Scalp flora in Indian patients undergoing craniotomy for brain tumors – Implications for pre-surgical site preparation and surgical site infection

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ABSTRACT

Introduction: Causation of surgical site infection (SSI) following craniotomy is multifactorial. Most preventive strategies (including site preparation and antibiotic prophylaxis) revolve around reducing preoperative contamination of the local site. There is little evidence, however, linking site contamination with postoperative infections. This is important given the preference for performing non-shaved cranial surgery. We undertook a prospective study to document the scalp flora in neurosurgical patients in an Indian setting and to assess possible association with SSI. **Materials and Methods:** A prospective study recruited 45 patients undergoing non-shaved clean craniotomies for various brain tumors. Standard perioperative procedures and antibiotic policy were employed. Prior to and immediately following the pre-surgical scrubbing, we collected swabs and evaluated their growth qualitatively. SSI was documented adhering to CDC guidelines. The association of swab-positivity with various parameters (including SSI) was evaluated. **Results:** Pre-scrub positivity was seen in 18 of 44 patients, three of them developed subsequent SSI. Most were known skin contaminants. Five patients had swab positivity after scrubbing, though none of these developed any SSI. Four of these five had pre-scrub positivity. In three the same organisms persisted (two being *Staphylococcus aureus*), and one had different growth post-scrub, whereas one patient developed new growth (contaminant mycelial fungus) in the post-scrub swab. We did not find any association between swab positivity and SSI. Swab positivity was also not related to hair-length or hygiene. **Conclusion:** Scalp flora in Indian patients is similar to that described. Pre-surgical preparation does not always eliminate this contamination (especially staphylococcus). However, this does not necessarily translate into increased SSI. Moreover, the results also provide objective evidence to support the performance of non-shaved cranial surgery without an undue risk of SSI.

Key words: Non-shaved neurosurgery, preoperative preparation, postcraniotomy infection, scalp flora

INTRODUCTION

Prevention of surgical site infections (SSI) is a prime consideration in planning any surgical intervention. This is more pronounced with neurosurgical procedures, given the grave implications of transgressing the central nervous system and potential for fatal infective complications. Wound infections not only retard wound healing and prolong postoperative stay, resulting in delay in initiating adjuvant therapy, but can also result in fatal intracranial infection, not to mention the financial implications of treating the infection and its attendant complications. Consequently, prevention of SSI is an integral part of the planning of any neurosurgical procedure. This is a multi-step process involving identification of risk factors (and their correction if possible), optimal surgical site preparation, judicious and appropriate use of antibiotic prophylaxis, implementation of universal aseptic precautions by the entire surgical team, gentle intraoperative tissue handling and complication avoidance, and rigorous postoperative surveillance. Current practice unfortunately focuses too much on antibiotic prophylaxis, which is indeed more abused than used, complacent under the misplaced belief that an "enhanced" antibiotic prophylaxis will cover for other deficiencies. This myth needs to be dispelled. Local surgical site contamination has been long believed to be a predictor of subsequent SSI. This may partly be the

Access this article online	
Quick Response Code:	Website: www.ijns.in
	DOI: 10.4103/2277-9167.94367

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reason for the over-reliance on antibiotic prophylaxis. However there is little objective data to support this. Documentation of the surgical site flora preoperatively not only facilitates correlation with subsequent SSI, but also helps formulate appropriate preventive strategies (site preparation, antibiotic policies) which may vary across geographical locations.

Despite the presumed causal association, a recent study did not find any correlation between preoperative scalp bacterial counts and subsequent SSI.[1] This data is difficult to extrapolate in the Indian setting because of the variable geographic, climatic and socio-economic profile of our patients. Few studies have looked at SSI following neurosurgery in the Indian setting.[2,3] Moreover preoperative scalp flora in Indian patients has not been studied. Our study attempts to document scalp flora in a homogenous group of patients in the Indian setting and analyze its correlation with subsequent SSI.

MATERIALS AND METHODS

Forty five patients were accrued in a prospective trial aimed at assessing the feasibility and safety of performing craniotomies with limited/minimal hair removal, specifically looking at surgical site infection rates. Patients with newly diagnosed brain tumors were included (those with previous craniotomy and/or local radiation were excluded). The study was approved by the IRB and registered with CTRI (CTRI/2008/091/000056). Detailed clinical assessment was conducted and noted. Specific parameters recorded were presence of diabetes and other immunocompromised states, hair-length and hygiene, recent infection, preoperative stay, ASA grade, duration of surgery, use of intraoperative adjuncts (which may compromise sterility, like ultrasound), use of postoperative wound or ventricular drain, exposure of paranasal sinuses intraoperatively, adequacy of dural closure and the use of dural graft. On the night before surgery as well as on the morning of the surgery, patients were given a head bath with shampoo. A uniform protocol of prophylactic antibiotic (intravenous cefuroxime 1.5 g at the time of induction and 750 mg repeated at 4 h if the surgery was prolonged) was employed. In the theater, after induction of anesthesia, the patient was positioned and scalp incision planned. Hair was parted (if long) and limited strip of 1–2 cm was removed. A swab was collected using a sterile swabstick with application of gentle pressure on the skin and this was placed in Stuart's medium and sent to the laboratory. The surgical site was then prepared with a povidone-iodine (7.5% w/v) soap-based surgical scrub and painted with povidone-iodine (10% w/v) aqueous solution. Immediately after this preparation another swab was collected and sent. Surgery was then performed as is routinely done. Postoperatively, the wound was inspected regularly and SSI documented strictly as per CDC guidelines.[4] Patients were followed up for one month (to assess 30 day SSI rates) as part of the trial and thereafter routinely as required. The microbiological examination included preparation of a Gram stain to look for any organisms. Subsequently the samples were plated on blood and Mac Conkey's agar and incubated at 37 degree C for 24 h. The growth, if any, was further characterized using routine microbiological tests for suspected organisms. Special culture media (anerobic, fungal, mycobacterial, etc) were not used routinely unless there was a strong clinical suspicion or unusual organisms were identified on the Gram stain.

Data was recorded using SPSS 15.0. Fisher's exact test (to study the difference in proportions) was used to assess the correlation between variables. This report focuses on the scalp flora pattern and its association with various factors.

RESULTS

Of the 45 patients, 44 were evaluable for perioperative events. One lady with a suspected brain metastasis was detected to have systemic metastases after being screened for the trial, and was subsequently only offered palliative radiotherapy and hence not operated. The mean age was 43.5 years (range 9 to -78 years). There were slightly more males than females (24 vs 21). All were elective, planned surgeries, 38 being supratentorial and six infratentorial surgeries. All patients were good ASA grade (1 or 2) and ventricular/lumbar drains were not used in any of these patients. There were six SSI in this group [Table 1] resulting in an infection rate of 13.6%. Table 2 shows the clinical risk factors in our patients and the SSI rates in the groups. Seventeen patients had long hair (three female patients had short hair, hence this discrepancy between hair length and gender). All patients (except one) had average to good hair hygiene as judged subjectively. Three patients had diabetes, and three others had a recent history of fever of unknown origin. The average preoperative stay was 2 to 11 days (1–10 days range). It was 2.2 days in patients with pre-scrub swab positivity and 2.0 days in those with no growth. The mean duration of surgery was 4.95 h. Sinuses were opened during four procedures. Intraoperative ultrasound (IOUS) was used in 9 cases. The

Table 1: Details of surgical site infection in patients

Type of SSI	No.
Superficial	2
Deep	0
Organ space	4
Total	6

SSI – Surgical site infection

dura was closed watertight in all (12 required a patch graft). Besides the SSI, no other wound related complications (gape, collection, and leak) were encountered.

Pre-scrub swabs were positive in 18 patients (41%) [Table 3]. The majority were coagulase negative staphylococci ($n=14$), followed by diphtheroids ($n=4$) and *Staphylococcus aureus* ($n=3$). Post preparation only 5 patients had positive swabs (9%) [Table 4]. Of these, four had pre-preparation swabs positive. Three were same as the pre-prep swab, two being staphylococcus; the fourth, however, grew a different pathogen (*E. coli*); and the fifth grew a contaminant mycelial fungus post-scrub (the pre-scrub swab was negative). The correlation between pre- and post-preparation swabs is shown in Table 4. Surprisingly, none of the five patients with positive post-scrub swabs developed SSI. Of the 18 with pre-scrub positive swabs, 3 developed SSI. The final pathogen in these did not correlate with the preoperative swab. Three others with SSI never had swab positivity [Table 5]. The correlation between SSI and pre-scrub swab positivity, post-scrub swab positivity, hair length, and hair hygiene did not yield any significant results (using Fisher's exact test to study the difference between proportions). We also did not find any association of hair length and hygiene with pre-scrub positivity (using the Fisher's exact test).

Table 2: Details of the clinical risk factors and SSI rates

Risk factor	Number	SSI
Female		
Yes	20	3
No	24	3
Diabetes		
Yes	3	1
No	41	5
Long hair		
Yes	17	2
No	27	4
Poor hygiene		
Yes	1	0
No	43	6
Prior infection/fever		
Yes	3	0
No	41	6
Prolonged surgery (>4 hours)		
Yes	30	2
No	14	4
Use of IOUS		
Yes	9	1
No	35	5
Use of wound drain		
Yes	20	2
No	24	4
Dural graft		
Yes	12	2
No	32	4
Sinuses opened		
Yes	4	0
No	40	6
Pre-scrub positive swab		
Yes	18	3
No	26	3
Post-scrub positive swab		
Yes	5	0
No	39	6

IOUS – Intraoperative ultrasound; SSI – Surgical site infection

DISCUSSION

Microbial (usually bacterial) contamination of the operative site prior to surgery is regarded necessary for SSI to develop subsequently.[4] In fact, most attempts to reduce SSIs usually aim to reduce this contamination (such as antibiotic prophylaxis, preoperative skin preparation, etc.). The scalp normally has a complex polymicrobial flora consisting of diphtheroids (mainly propionibacteria), staphylococci (epidermidis and aureus), other Gram positive cocci and bacilli besides resident fungi.[5,6] The floral pattern may vary depending on different factors such as personal hygiene, place of origin (home or hospital), duration of prehospital stay and technique of sample collection amongst others. Cronquist *et al*.[1] showed a very high (99%) rate of preoperative scalp colonization rate in their patients. Our pre-preparation scalp colonization rates were not as high (41%), possibly because of differences in culture techniques. Nonetheless, similar to their findings, a quarter of our patients too remained positive after the scrub, despite using a rigorous pre-surgical scrubbing routine. This means that surgical

Table 3: Prescrub positive swabs details

Type of organism	Number
Coagulase negative staphylococcus (CoNS)	10
Diphtheroids	4
Staphylococcus aureus	3
Pseudomonas sp	1
Total	18

Table 4: Post scrub positive swabs details

Type of organism	Pre scrub growth
Staphylococcus aureus	*Staphylococcus aureus*
Staphylococcus aureus	*Staphylococcus aureus*
Diphtheroids	CoNS
E. coli	Skin contaminants
Mycelial fungus	Nil
Total	5

Cons – Coagulase negative staphylococcus

Table 5: Details of the six patients with surgical site infection

Pre scrub	Post scrub	Onset of SSI	Type of SSI	Type of organism
Diphtheroid	Nil	Delayed (>15 days)	Organ space	MRSA
Staph aureus	Nil	1-7 days	Organ space	*Klebsiella pneumonia, E. coli*
CoNS	Nil	7-15 days	Superficial	*Staphylococcus aureus, Pseudomonas*
Nil	Nil	7-15 days	Superficial	*Enterobactar cloacae*
Nil	Nil	1-7 days	Superficial	*Klebsiella pneumoniae, E. coli*
Nil	Nil	7-15 days	Superficial	CoNS sensitive to linezolid

SSI – Surgical site infection

preparation does not always sterilize the surgical field. However, this lack of absolute sterility does not necessarily translate into increased postoperative infections. None of our patients with positive post-preparation swabs had SSI. Even in the large study by Cronquist, there was no correlation with postoperative SSI.[1] It has been suggested that surgical preparation techniques are unable to eliminate sub-surface resident flora which may not be always sampled by culture techniques using swabs.[7] However, the surface flora may be a surrogate marker for deeper flora and predict an increased risk for SSI. Microbiological studies have shown that the density of surface flora predicts the presence of bacteria in the wound postoperatively.[8] However, as reported by Cronquist and our present study, this does not necessarily result in increased infections. Moreover numerous studies evaluating various site-preparation techniques also do not show any significant effect on SSI.[9]

This evidence does not undermine the causative role of local skin contamination or the use of appropriate surgical scrubbing technique in influencing infection rates. Rather it reinforces the multifactorial nature of causation of surgical site infections. It also means that antibiotic prophylaxis, which specifically counters the presumed contamination perioperatively, is useful but not the panacea for preventing infections. Ongoing contamination (from the local surgical site, as well as other sources) throughout the surgery and in the postoperative period is equally important and cannot always be prevented by the antibiotic. Continuous and meticulous aseptic techniques are important. Extending antibiotic prophylaxis irrationally may in fact select more resistant organisms and compound the problem of postoperative infections.[10]

The issue of local contamination becomes more important when surgery without hair removal is considered. Early medical practice emphasized the role of hair in wound infections paving the way for established removal of hair, especially in neurosurgery.[11] This was thought to provide a "clean" field, facilitating postoperative nursing and wound inspection. Head shave prior to any cranial surgery is a routine practice in most centers. Most patients accept it as a necessary part of the surgical procedure. However, recent evidence points to the contrary, with hair removal being associated with a higher rate of surgical site infection. A Cochrane review addressing this issue revealed no difference in SSI rates whether the operative site was shaved or not.[12] In that case, shave less surgery should become the routine practice. Few studies addressing the same issue in neurosurgical patients too revealed similar results.[13-18]

Studies have shown that shaving introduces microabrasions in the skin which can ooze serum and facilitate colonization by bacteria. Hair removal is also known to have an adverse psychological impact on patients (though patients may not always admit it).[19] Despite this evidence, non-shaved surgery is still not widely used in Indian settings because of the perceived lack of hygiene in general. However, there is no objective evidence to support this. SSI rates in the Indian setting have been occasionally studied,[2,3] but assessment of the role of shaving is not available. Though no direct data is available in this regard, a study from Thailand, a tropical country sharing a similar geographic, climatic and socio-economic profile showed that SSI rates were lower with non-shaved neurosurgical procedures.[20] If preserving hair is not associated with any adverse wound healing events, it may be worthwhile in the interest of patient satisfaction. Our results support the feasibility of performing neurosurgery without shaving the head completely. The main criticism against such a practice, namely poor hair hygiene was not seen in our small study group. Hair are known carrier for *Staphylococcus aureus*.[5] However, only three of our patients grew this on the pre-prep swabs. What is concerning however, is that in two of them the organisms persisted even after the scrubbing. Though this did not result in any SSIs in our small study, this raises questions about the efficacy of the preparation techniques used in decontaminating the surgical field. Nonetheless numerous studies have shown that the various techniques of surgical site preparation do not differ in their efficacy in terms of ultimate wound infection. We believe that more than hair, it is the hygiene of the skin which is important and that remains same irrespective of whether the head is shaved or not.

Our study was small and lacked power to statistically detect a significant association between the presence of skin contamination and SSI. However, we had a homogenous group of patients and a uniform protocol for incision site preparation and antibiotic prophylaxis. Though statistically not significant, the results suggest that the pattern of scalp flora in Indian patients is not different from that described. Moreover, the hygiene is acceptable and surgery without shaving is practical and safe. What is important is to remember that surgical site decontamination and antibiotic prophylaxis are contributors and not sole determinants in preventing SSI. An integrated and holistic approach to preventing SSI is essential.

ACKNOWLEDGMENT

We are grateful to Ms. Sadhana Kannan (data manager) and Mr. Madhu Mohan M (Medical Records Officer) for assistance in data management and analysis.

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How to cite this article: Moiyadi AV, Sumukhi U, Shetty PM, Biswas S, Kelkar RS. Scalp flora in Indian patients undergoing craniotomy for brain tumors - Implications for pre-surgical site preparation and surgical site infection. Indian J Neurosurg 2012;1:28-32.
Source of Support: Nil, **Conflict of Interest:** None declared.