

The impact of ventricular catheter impregnated with antimicrobial agents on infections in patients with ventricular catheter: interim report

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Abstract

Introduction Previous prospective study in our unit had shown that the use of dual antibiotic prophylaxis in patients with external ventricular drain was associated with decreased incidence of cerebrospinal fluid infection but complicated with opportunistic extracranial infection. In recent years, cerebrospinal fluid shunt catheters impregnated with antimicrobial agents have become available. Theoretically, these catheters provide antibiotic prophylaxis locally without the associated complications of systemic opportunistic infection.

Methods We carried out a prospective randomized, controlled clinical trial in a regional neurosurgical center in Hong Kong. We recruited patients admitted for emergency neurosurgical operation after informed consent was obtained from next-of-kin. Eligible patients were randomized to receive an antibiotic-impregnated ventricular catheter or plain ventricular catheter. Dual prophylactic antibiotic coverage was given to the patients randomized for plain ventricular catheter only. Patients who received antibiotic impregnated catheters were not treated with systematic prophylactic antibiotics. Here we present the analysis of 110 patients, recruited over a 2-year period, to receive antibiotic-impregnated ventricular catheters versus non-impregnated ventricular catheters with prophylactic antibiotic coverage.

Findings Fifty-two patients were randomized to antibiotic-impregnated ventricular catheter with no systemic antibiotic prophylaxis (Group A) and 58 patients were randomized to plain ventricular catheters with prophylactic dual antibiotics (Group B). There was no ventriculostomy-related infection in either groups of patients. There was also no statistical significant difference in incidences of extracranial infections between the two groups, $p=0.617$.

Conclusions In this analysis, antibiotic-impregnation of ventricular catheters was as effective as systemic antibiotics in the prevention of ventriculostomy infections, with the potential advantage of avoiding the systemic side-effects of prophylactic antibiotics.

Keywords Ventriculostomy · Infection · Cerebrospinal fluid · Antibiotic

Introduction

External ventricular catheters are used for intracranial pressure monitoring and temporary cerebrospinal fluid drainage in neurosurgery. An incidence of ventriculostomy-related cerebrospinal fluid infection has been quoted to be between 2.2% and 10.4% [3–6, 10–12] in the more recent literature. A previous prospective study in our unit [7] had shown that the use of dual antibiotics prophylaxis in patients with external ventricular drainage was associated with decreased incidence of cerebrospinal fluid (CSF) infection but was complicated by opportunistic extracranial infections. The current practice is to cover all patients with external ventricular drains with prophylactic dual antibiotics, unless microbiology results guide more selective antibiotic regimens. In recent years, cerebrospinal fluid shunt catheters impregnated with antimicrobial agents have become available. The antibiotic-impregnated catheter is a

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silicone catheter impregnated with 0.15% clindamycin and 0.054% rifampicin. Experimental studies [2, 7] have shown that these antibiotic impregnated catheters provide protection against *Staphylococcus aureus* and coagulase-negative staphylococci strains for at least 42 days. Theoretically, this provides antibiotic prophylaxis locally without the associated complications of systemic antibiotics. The beneficial effect in reducing CSF infection was shown with reduction in positive CSF cultures by Zabramski [14], in which they were not employing the effective policy of systemic dual antibiotics for prophylaxis as long as the ventricular catheter was in situ, and no data was available in terms of nosocomial infection was available in the literature.

Method

We carried out a prospective randomized controlled clinical trial in a regional neurosurgical center in Hong Kong to investigate whether antibiotics-impregnated ventricular catheters could replace prophylactic systemic antibiotics prophylaxis.

The pre- and post-operative care was in accordance with standard protocols currently used in the center. The ventricular catheter might be inserted as a separate procedure or in the setting of craniotomy as determined clinically. Prophylactic antibiotic coverage was used during the period of external ventricular drain placement. This was based on the results of a randomized controlled trial performed in our unit [8], which demonstrated a reduction in CSF infections with peri-procedural prophylactic antibiotic therapy. Subsequent analyses by Rebeck et al. [9] and Alleyne et al. [1] have questioned this effect, but the retrospective nature of their studies and the choice of antibiotics used makes comparison difficult. We performed all our ventricular drain insertion under stringent aseptic techniques in the operating theatre with a subgaleal tunneling of 5 cm. We had a standard guideline and standard instrument sets. Cerebrospinal fluid was collected under aseptic technique from the three-way connector just distal to the ventricular catheter every 5 days or on evidence of clinical sepsis. We did not perform regular exchanges of external ventricular drain catheters according to the published randomized controlled clinical trial of our unit [13].

Patients who were likely to have ventricular catheter in-situ for 5 days or more would be recruited before emergency or elective neurosurgical operation. They included patients with head injury, haemorrhagic stroke or hydrocephalus. Randomization would be taken care of by

the research assistant through a computer-generated randomization number. Consent was obtained from a guardian or next-of-kin if the patient was mentally unfit for consent. Patients were randomized into one of the two groups:

1. Periprocedural antibiotics only ie Unasyn and Rocephin and insertion of the antibiotics-impregnated (0.15% Clindamycin and 0.05% Rifampicin) ventricular catheter;
2. Periprocedural antibiotics and prophylactic dual antibiotics ie Unasyn and Rocephin and insertion of ventricular catheter without impregnation of antibiotics.

“Prophylactic” means to use the antibiotics named above, as long as the ventricular catheter was in-situ. Changes in antibiotic treatment were directed by the clinical status of the patient, as for example, by the presence of concurrent, extracranial infection.

Primary outcomes include ventriculostomy-related infection and extracranial infection. Statistical analysis was carried out with SPSS for Window Version 14.0. Categorical outcome measures, such as CSF infection, were compared between groups using Fisher Exact Test. Continuous outcome measures, such as hospital stay, were compared between groups using unpaired *t*-test.

Results

Here we presented the interim analysis of the 110 patients, which were recruited over a 2 year period. 52 patients were randomized to antibiotic-impregnated ventricular catheter (Group A) and 58 patients were randomized to plain ventricular catheters with prophylactic dual antibiotics (Group B). Age (mean \pm SD) was 50.1 \pm 14.1 years. Male to female ratio was 1:1. The neurosurgical indications were stroke (74%), trauma (17%) and others such as tumor and hydrocephalus (9%). Risk factors for ventriculostomy-related infection included diabetes (11%), steroid consumption (4%), skull base fracture (10%) and craniotomy/craniectomy (57%). The duration of ventricular catheter in-situ (mean \pm SD) was not different between the two groups, 9.9 \pm 5.4 days for Group A and 10.1 \pm 5.4 for Group B, $p=0.823$. There were no ventriculostomy-related infections in either group of patients. There was also no statistical significant difference in the incidence of extracranial infections between the two groups, 51% for Group A and 46% for Group B, $p=0.617$. The incidence of resistant organisms (MRSA or fungi) in cases of extracerebral infection was also not different between the two groups.

Discussion

External ventricular catheter insertion through burr hole and ventriculostomy represented an advance in the management of neurosurgical patients. Through a simple procedure, neurosurgeons could have a simple way to (a) monitor change in intracranial pressure, which per sec would be a good indicator for new intracranial events such as oedema or rebleed; (b) provide a reliable mean for drainage of cerebrospinal fluid for hydrocephalus or intracranial pressure control. In patients with severe head injury, the application of a threshold intracranial pressure leads to an improvement of management outcome. The downside is that as a foreign body and conduit to the cerebrospinal fluid compartment, it carries a risk of infection, which may result in neurological morbidity and mortality. Systemic antibiotic prophylaxis has been prescribed, following a variety of different protocols, to reduce the incidence of catheter-induced CSF infection. Being systemic in nature, this has the risk of systemic side-effects such as allergic reactions and pseudomembranous colitis. Moreover, prophylactic antibiotic treatment has been associated with nosocomial infections with resistant strains.⁷ The other way to give antibiotics prophylaxis would be topical. One simple way would be to give the antibiotics locally through the ventricular catheter. With the advance of technology, antibiotics impregnation of ventricular catheter became feasible. These catheters have the advantage of sustained release throughout the catheter-in-situ period. In our interim analysis, our results showed that the strategy of antibiotics-impregnated catheter insertion is as effective as systemic dual antibiotics prophylaxis in terms of cerebrospinal fluid infection and clinical outcome.

Conclusion

In this analysis, antibiotic-impregnated ventricular catheter was as effective as systemic antibiotics in prevention of ventriculostomy infection, with the potential advantage of avoiding the systemic side-effects of prophylactic antibiotic treatment.

Conflict of interest statement We declare that we have no conflict of interest.

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