized category is that of patients suffering from hydrocephalus. A large number of medical reports and citations in support of surgical care of the hydrocephalic disorder are available in literature. However, reports on dental studies offer contradictory statements on the relationship between hydrocephalic shunts and oral manoeuvres. The purpose of the current narrative review is to conduct an in-depth discussion on the controversial association between shunt infections (SI) and dental procedures and provide updated information on antibiotic prophylaxis prior dental treatment for hydrocephalic patients.

In order to have a better understanding of contradicting opinions on SIs, it is essential to know the fundamental and characteristic

features of hydrocephalus candidates that provide information on prevalence, microbiology, etiology and management.

Epidemiology

Hydrocephalus is a disorder that primarily targets pediatric patients and is frequently encountered in the field of paediatric neurosurgery. In case of adults, acquired conditions are predominantly seen subsequent to a trauma or infection of the brain. Annual reports of United States indicate that around 0.5% of the hydrocephalus patients are susceptible because of congenital etiology.¹ As per statistics revealed by the ‘Public Health Agency of Canada’, 70 out of every 100,000 individuals are afflicted with this disease.² Although in terms of numbers, hydrocephalus cannot be classified as a common disease or a disease of high public health significance, it does not dilute the relevance of our current discussion on how to provide optimal oral care to patients suffering from this condition.

Microbiology

From the microbiological point of view, it is well established in literature that Gram positive microorganisms, such as *Staphylococcus aureus* and *Staphylococcus epidermidis*, are commonly associated with the occurrence of early VP shunt infections.³ On the other hand, delayed infections are linked with the incidence of Gram-negative pathogens such as *Pseudomonas aeruginosa*. Other organisms associated with SIs include *Corynebacterium*, *Streptococcus* spp., and *Candida albicans*.⁴ The presence of aforementioned pathogens in the oral cavity is the basis of the controversy that this paper intends to document and detail. It is the concurrent presence of these bacteria in the oral micro flora that influenced researchers such as Croll and his team to voice their opinion on their relationship with shunt infections (SIs).

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Etiology and Management

The physiological cause of hydrocephalus is a disturbance in the balance between production and adsorption of cerebrospinal fluid (CSF) resulting in an excessive accumulation of CSF in the brain. The consequent intracranial hypertension causes the ventricular system to dilate leading to a condition called macrocephaly or large head which is a textbook symptom of hydrocephalus. Medical theory categorizes hydrocephalus into two categories: (a) communicating and, (b) non-communicating or obstructive hydrocephalus. The former type of obstruction is found in ventricles and the later is characteristic of the subarachnoid space. Normal pressure hydrocephalus (NPH), a special entity occurring in midlets, is anticipated to increase in frequency in the near future.⁵ Although, via pharmacotherapy, hydrocephalus can be supported and contained; it serves only as a temporary remedy and has proved ineffective in terms of managing the build-up pressure. Surgical placement of cerebral shunts remains the golden standard for managing progressive hydrocephalus in afflicted individuals. Ventriculo-peritoneal (VP) shunt, a tried and tested device, remains the shunt of preference for retrieving accumulated CSF; other popular shunts include the ventriculo-atrial (VA) shunt and the ventriculo-pleural shunt. Patients of VA shunting require more post-operative review as compared to others, which may explain why its usage is comparatively restricted. Despite of the myriad benefits hydrocephalus patients derived from the use of the VP shunt, complications, both in adults as well as in children, are known to occur occasionally.^{3,6}

SHUNT INFECTION

SI is one of the most common complication that are observed in hydrocephalus patients; they are also known to be a major contributor to the morbidity and mortality rates. Despite the rising incidence of complications in patients with VP shunts, they retain their status as one of the most popular regimens for treatment of hydrocephalus.⁶ SI developed during the initial days of insertion can be satisfactorily controlled with the usage of antibiotic coated catheters.⁷ Recent studies have reported that the use of such antibiotic-coated shunts is particularly favorable in case of high-risk patients such as those with of an age less than one year.⁸ Infections that occur in the later stages (after installation\review period) are termed as delayed SI and are known to be the by-product of peritonitis. Current therapeutic protocols advocate removal of the infected catheter along with administration of intra-ventricular (IV) antibiotics (Vancomycin IV dose 10 mg\kg for 7days) in order to control the CSF infections.⁹ Further discussion is narrowed considering the arguments received in favor \against the association between SI and dental procedures, which will be better understood with the support of literature.

Literature: Past and Present

Literature provides several controversial facts on the association between SI and dental procedures. A summary of the below mentioned per-reviewed articles is presented in Table 1. The honorary work, such as one documented by Croll *et al* has served

Table 1. Summary of peer-reviewed articles

Author	Design of study	Subjects	Dosage of Antibiotics	Recommendation
Croll <i>et al</i> ¹⁰	Literature review		Child < 40 kg- 1g Dicloxacillin p.o 30-60 minutes before dental procedure and 250mg for every 6 hours; Child > 40 kg- 2g Dicloxacillin p.o 30-60 before dental procedure and 500 mg for every 6 hours	Advocated antibiotics for individuals with VA and VP shunts.
Acs and Cozzi ¹¹	Survey (questionnaire evaluation)	Pediatric dentists Neurosurgeons	Penicillin Dicloxacillin	Pediatric dentists advised Penicillin as a prophylactic antibiotic in case of both VA and VP shunts. Neurosurgeons preferred Dicloxacillin more for VA candidates.
Helpin <i>et al</i> ¹²	Prospective pilot study	14 children with VP shunts	No antibiotics administered	Antibiotic prophylaxis not recommended as the performed dental procedures did not cause risk.
Aptekar and Sandor ¹³	Short Communication			Adopted guidelines of AHA ²²
Galleretta <i>et al</i> ¹⁴	Literature review			Adopted guidelines of AHA ²²
Mozzam <i>et al</i> ¹⁵	Retrospective study	100 pediatric patients (204 shunt surgeries performed)		Antibiotic prophylaxis not recommended as neither high-risk nor low-risk dental manoeuvres produced statistical data significant enough to substantiate their involvement in SI.

p.o : orally

VA: Ventriculo-atrial

VP: Ventriculo-peritoneal

AHA: American Heart Association

SI: Shunt infection

as benchmark for the forthcoming researches in dentistry.¹⁰ The eminent authors provided the preliminary report on possibility of shunt infection during dental care and recommended antibiotic prophylaxis (child < 40 kg- 1g Dicloxacillin p.o 30-60 min before dental procedure and 250mg for every 6 hours; child > 40 kg- 2g Dicloxacillin p.o 30-60 before dental procedure and 500 mg for every 6 hours; Cephalosporin 50mg/kg for allergic patients) for individuals with VA and VP shunts.¹⁰ Aware of the fact that hydrocephalic individual with VP shunt are less vulnerable to bacterial colonisation, the scholars advocated antibiotics considering the insufficient researches. But the authors quoted to solve the existing dilemma between shunt infection and oral care when concrete evidence is retrieved from animal studies. In the context of precautionary measures, Croll emphasized the importance of honest conversation between the physician and dentist and adherence to standard sterilisation protocols.¹⁰ A few decades following the introduction of the above mentioned therapy, in the 90s, a questionnaire-based evaluation was performed amongst the pioneers of the fields of paediatric dentistry and neurosurgery with the intention of overcoming the limitations presented by the previous reports.¹¹ The objective of the survey was to assess the risks associated with VA and VP shunts following dental procedures in hydrocephalus patients. To the great surprise of investigators the responses of this study were inconclusive in reaching a consensus. It was found that most pediatric dentists preferred prescribing Penicillin as a prophylactic antibiotic in case of both VA and VP shunts in spite of there being a known low risk of infection with the VP device. Neurosurgeons on the other hand preferred recommending the antibiotic Dicloxacillin more for VA candidates than for those with VP shunts. The later received antibiotic therapy while undergoing invasive procedures in an attempt to prevent incidence of bacteraemia. In face of such mixed statements, the authors concluded on an unclear note and demanded the execution of more evidence-based studies on the impact of surgical (oral) procedures on SI.¹¹ Meanwhile, Helpin and their team exclusively recruited candidates with VP shunts and analysed the influence of dental prophylaxis and fluoride application for one year in fourteen children. Even though the performed dental procedures did not cause any risk in the hydrocephalic patients, the authors advised to confirm the accuracy with large-population studies and invasive dental procedures (periodontal surgery/extraction) as their results were derived from a small group.¹² However, subsequent to their landmark input, reports that contributed significantly to the field were not forthcoming except for a chronicle in the CDA (Canadian Dental Association) that addresses the cautionary aspect of hydrocephalic patients in light of the above parent reports¹³ and recommended antibiotic therapy (2.0 g Amoxicillin 1 hour before the invasive dental procedure (or 600 mg Clindamycin: patient's allergic to Penicillin) based on the guidelines of American Heart Association (AHA). Similarly, a review paper by Gallaretta *et al*¹⁴ supported the standard regimen of AHA and highlighted the dental needs and characteristics of hydrocephalic patients. This happens to be the only paper wherein authors have denoted the accessory aids in dental chair required to comfort the handicapped patient.

In the meantime, similarities between the pathogens involved in both conditions not only strengthen the proposed hypotheses of the current paper but also prompt us to seek concrete evidence for the same for hydrocephalus patients undergoing oral care. In this respect,

a recent retrospective study done in order to evaluate the association between SI and dental procedures reports that risk involved in case of paediatric patients is negligible.¹⁵ The authors stated that neither high-risk nor low-risk dental manoeuvres produced statistical data significant enough to substantiate their involvement in SI. The results presented in the above investigation are in direct contradiction to the previously outlined theories and suppositions proposed by the eminent scholars. In light of experience with SI and oral manoeuvres, we feel strongly that the principles contemplated above cannot be denied but the limitations of the above mentioned study in terms of sample size suggest that it is prudent for us to maintain cautious attitude with respect to microbial infection. The above descriptions of hydrocephalus make the readers question the association between a shunt infection and dental procedures. With the intention of updating the American scenario, further communication is tailored so as to be based on current American Academy of Pediatric Dentistry (AAPD) regulations.

Outlook of American Dental Association\ American Heart Association\ American Academy Of Pediatric Dentistry

Insofar as bacteraemia is concerned, dental citations indicate that bacterial infections can occur even during routine brushing of teeth.^{16,17} In light of this, even the least intrusive procedure (See Table 2) is liable to introduce microorganisms in the system of patients especially those who are infirm. Numerous organisations have taken sincere efforts to produce evidence based protocols regard to antibiotic prophylaxis prior dental care in healthy and medically compromised subjects. One among the nation's foremost dental organization, the ADA, an institution that possesses of more than a century long history, has been at the forefront of devising clinical guidelines especially tailored and based on experience in United States (US). The evidence collated by the ADA underlines the importance of prescribing pre-operative prophylactic antibiotics for all dental procedures that involve invasion of the oral (gingival) tissues. In order to forestall the bacterial threat, practitioners are reminded to administer antibiotic therapy especially in cases of patients that have conditions that weaken their immune system (ex: renal/liver disease, cardiac defects) and/or have implanted medical aids (catheter, prosthesis)¹⁸⁻²¹ Such measure will reduce the incidence of post-operative wound infection. The above mentioned observations suggest that individuals that suffer from compromised/neglected health could be victims of post-operative bacteraemia which in turn could lead to inflation in the frequency of such infections.

Table 2. Dental procedure which requires antibiotic regimen in susceptible patients²²⁻²⁴

Dental procedures
Periodontal treatment (sub-gingival scaling, root planning)
Dental implant placement
Orthodontic treatment (stabilization of orthodontic bands)
Rubber dam installation (sub-gingival)
Intraligamentary injection (local anesthesia)
Reimplantation of teeth

Note: Any dental procedure that encounter\expect bleeding is eligible to receive antibiotic therapy

In light of above evidence it is easy to comprehend that hydrocephalic patients are especially susceptible to bacterial infection. Studies in literature clearly demonstrate that a higher incidence of tooth decay is observed in cases where there is improper oral hygiene; the same is also observed with routine intake of drugs (sweetener ingredients)\carb-products and leads to a decline in oral health.¹⁴ In spite of the meticulous protocols that are followed, these patients must be treated as compromised candidates when under the care of an oral physician. The above stated factors, when considered in combination with generic ill-health, are sufficient to classify them high-risk candidates. In an attempt to benefit the dental patients with high-risk profiles, guidelines recommended by AHA encourage prescribing antibiotics to prevent infection; this is especially true in case of patients with VA shunts.²²⁻²⁴ Meanwhile, the Canadian Dental Association (CDA) guidelines also acknowledge the statements recorded by AHA in an attempt to prevent potential bacteraemia in patients with CSF shunts.²⁵ Based on the exhaustive documents of AHA, the current AAPD guidelines recommend a preoperative (1 h) dose of Amoxicillin for adults (2 g) as well as children (50 mg/kg) with VA shunts; this is in light of their increased predisposition towards bacteraemia via the vascular mode of entry.²⁶

For patients with difficulty in oral consumption, Ampicillin (adults-2g IM or IV; child- 50mg/kg IM or IV) or Cefazolin (adults-1g IM or IV; child- 50mg/kg IM or IV) is advised one hour prior the dental procedure. Individual reporting an allergy to penicillin is proposed an alternative such as Clindamycin (adults, 600 mg IM or IV; children, 20 mg/kg IM or IV).²⁶ In addition to these measures an exhaustive discussion with the candidate's physician is mandatory to prevent the development of anti-microbial resistance and resultant complications. It is noteworthy that the panel teams have made sincere efforts to include guidelines for most types of the dental interventions encountered in routine practice; it is hoped that this eventually serves as an encyclopaedia of knowledge for budding clinicians. Additionally, all the suggested instructions are revised periodically and the information has been made available for all readers who are interested.

Way Forward

Further evidence from large scale randomized clinical trials investigating antibiotic controversies prior to invasive dental procedures conducted in shunted patients are required to determine the most optimum therapeutic approach. This approach is useful and vital and has the potential to make a sizable contribution towards the oral-health of the nation. On a positive note, United States Congress has sanctioned a bill recently to update the epidemiology and recoup more data on hydrocephalus which is a healthy intervention.²⁷ Updating future studies and guidelines would greatly benefit the well-being of a dental patient in getting the best possible dental care as can be made available to them by synergizing the expertise of neurosurgeons, family physicians and paediatric dentists.

CONCLUSIONS

To conclude, inadequate research-based evidence in the past led the honorary scholars to advise antibiotic therapy for both (VP &VA) type of shunts. As VP shunts are not associated with a high risk of infection development, they do not require antibiotic therapy preceding oral care in case of hydrocephalus patients. However, in the interest of patient welfare, while treating individuals shunted with VA device, AAPD guidelines need to be adhered to in order to avoid incidence of bacteraemia. With the possibilities of an increased incidence of caries in such candidates, parental education must be made a part of the treatment plan in order to enhance prognosis. Although literature is unclear on a direct association of SI with dental manoeuvres, complications should be expected in the context that an implanted device is still a foreign body. It's on good belief that the information narrated in this review regarding treatment of a reserved population (hydrocephalic) will also make a useful addition to the repertoire of dental practitioners who are new to the profession.

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