Bandages, dressings, and cranial neurosurgery

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Object. Bandages and dressings are commonly applied to incisional scalp wounds to prevent complications, particularly infection, during the early stages of wound healing. Bandaging cranial incisional wounds requires resources, consumes healthcare workers’ time, and incurs expense; it is therefore important to examine its efficacy.

Methods. All cranial operations (excluding shunt placements, procedures on the scalp alone, and bur hole procedures) performed between June 30, 2001 and January 1, 2006, by two neurosurgeons at either of two hospitals, one adult and one pediatric institution, were reviewed. Surgical site infections (SSIs) and other postoperative complications were investigated with respect to the use of bandaging for incisional wounds and other aspects of postoperative wound management. The operations were classified into four categories based on wound type: “clean,” “clean–contaminated,” “contaminated,” and “dirty,” according to the criteria of the Centers for Disease Control and Prevention.

Conclusions. A total of 702 operations were performed in 577 patients; only five patients received any type of surgical bandaging. There were four SSIs (0.57%; 95% confidence interval [CI] 0.16–1.45). The postoperative infection rate in the 626 clean cases was 0.48% (95% CI 0.10–1.39) and was 2.63% (95% CI 0.07–13.81) in the 38 clean–contaminated cases.

The data obtained in this investigation is consistent with the position that bandaging incisional scalp wounds after cranial surgery adds little if any benefit beyond the easier, simpler, and cheaper practice of using antibiotic ointment as a dressing without bandaging.

KEY WORDS • cranial bandage • cranial dressing • surgical site infection • wound care • pediatric neurosurgery

The art of dressing wounds long constituted the whole of the healing art; the use of internal remedies, herbs, etc., and that of the knife or of fire came much later. A dressing can be any of a range of substances, including ointment, gauze, or other materials, often containing medication, which is applied directly against a wound. A bandage is a strip of material, often fabric, used to bind or wrap a diseased or injured part of the body. It can also be secured in place with tape or another adhesive. A bandage can do the following: 1) hold a dressing in place; 2) protect a wound from contamination by bacteria and other foreign materials; 3) protect a wound from digital manipulation and other disruption by the patient or other individual; 4) absorb exudate from a wound; 5) compress to obliterate dead space and minimize accumulation of fluid beneath skin; 6) stabilize or physically immobilize a wound; 7) minimize bleeding; and 8) serve an aesthetic purpose. Bandages also conceal wounds, which may or may not be desirable depending on the circumstances.

The choice of dressing and bandaging method for wound care has always been based on a contemporary understanding of wound healing. The Ebers and the Edwin Smith papyri (circa 1550 BCE) list several concoctions for dressing wounds, requiring such ingredients as lint, grease, honey, fly blood, and even feces. Dressings and bandages for wounds are discussed in Homer’s Iliad and Odyssey (circa 900–800 BCE), in the Sanskrit writings and in the writings of Sushruta, the father of Hindu surgery (circa 600 BCE), in the writings of Hippocrates (circa 460 BCE), and also in the Bible (Jeremiah 8:22). Pasteur’s Germ Theory and Semmelweis’ demonstration of the effectiveness of carbolic acid as an antiseptic led Joseph Lister (1827–1912) to pioneer the use of bandages soaked in carbolic acid. For neurosurgeons of the twentieth and early twenty-first centuries, the standard management of an incisional scalp wound has been the immediate application of a sterile turban bandage that was kept in place for a variable number of days.

Bandaging incisional wounds requires resources, consumes time, and incurs expense; therefore its efficacy should be clearly demonstrable. This investigation examines the consequences of managing incisional cranial wounds without bandaging.

Abbreviations used in this paper: CDC = Centers for Disease Control and Prevention; CI = confidence interval; CSF = cerebrospinal fluid; SSI = surgical site infection.
Dressings for cranial incisional wounds

Clinical Material and Methods

Patient Population

All patients who underwent cranial operations at The Children’s Hospital of Denver or at the University of Colorado Hospital performed by either of two neurosurgeons (K.R.W. or L.A.M.) between June 30, 2001 and January 1, 2006, and who were followed up for a minimum of 5 months afterward were included in this study. Patients who underwent the following procedures were excluded: bur hole placement only, endoscopy, ventriculostomy not associated with another cranial surgery, operations for CSF diversion only (shunt placement), and surgery done in the presence of an active infection involving the scalp. Surgical wounds were classified according to the schema published by the CDC. Wounds in patients who had previously undergone ventriculostomy were classified as “clean.” In the presence of transcutaneous devices that had been implanted during a prior operation (such as subdural recording grids or cranial distracters) the wounds were classified as “clean–contaminated,” and compound cranial wounds were classified as “contaminated” unless there was evidence of infection, in which case the wound was classified as “dirty.” A wound was considered dirty if the patient was being treated for infection at the time of surgery, regardless of whether there was a positive culture. The definitions used for SSIs and central nervous system infections were those established by the CDC. A stitch abscess was not classified as an SSI unless it was treated for infection.

Surgical Technique

All operations were done without clipping or shaving hair. Patients who were undergoing craniofacial surgery that required facial exposure and patients with open wounds from trauma were scrubbed with iodophor; all other patients’ skin was scrubbed with undiluted 4% chlorhexidine. It was the practice of both neurosurgeons to administer intravenous antibiotics in the absence of contraindication, usually cefazolin 25 mg/kg was used intraoperatively and postoperatively at 6-hour intervals for 24 hours.

In closing the scalp, the galea aponeurotica was approximated with polyglycolate sutures (2-0 and 3-0 in adults, 3-0 in children, and 4-0 in newborns). Polyglactin 910 sutures (4-0 Vicryl Rapide, Ethicon) were used to join the skin edges together in approximately 95% of the children included in this study. Monofilament nylon sutures (3-0 or 4-0) were used to close the scalp edges in patients who had received, or were soon to receive, radiation therapy or chemotherapy. Staples were used in a few children whose wounds appeared to be under more tension than usual, regardless of reason, and also to increase the speed of closure in a few children in critical condition who had undergone surgery for traumatic injuries. Staples were used to approximate the edges of the scalp in approximately half of the adults; in the remainder of the patients the scalp was closed with a variety of absorbable sutures.

One of the neurosurgeons (K.R.W.) placed subgaleal drains attached to bulb suction in all patients who underwent supratentorial operations and removed the drains after 12 to 36 hours; the other surgeon only rarely used postoperative drains.

Wound Management

Wound management immediately after closure of the scalp incision consisted of washing the hair and scalp with sterile water and shampoo, combing as needed to remove tangles and any residual particulate material, followed by drying with a sterile towel. In children with long hair, a generous application of hair detangler (No More Tangles, Johnson & Johnson) was applied before combing and drying. Lastly a dressing of topical antibiotic ointment was applied along the surgical incision in all patients. Decisions regarding the use of a cranial bandage were made at the discretion of the attending neurosurgeon.

Shampooing of the hair of all patients without drains was encouraged on the day following surgery in one surgeon’s patients and on Day 2 postoperatively in patients treated by the other surgeon; hair was usually shampooed in patients with subgaleal drains on the day after drain removal. The patients’ neurological and general physical condition occasionally delayed washing of the hair and scalp for several days.

The postoperative treatment of all patients included the daily assessment of surgical wounds until discharge from the hospital. Thereafter all patients were seen and their wounds examined at least once in a follow-up examination conducted by a staff neurosurgeon, a neurosurgical resident, or a neurosurgical nurse practitioner, and most patients were seen on multiple occasions. Confidence limits were computed with the assumption of a binomial distribution of infections.

Results

Seven hundred and two operations met the inclusion criteria for this study. These operations were performed in 577 patients; there were 425 operations in male patients, and 277 in female patients. Five hundred and fifty-nine operations were performed at a pediatric hospital; however, 23 patients in this group were 18 years of age or older (Table 1). One hundred and forty-three operations were performed in a hospital for adults and of these four were performed in patients younger than 18 years of age. One neurosurgeon performed 529 operations and the other performed 173. Physicians in training, most often neurosurgical residents, participated actively in 530 of the operations. Because so many of the patients required long-term medical attention, many had ongoing follow up that far exceeded the 5 months required for inclusion in this study.

A very large number of the operations were performed in children (Table 2). Five hundred thirty-five operations (76%) were performed in patients younger than 18 years of age. The diagnostic categories for the children are distributed as expected in a pediatric neurosurgical practice at a hospital with a Level 1 trauma center (Table 3). Surgery for

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Distribution of 702 operations by neurosurgeon and hospital type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurosurgeon</td>
<td>No. of Ops at Pediatric Hospital*</td>
</tr>
<tr>
<td>Total</td>
<td>Bandaged</td>
</tr>
<tr>
<td>A</td>
<td>390</td>
</tr>
<tr>
<td>B</td>
<td>169</td>
</tr>
</tbody>
</table>

* Includes 23 patients ≥ 18 years of age.  
† Includes four patients < 18 years of age.
epilepsy, which included craniotomy for grid implantation, lobectomy, corticectomy, and callosotomy accounted for 145 (88%) of the 165 patients who were 18 years of age or older.

Craniofacial operations that involved entry into the nasal or oral cavity and operations in patients with transcortaneous devices, such as subdural recording electrode cables implanted at a prior operation, accounted for most of the 38 cases in the clean–contaminated group (Table 4). All 30 of the contaminated wounds were in patients who had sustained traumatic injuries. The eight cases categorized as dirty included one brain abscess, one epidural empyema, three subdural empyemas, one case of encephalitis, one case of meningitis, and one case of cysticercosis.

Five patients received a cranial turban bandage following craniotomy. All bandaged patients were adults (28–43 years of age) and all had undergone surgery for epilepsy, one for temporal lobectomy, and the other four for insertion of subdural recording grids. These five patients underwent surgery in the first 10 months of this study and, in retrospect, they were bandaged only as a perpetuation of tradition and not on the basis of any other consideration. No patient in this investigation received a cranial bandage during the last 4 years and 8 months of the study.

After 702 operations there were four SSIs (0.57%; 95% CI 0.16–1.45). The infection rate for the 626 clean cases was 0.48% (95% CI 0.10–1.39) and for the 38 clean–contaminated cases was 2.63% (95% CI 0.07–13.81) (Table 4). The four SSIs occurred in the following patients: 1) an 11-month-old child with osteopetrosis, craniosenosis, and a bone marrow transplant who underwent surgery to enlarge the cranial vault while on immunosuppressive medications; 2) a 13-year-old child who underwent cranioplasty with methyl methacrylate; 3) a 28-year-old patient who underwent temporal lobectomy for epilepsy after having had subdural recording electrodes implanted for 4 days; and 4) an 18-year-old woman with seizures and hemimegalencephaly who underwent a hemispherectomy. This last patient opened several centimeters of her surgical wound with her fingernails a few days after surgery and an SSI and meningitis developed. The only central nervous system infection in our patients occurred in this woman (0.14%; 95% CI 0.00–0.79). The infection rates in these patients were insignificantly different by hospital, surgeon, and diagnosis (Table 1). The infection rate in cases at the pediatric hospital was 0.54% (95% CI 0.11–1.56) and 0.70% (95% CI 0.02–3.83) at the adult hospital. The infection rate after operations by surgeon A was 0.76% (95% CI 0.21–1.92) and after operations by surgeon B was 0.00% (95% CI 0.00–1.72). No patient other than the four with SSIs required reoperation for any wound-related issue, and no patient required evacuation of a subgaleal hematoma.

### Discussion

No postoperative bandaging was used after 697 of the 702 consecutive cranial operations. The SSI rate was 0.48% for the 626 cases in the clean wound group and only 0.57% overall for the clean–contaminated, contaminated, and dirty groups combined (Table 4). These rates compare favorably with 0.91% SSI for risk Category 0 and the 2.4% for risk Categories 2 and 3 in the 24,330 craniotomies reported in the National Nosocomial Infection Surveillance data gathered between January 1992 and June 2004.²³ Our use of prophylactic intravenous antibiotics undoubtedly contributed to the low infection rate but this factor does not set this series apart from other series or metaanalyses.¹,²,³,⁵,⁶,⁷,¹⁰,¹⁴,¹⁸,²⁰,³¹ In 1992, the senior author (K.R.W.) reported a 0.3% rate of SSI in 312 patients who underwent craniotomy without shaving. All patients in that study received bandages.³²

Our study does not include a prospective randomized control group, and therefore must be interpreted in comparison with published data. The CIs are an indication of the extent to which the observed infection rate is reliable. If bandaging is associated with an SSI rate of approximately

### TABLE 2

<table>
<thead>
<tr>
<th>Patient Age</th>
<th>No. of Ops</th>
<th>Bandaged</th>
<th>w/ SSIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>premature to 3 mos</td>
<td>29</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3–6 mos</td>
<td>97</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6–12 mos</td>
<td>71</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1–5 yrs</td>
<td>117</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5–10 yrs</td>
<td>108</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>10–20 yrs</td>
<td>130</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>20–40 yrs</td>
<td>102</td>
<td>3</td>
<td>1*</td>
</tr>
<tr>
<td>40–60 yrs</td>
<td>45</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>60–80 yrs</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Patient with infection was not bandaged.

### TABLE 3

<table>
<thead>
<tr>
<th>Diagnostic/Op Category</th>
<th>No. of Ops</th>
<th>Bandaged</th>
<th>w/ SSIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>birth defect (excluding craniofacial abnormality)</td>
<td>12</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>craniofacial abnormality (primarily craniosynostosis)</td>
<td>207</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chiari malformation Type I or II</td>
<td>26</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>cranial defect (cranioplasty)</td>
<td>34</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>infection (not involving scalp)</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>epilepsy</td>
<td>168</td>
<td>5</td>
<td>1*</td>
</tr>
<tr>
<td>traumatic injury</td>
<td>78</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>tumor</td>
<td>71</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>posterior fossa</td>
<td>75</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>supratentorial</td>
<td>23</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Note that patient with infection in this category did not receive a bandage.

### TABLE 4

<table>
<thead>
<tr>
<th>Wound Class</th>
<th>No. of Ops</th>
<th>Bandaged</th>
<th>w/ SSIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>clean</td>
<td>626</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>clean-contaminated</td>
<td>38</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>contaminated</td>
<td>30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>dirty</td>
<td>8</td>
<td>0</td>
<td>0*</td>
</tr>
</tbody>
</table>

* There were no new infections in this group after surgery.
Dressings for cranial incisional wounds

1.8%, a prospective randomized study would require approximately 2700 operations for a two-tailed test to have a 90% chance of identifying a difference at the 5% confidence level.28 If we assume smaller differences, vastly larger numbers of patients would be required. Given the magnitude (and other practical considerations) of a study that could meaningfully compare differences in samples with relatively low infection rates, such a study is unlikely to be done in the near future. Until and unless such a study is completed, we have no compelling basis for concluding that bandaging or nonbandaging is superior with respect to infection rate, and therefore we must examine the less direct, but not necessarily less reliable, evidence.

Consideration of the efficacy of bandaging for cranial wounds should not be limited to a comparison of SSI rates (see introductory remarks). None of the patients included in this study required follow-up procedures for wound dehiscence or cosmetic issues, and none had subgaleal fluid collections that required any type of drainage procedure. The subgaleal suction drains placed in most of the patients who underwent supratentorial operations would be expected to reduce the subgaleal accumulation of blood and CSF, and also to reduce incisional ooze and overt leaks. Given that all surgical wounds involve some degree of bacterial contamination, it seems reasonable that the incidence of SSIs in patients with drains would be reduced compared to those without drains because these subgaleal pockets of protein-rich culture media would be eliminated. The use of subgaleal drains also reduces the risk of further bacterial contamination should leaking occur.

It is unlikely that any of the four SSIs that developed after our 702 operations would have been prevented by postoperative bandaging. The only wound opened by trauma was in a mentally impaired 18-year-old who scratched her wound open several days after surgery. A cranial bandage, however applied, would not have prevented this complication, although perhaps arm restraints would have.

Our patient population is diverse with respect to age, diagnosis, and surgical procedure, and includes patients who underwent operations performed by two different surgeons in both adult and pediatric hospital settings (Table 1). The age distribution is weighted toward patients younger than 20 years of age, but 150 of the operations were in patients 20 years of age or older (Table 2). Most surgical procedures in adults were elective operations for epilepsy.11,30 One SSI developed in the 68 clean–contaminated and contaminated cases combined, which together account for 9.7% of the cases in this sample (Table 3). Although there were no infections in the 29 cranial operations performed in children younger than 3 months of age, this group is normally reported to have a relatively high risk of infection following various types of surgery.37 There were no infections after 207 craniofacial operations, but the majority of these procedures were for single sutural synostoses; nevertheless Fearon and colleagues38 reported a 2.5% infection rate after craniofacial operations at two surgical centers. Therefore the low wound complication rate in the present study cannot reasonably be ascribed to a fortuitous assembly of low-risk patients.

In the normal process of wound healing, the narrow incisional space that exists after closure immediately fills with clotted blood containing fibrin and blood cells. The same is true for the needle holes or holes made by staples used to secure the coapted edges of a surgical wound. If exposed to air, dehydration of the exposed surface clot results in the formation of a scab, and thereafter the normal healing process follows a series of sequential steps.32 There is evidence from studies in pigs that an effective barrier against bacterial contamination from external sources is present by 6 hours after an incision is closed; another article supports the position that a wound is effectively sealed against invasion by pathogenic bacteria by 1 hour after wound closure.16,22 A moist environment is conducive to wound healing in abrasions of skin and therefore may be favorable to the healing of incisional wounds.33

It is reasonable to believe that reducing the number of bacteria present on the skin in preparation for surgery is beneficial. The use of chlorhexidine on the skin around the incision site in preparation for surgery has been shown to reduce the number of colony forming units on the surface of the skin for at least 72 hours afterwards.7,12,15,21,22 Likewise it is reasonable to believe that it is beneficial to protect incisional wounds from bacterial contamination during the brief period of wound vulnerability after closure. Only the incision line itself and a few millimeters of skin beyond the needle or staple punctures on each side of the incision are critical. The authors chose to protect the incisional wounds in these patients with a dressing of antibiotic ointment. Antibiotic ointment applied directly to a wound seals it from airborne bacteria and may also give additional protection from the resident flora of adjacent skin. Ointment adheres to the scalp and is not easily removed by casual mechanical contact and it prevents evaporative drying of the wound. It is not clear which antibiotic ointment is best. Bacitracin is probably most effective against gram-positive organisms, neomycin is effective against most gram-positive and gram-negative bacteria (with the exception of Pseudomonas), and polymyxin B is effective against gram-negative bacteria including Pseudomonas.12,29

Disadvantages of Bandaging

There are many disadvantages to the use of bandaging after craniotomy. A bandage can conceal a CSF leak and delay the recognition of wound infection. Scalp wounds without a bandage can be much more easily and conveniently examined by the physician with little or no patient discomfort. Discomfort, including itching, can be accentuated by bandages, and this often encourages patients to manipulate the bandage, and hence the wound. Cranial bandages, however expertly applied, can be displaced or shifted back and forth across a wound, particularly in an agitated or uncooperative patient. A loose bandage can predispose to the wiping away of dressing material or to contamination of the wound. Postoperative swelling can convert a snugly applied bandage into an overly tight one, and an excessively tight circumferential bandage can compromise blood supply to the scalp with resulting pain and rarely even alopecia or infarction.5,18

The practice of early and frequent shampooing after surgery is not likely to have had a direct effect on infection rates in these patients because the wounds were sealed to bacterial invasion within a few hours after their closure. However, shampooing may have reduced itching caused by residual soap or blood products and this probably reduced the patients’ inclination to scratch, which would violate and contaminate a surgical wound.

The critical observation is that in 702 consecutive opera-
tions, almost all patients with incisional scalp wounds were treated without bandaging and had an SSI rate that was clearly no worse—actually numerically better—than the SSI rates from other series of patients who received postoperative bandaging. It is not clear whether the findings of this investigation are the result of the overall schema of operative bandaging. It is not clear whether the findings of treated without bandaging and had an SSI rate that was consistent with the position that bandaging cranial incisions, almost all patients with incisional scalp wounds were dressing without bandaging.

Surgical Technique

Conclusions

Cranial bandaging contributes to expense. The price of the required materials and instruments themselves, the sterilization of instruments, ordering, purchasing and shelving of bandaging materials, as well as handling and disposal of contaminated bandages all have associated costs. The time it takes for healthcare workers to apply and attend to cranial bandages also adds to the expense of medical care. The same is true for the brief prolongation of anesthesia required for the application, however rapidly, of a turban bandage. No systematically collected data is available regarding these expenses. Although the cost of an individual bandage may be small, the expense of incisional bandaging in a population of patients served by a hospital or a large healthcare system, particularly in countries with limited resources, can be considerable.

There are advantages and disadvantages to bandaging cranial wounds, and it is unreasonable to argue for universal use or discontinuance. If a sensible case can be articulated for bandaging a patient’s wound, then it should be done, but if tradition is the raison d’etre, then the expense of bandaging and the minor associated risks make not bandaging the reasonable decision. The data reviewed here is consistent with the position that bandaging cranial incisional wounds offers no benefit beyond the simpler, easier, and cheaper practice of using an antibiotic ointment as a dressing without bandaging.

References


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