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PROSPECTIVE AND RETROSPECTIVE STUDYEVALUATING POST-OPERATIVE NEUROLOGICAL INFECTION FOLLOWING NEUROSURGERY IN TERTIARY CARE HOSPITAL

Medicine

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ABSTRACT

Introduction: The central nervous system (CNS) is known as a delicate and vulnerable system enjoying protection by many layers of covering, providing an anatomical barrier against microbial invasion. **Aims:** To evaluate the incidence of post-operative neurological infections and to describe the microbiological profile and risk factors associated with infections in postoperative neurosurgery patient. **Materials And Methods:** The present study was a Cross-sectional study. This Study was conducted from was 12 months at Department of Family Medicine, Sterling Hospital, Ahmedabad. 76 participants were included for study. **Result:** 86.8% underwent elective surgery and rest of the patients underwent emergency surgery. This was not significantly associated with post-operative infections (p value = 0.39). Based on site of surgery, 13.2% underwent spine surgery, 73.7% had supratentorial surgery and 13.2% had infratentorial surgery. Site of surgery was not significantly associated with post-operative infections (p value = 0.11). **Conclusion:** The results of our study can be considered to identify post-neruosurgical patients who are at high risk of developing post-operative infections and improve hospital management protocols

KEYWORDS

Cerebral Abscess; Craniotomy; Meningitis And Surgical Site Infection.

The central nervous system (CNS) is known as a delicate and vulnerable system enjoying protection by many layers of covering, providing an anatomical barrier against microbial invasion. During surgery these barriers are breached, increasing the risk of infection. The CNS differs from other systems in having less immune activity and lower immunoglobulin levels. Therefore, organisms are able to invade and multiply more quickly, harming the host with a higher mortality than in other parts of the body. Infections spreading to the CNS often have devastating complications increasing morbidity and mortality.[1]

Due to its rich vascular network, the scalp is an area with a high wound healing potential. However, about 2.47% of all neurosurgical patients develop wound infections.[2] Several risk factors for wound infections have been described. The number of previous surgeries was found to be an independent risk factor for wound infections after craniotomy.[3]

Multiple operations lead to the formation of scar tissue and altered blood supply, possibly contributing to higher susceptibility to wound infections. In addition, the duration of surgery is another independent risk factor. In long-lasting operations, the risk of contamination during surgery is increased making the surgical site vulnerable to pathogens for a longer time period. Hardy et al could show a 43% increase of the risk to develop wound infections with each additional hour in surgery in patients undergoing craniotomy due to a brain tumor.[4] As a consequence, strategies for optimizing structural processes are necessary, e.g., minimizing delays once the patient is in the operating room. Several authors reported postoperative CSF leak as a risk factor for neurosurgical wound infections.[5] CSF leaks provide a portal of entry for organisms and lead to a higher risk for meningitis.

The patient's immune status might influence the manifestation of wound infection. The risk factors associated with the development of wound infections are preoperative use of steroids, chemotherapy in 30days, diabetes mellitus, and postoperative sepsis, and recent systemic infection.[6] Furthermore, studies revealed the implantation of foreign material as a risk factor for wound infection. The use of surgical drains and external ventricular drains significantly associated with the occurrence of wound infections. The length of stay on the intensive care unit (ICU) was shown to be associated with a higher risk for wound infections. This might be due to multifactorial reasons, comprising concomitant diseases, immunosuppression, and a higher likelihood of skin colonization in the ICU.

MATERIAL AND METHODS

4.1 Study Design
It was a cross-sectional observational study.

4.2 Study Duration
It was 12 months

4.3 Study Site
Department of Family Medicine, Sterling Hospital, Ahmedabad

4.4 Inclusion Criteria
1. Adults (aged 18-75yrs) males and females
2. Patients who underwent elective or emergency neurosurgery (cranial or spinal surgery) in our hospital.
3. Patients who survived for at least 7 days post-surgery.

4.5 Exclusion Criteria
1. Patients who underwent neurosurgery at another institute and was referred to our center.
2. Patients with immunocompromised state i.e. HIV sero positive, uncontrolled diabetes (HbA1c > 12.0%)
3. Patients with chronic kidney disease and on maintenance dialysis
4. Pregnant and lactating mothers.

RESULT AND DISCUSSION

In our study sample, post-operative central nervous system infections(PCNSI) rate was 2.6% and post-operative infection rate was 11.8%. This rate is higher than that reported in many previous series. We excluded minor neurosurgical procedures and we included high post-operative infections risk surgeries, emergency operations, and CSF surgeries. Higher infection rates may also be due to the fact that this study was carried out in a hospital with more surgeries of great complexity. Various types of infections noted in our study population was catheter acquired urinary tract infection (5.3%), ventilator associated pneumonia (3.9%), brain abscess (1.3%) and meningitis (1.3%). Causative organism isolated in our patients were pseudomonas aeruginosa (55.5%), klebsiella pneumoniae (33.3%) and budding yeast cell (11.1%).

In the study by Gizaw et al, the diagnosis of PCNSIs was entertained in 41 cases (16%), but only 29 cases (11.3%) fulfilled the CDC criteria. The commonest pattern of infection is meningitis/ventriculitis (n=24, 82.8%) followed by subgaleal abscess/ bone flap infections (n=4, 13.8%) and brain abscess (n=1, 3.4%). PCNSIs were related to instrumentation (EVD/ VP-shunt) in 12 (41.4%) patients.

In the study by Kourbeti et al, meningitis developed after 16 (4.8%) of the procedures and SSIs developed after 9% of the procedures. In addition, ventilator-associated pneumonia was the most common infection in this population (22.5%) with 9% of patients developing an SSI other than meningitis, 9% a UTI, and 15% pneumonia not associated with mechanical ventilation.

Demography

We observed that mean age of the patients with post-operative infections was 49.2 ± 10.1 years which was not significantly different from that of patients without post-operative infections (43.5 ± 13.3 years), p value = 0.21. In addition, post-operative infections were more common among male patients (p value < 0.05). In the study by Gizaw et al, among 256 cases constituting the series 52.7% were males and 47.3% were females. [7] The mean age is 33.3 years (SD ±15.9) and ranges from 10 months to 72 years. More than 60% of the population were in their 3rd to 5th decades of life.

In the study by Ma et al, a total of 1,616 cranial surgery procedures, 873 males, 743 females, mean age: 53.8 ± 16.0 years were included.[8]

In a similar study by Zhan et al, 808 men and 662 women were included in this study, of whom 1,340 underwent craniotomies and 130 underwent CSF surgeries. [9] The mean age at the time of surgery was 52.3 years (median age, 54 years. In their study, patients with younger age had higher odds of having PCNSI (odds ratio = 1.5, p value < 0.05). Contrary to our findings, gender was not significantly associated with PCNSI.

Chidmabaram et al found that mean age of patients with PCNSI was 38 years, which was significantly lower as compared to those without PCNSI (38 years vs 46 years, p value < 0.05).[10] Males comprised 49.3% of the group with PCNSI, which was similar to that of those without PCNSI (61.6%).

Clinical History And Presentation

We observed that hypertension was found to be significantly more common among patients with post-operative infections (33.3% vs 6%, p value < 0.01). Most common symptom was weakness (39.5%). Other common symptoms were loss of consciousness (31.6%) and headache (27.6%). Only loss of consciousness was found to be significantly more common among patients with post-operative infections (66.7% vs 26.9%), p value < 0.05. Fotso et al observed that the commonest underlying neurosurgical abnormalities were hydrocephalus (48.8%), traumatic brain injury (33.1%) and brain abscess (9.4%). 97.6% of the patients with traumatic brain injuries had infection (p value < 0.01).[11]

Clinical Examination

We found that mean body temperature was significantly higher among patients with post-operative infections (101.50 ± 0.57 vs 97.77 ± 1.08, p value < 0.01). Similarly, mean pulse rate was significantly higher among patients with post-operative infections (109.44 ± 13.68 vs 85.90 ± 18.25, p value < 0.01). It was observed that 46.3% of the patients without post-operative infections had a normal CNS examination, which was significantly higher as compared to those with post-operative infections (p value < 0.01). Among patients with post-operative infections, 33.3% had minor brain injury, while 66.7% had moderate brain injury. GCS score was found to be significantly associated with post-operative infections (p value < 0.01). Similar to our findings, Gizaw et al found that all patients diagnosed with PCNSI had fever record of ≥380C and 75.9% had meningeal signs.[7]

In the study by Ahmadinejad et al, GCS was 9.85±1.21 in the group with bacterial meningitis and 12.65±0.32 in other patients; mean of GCS was significantly lower in the group with bacterial meningitis than other patients.[12] Furthermore, 71 cases had underlying disease and 75 patients had no underlying disease. Four of patients with underlying disease (5.6%) developed bacterial meningitis and 9 of other patients (12%) developed bacterial meningitis. There was no significant difference.

Surgery Related Variables

In our study, 86.8% underwent elective surgery and rest of the patients underwent emergency surgery. This was not significantly associated with post-operative infections (p value = 0.39). Based on site of surgery, 13.2% underwent spine surgery, 73.7% had supratentorial surgery and 13.2% had infratentorial surgery. Site of surgery was not significantly associated with post-operative infections (p value = 0.11). In addition, use of Foley's catheter (p value < 0.01), Ryle's tube (p value < 0.01) and tracheostomy (p value < 0.01) were found to be significantly associated with post-operative infections. Duration of intubation, duration of surgery and number of surgeons involved in surgery was not significantly associated with post-operative infections.

In the study by Zhan et al, patients who underwent CSF surgeries had a higher risk of infection (PCNSI rate = 9.2 %) compared with those who underwent craniotomies (PCNSI rate = 7.2 %).[9] The surgical types associated with the highest PCNSI rates were craniotomy for AVM (22.7 %), followed by external CSF shunt (15.4 %), microvascular decompression (10.3 %), and tumor resection (10 %). The mean duration of surgery was 3.42 ± 2.1 h.

Ahmadinejad et al found that of 146 patients undergoing craniotomy, 77 cases had elective surgery and 69 patients underwent emergency surgery.[12] Of 77 cases undergoing elective surgery, 5 (6.5%) developed bacterial meningitis. Of patients who underwent emergency surgery, 8 cases (11.6%) developed bacterial meningitis; there was no significant difference in prevalence of bacterial meningitis between the two groups of patients undergoing emergency and elective craniotomy. Mechanical ventilation time was 37.23±8.50 days in the group with bacterial meningitis and 5.38±0.86 days in other patients. Mechanical ventilation time was significantly higher in the group with bacterial meningitis.

Laboratory Investigations

We observed that mean total leucocyte count was significantly higher among patients with post-operative infections (18255.56 ± 1441.45 vs 8704.48 ± 3524.91 per cumm, p value < 0.01). In addition, mean CRP was also significantly higher among patients with post-operative infections (26.64 ± 17.72 vs 8.87 ± 4.16 mg/dl, p value < 0.01). Mean procalcitonin level was 2.39 ± 0.35 ng/ml among patients with post-operative infections, which was also significantly higher than patients without post-operative infections (1.23 ± 0.63 mg/dl), p -value < 0.01. Both mean serum creatinine levels and blood urea levels were significantly higher among patients with post-operative infections (0.86 vs 0.65 mg/dl, p value < 0.01 and 29.93 vs 19.51 mg/dl, p value < 0.01 respectively), which could be explained by subclinical sepsis induced Acute Kidney Injury. On CSF examination, mean glucose and cells were significantly lower in patients with post-operative infections (43.11 vs 50.03 mg/ml, p value < 0.05 and 6 vs 11.6 per cumm, p value < 0.01 respectively).

PCT is a precursor protein produced mainly by the C-cells of the thyroid gland that is further cleaved into calcitonin, which is involved in calcium homeostasis. Described back in 1993 as a marker of sepsis; nowadays, this molecule is included in different antibiotic stewardship algorithms for initiation and discontinuation of antimicrobial therapy, aiming to reduce the excessive antibiotic consumption.[13]

In our study we found that mean procalcitonin level was 2.39 ± 0.35 ng/ml among patients with post-operative infection, which was significantly higher than patients without post-operative infection (1.23 ± 0.63 mg/dl), p value < 0.01.

CULTURE RESULTS

These results highlighted that gram-negative infections were associated with high economic burden. In addition to gram-negative infections, post- neurosurgical wound infections also lead to higher costs and poor resource allocations.[14]

In the study by Gizaw et al, among the 29 patients with PCNIS a total of 77 culture and sensitivity tests were done, 62 samples from CSF /surgical tissue/abscess and 15 of them were from blood. [7] Thirty-five (45.5%) of the samples grew organisms, 29 of them were from CSF/abscess/surgical tissue and 6 from blood samples. Organisms isolated from CSF/abscess/surgical tissue includes Acinetobacter spp. (n=11, 37.9%), Klebsiella pneumoniae (n=8, 27.6%) and Pseudomonas spp. (n=2, 3.2%). CoNS is isolated only in one CSF sample (1.6%), but it was the commonest organism cultured from three blood samples (50%). The predominant Gram negative organism was Acinetobacter baumannii (41.0%) followed by Klebsiella pneumoniae (14.0%), Escherichia coli (11.7%), Pseudomonas aeruginosa (7.8%), Serratia marcescens (7.3%), and Enterobacter cloacae (4.4%). The predominant Gram positive isolate was Staphylococcus aureus (5.6%) followed by Enterococcus faecium (1.1%) and coagulase negative staphylococci (1.1%)

In the study by Ma et al, of the 29 cases complicated by PCNSI, 11 had positive CSF cultures.[8] The microorganism most commonly responsible for PCNSI was Staphylococcus (seven cases of Staphylococcus, and among them three cases of methicillin-resistant Staphylococcus aureus) and Klebsiella pneumoniae (two cases), both of which are pan-drug resistant (PDR) bacterial strains. The remaining two positive CSF cultures were of Acinetobacter baumannii (a PDR bacterial strain) and Pseudomonas aeruginosa.

Zhan and colleagues observed that Gram-positive organisms predominated (16 cases, 59.3 % of positive culture results), and were most commonly caused by Staphylococcus aureus [13 cases, 48.1 % of positive culture results (two cases of methicillin-resistant Staphylococcus aureus)].[7] Gram-negative organisms (8 cases, 29.6 % of positive culture results) were most commonly caused by Acinetobacter baumannii (4 cases, 14.8 % of positive culture results).
In the study by Kourbeti et al, Acinetobacter spp. were the main isolates (present in 45% of cases) in patients with meningitis. The other pathogens included: Klebsiella spp. (4 cases), Pseudomonas aeruginosa (2 cases), Enterobacter cloaceae (1 case), Proteus mirabilis
Of the 13 cases who developed meningitis in the study by Ahmadinejad et al, 5 of them had positive CSF culture for bacteria; one case of A. baumannii, S. epidermidis, one case of S. pyogenes, one case of S. aureus and one case of P. aeruginosa were reported.[12]

Mortality

In a similar study by Gizaw et al, the overall surgical mortality is 9.8% (n=25). Mortality in patients with PCNSIs is 27.6 % (n=8).[7] Deaths in five of the patients was documented as attributable to sepsis or neurologic complications of infection. So PCNIs may contribute to 20% of the overall surgical mortality. Chidambaram et al observed that mortality rate was significantly higher among patients who had PCNSI (15.4%) as compared to those who did not have PCNSI (6.8%), p value < 0.05.[10]

CONCLUSION

Based on the results of our study, we conclude that:

1. Post-operative central nervous system infection rate was 2.6% .
2. Post-operative infections rate was 11.8%.
3. Sputum culture revealed 3 samples positive for Klebsiella pneumoniae and Pseudomonas aeruginosa each and two were positive for Stenotrophomonas maltophilia. On urine culture, five cases were positive for Pseudomonas aeruginosa.
4. Male gender, loss of consciousness, past medical history of hypertension, moderate brain injury on GCS, cannulation of any type, lower CSF glucose and abnormal brain imaging were significantly associated with post-operative infections.

This study highlights the prevalence and causative organisms of post-operative infections from a modernized yet resource-limited neurosurgical center located in India, an area of the world that is often underreported in the neurosurgical literature due to the paucity of clinical, neurosurgical research currently being undertaken here.

We Recommend That:

1. The results of our study can be considered to identify post-neruosurgical patients who are at high risk of developing post-operative infections and improve hospital management protocols.
2. Further research in this area should explore identifying possible causes of post- operative infections and implementing and monitoring specific interventions to reduce post-operative infections ideally in a multicenter research effort.

Table: Association of post-operative infection with culture results

		Post-operative infection		Total	
Sputum culture		No	Yes		p value*
Klebsiella pneumoniae	N	0	3	3	
	%	0.00%	33.30%	3.90%	
Pseudomonas aeruginosa	N	0	3	3	< 0.01
	%	0.00%	33.30%	3.90%	
Stenotrophomonas maltophilia	N	0	2	2	
	%	0.00%	22.20%	2.60%	
Negative	N	67	1	68	
	%	100.00%	11.10%	89.50%	
Urine culture					
Pseudomonas aeruginosa	N	0	5	5	< 0.01
	%	0.00%	55.60%	6.60%	
No organism	N	67	4	71	
	%	100.00%	44.40%	93.40%	
Blood culture					
No organism	N	67	9	76	NA
	%	100.00%	100.00%	100.00%	
Total	N	67	9	76	
	%	100.00%	100.00%	100.00%	

Table: Comparison of mean duration of surgery between patients with and without post- operative infection

Post-operative infection	N	Mean duration of surgey (hours)	Std.Deviation	P -Valeue
Yes	9	3.11	0.93	0.53
No	67	3.37	1.19	

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