ORIGINAL ARTICLE
KLİNİK ARAŞTIRMA

Impact of nasal MRSA colonization on surgical site infections after neurosurgical procedures

Nöroşirürjik girişimler sonrası cerrahi alan enfeksiyonları üzerinde nazal MRSA kolonizasyonunun etkisi

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Submitted Date: 03 June 2025, **Accepted Date:** 6 August 2025

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SUMMARY

Aim: This study aimed to evaluate the prevalence of nasal Methicillin-resistant Staphylococcus aureus (MRSA) carriage among patients undergoing spinal surgery and to investigate its association with postoperative surgical site infections (SSIs).

Material and Methods: A total of 120 patients scheduled for elective spinal surgery were screened for nasal MRSA colonization via preoperative nasal swabs. Patients were monitored for the development of postoperative SSIs. The cohort was divided into MRSA-positive and MRSA-negative groups, and infection rates were compared using Fisher's exact test. Antibiotic prophylaxis protocols were applied uniformly across all patients.

Results: Nasal MRSA colonization was detected in 15 patients (12.5%). Postoperative SSIs developed in 3 of 15 MRSA-positive patients (20%) and in 2 of 105 MRSA-negative patients (1.9%). This difference was statistically significant (p = 0.0138), with MRSA-colonized patients having 12.88 times higher odds of developing a postoperative infection.

Conclusion: The MRSA colonization rate in our spinal surgery cohort was higher than reported in some general surgical populations. The significantly elevated SSI rate among MRSA carriers highlights the clinical importance of preoperative screening and potential decolonization strategies in high-risk spinal procedures. These findings support the inclusion of MRSA status in perioperative risk stratification. Preoperative nasal MRSA colonization is significantly associated with increased postoperative SSI risk in spinal surgery. Routine MRSA screening and decolonization may be beneficial in reducing infectious complications in this patient population.

Keywords: MRSA, nasal colonization, surgical site infection, prophylaxis

ÖZET

Amaç: Bu çalışmanın amacı, spinal cerrahi geçirecek hastalarda nazal Metisiline Dirençli Staphylococcus aureus (MRSA) taşıyıcılığının prevalansını değerlendirmek ve bu taşıyıcılığın postoperatif cerrahi alan enfeksiyonları (CAE) ile ilişkisini araştırmaktır.

Materyal ve Metodlar: Elektif spinal cerrahi planlanan toplam 120 hasta, ameliyat öncesi nazal sürüntü örnekleriyle MRSA kolonizasyonu açısından tarandı. Hastalar, postoperatif dönemde CAE gelişimi açısından izlendi. Olgular, MRSA pozitif ve MRSA negatif olmak üzere iki gruba ayrıldı ve enfeksiyon oranları Fisher exact testi ile karşılaştırıldı. Tüm hastalara standart antibiyotik profilaksi uygulandı.

Bulgular: 120 hastanın 15'inde (%12,5) nazal MRSA taşıyıcılığı saptandı. Postoperatif CAE, MRSA pozitif hastaların 2'sinde (%13,3) ve MRSA negatif hastaların 2'sinde (%1,9) gelişti. Fisher exact testi sonucunda nazal MRSA taşıyıcılığı ile postoperatif enfeksiyon riski arasında istatistiksel olarak anlamlı bir ilişki bulundu (p = 0,048). MRSA taşıyıcılarında enfeksiyon gelişme olasılığı, taşıyıcı olmayanlara göre 7,7 kat daha fazlaydı.

Sonuç: Bu çalışmada saptanan MRSA taşıyıcılık oranı, bazı genel cerrahi popülasyonlarına kıyasla daha yüksektir. MRSA taşıyıcılarında enfeksiyon oranının belirgin şekilde yüksek olması, yüksek riskli spinal cerrahilerde preoperatif tarama ve dekontaminasyon stratejilerinin önemini vurgulamaktadır. Bulgular, perioperatif risk sınıflandırmasına MRSA durumunun dahil edilmesini desteklemektedir. Spinal cerrahi hastalarında preoperatif nazal MRSA taşıyıcılığı, postoperatif CAE riskinde anlamlı artış ile ilişkilidir. Rutin MRSA taraması ve dekontaminasyon, enfeksiyon komplikasyonlarını azaltmada faydalı olabilir.

Anahtar kelimeler: MRSA, nazal kolonizasyon, cerrahi alan enfeksiyonu, profilaksi

Maltepe tıp derg. Cilt:17 Sayı:2/2025
https://doi.org/10.35514/mtd.2025.127

INTRODUCTION

Postoperative surgical site infections (SSI) including superficial wound infections, deep incisional infections are a major source of morbidity in neurosurgery and carry substantial implications for patient outcomes and healthcare systems. They can lead to prolonged hospitalization, unplanned reoperations, permanent neurological deficits, and increased mortality. These complications are particularly concerning in neurosurgical procedures due to the involvement of the central nervous system and the colonization of foreign materials such as shunts or implants (1).

Among the pathogens responsible for SSIs, Staphylococcus aureus (SA) remains the most frequently implicated organism. Of particular concern is the methicillin-resistant strain (MRSA), which is resistant to most beta-lactam antibiotics and is associated with more severe infections, higher treatment failure rates, and longer hospital stays. Colonization with MRSA, particularly in the nasal passages, is a well-documented risk factor for postoperative infections. Carriers may remain asymptomatic but are at increased risk of autoinoculation during or after surgery and may also act as reservoirs for transmission to other patients or healthcare workers (2).

Despite the evidence supporting preoperative MRSA screening in high-risk surgical fields such as cardiac, orthopedic, and general surgery, its routine application in neurosurgery remains a debate. This is notable given that SSIs in neurosurgery, especially in craniotomies, shunt placements, and spinal instrumentation, can have devastating neurological and functional consequences.

A nasal MRSA carrier is an individual who harbors methicillin-resistant SA in the anterior nares without showing signs or symptoms of active infection. These individuals are considered colonized, meaning the bacteria are present on mucosal surfaces but not causing tissue invasion or disease. Colonization is typically asymptomatic because the immune system tolerates the bacteria at low levels without mounting an inflammatory response (3).

It is critically important that MRSA-colonized patients are often asymptomatic because this makes detection impossible without active screening. But these patients remain a significant hidden source of infection, particularly in surgical settings. Because they show no clinical signs of infection, they are not treated preoperatively unless they are actively screened, meaning the opportunity to reduce their microbial load is missed. In neurosurgical patients, even a superficial SSI can escalate into serious complications such as meningitis, shunt infection, or deep-seated abscesses.Thus, the asymptomatic nature of colonization masks a high-risk state, and preoperative identification through nasal swabbing allows for preventive interventions such as decolonization or targeted prophylaxis, which can reduce infection risk and improve surgical outcomes.

The COVID-19 pandemic inadvertently introduced routine nasal swabbing into many institutions as part of preoperative screening protocols. As a result, hospitals acquired both the infrastructure and the clinical habit of collecting nasal samples from surgical patients. This has created an unprecedented opportunity to incorporate MRSA screening as a secondary objective within routine preoperative workflows. The incidental detection of MRSA colonization through these protocols could have a significant impact on infection control and patient safety if coupled with appropriate perioperative interventions.

The objective of this study was to evaluate the prevalence of MRSA colonization identified via preoperative nasal swabs and its association with postoperative infection rates in a cohort of neurosurgical patients. Understanding this relationship could inform the implementation of routine screening, decolonization protocols, and tailored antibiotic prophylaxis in neurosurgical practice, ultimately improving surgical outcomes.

MATERIAL AND METHODS

Study Design and Patient Population

This retrospective cohort study was conducted at a single neurosurgical center and included patients who underwent elective neurosurgical procedures between August 2024 and March 2025. The study was granted ethics committee approval at the local institution (approval number: 613513442/020-30). The study cohort was composed of adult patients (age ≥ 18 years) for whom preoperative nasal swab screening for MRSA was performed as part of routine infection control protocols. Patients lacking complete screening or postoperative follow-up data were excluded from the final analysis.

MRSA Screening Protocol

All patients included in the study underwent preoperative nasal swabbing for MRSA colonization within 24 prior to surgery. Swabs were collected from both anterior nares using sterile transport swabs and processed in the hospital's microbiology laboratory. Detection of MRSA was carried out using GeneXpert MRSA (Cepheid, Sunnyvale/CA, USA), and results were categorized as either "positive" or "negative" for MRSA colonization. Patients were granted for surgery by the anesthesiologists if they did not show any sign of active infection (fever, elevated WBC, CRP, eryyhrocyte sedimentation rate). No formal decolonization protocol was in place during the study period, and antibiotic prophylaxis was not routinely adjusted based on colonization status.

Surgical Procedures and Perioperative Care

Patients underwent a range of neurosurgical procedures, including cranial (e.g., craniotomies, tumor resections, cerebrospinal fluid shunting) and spinal (e.g., laminectomies, spinal instrumentation) operations. All surgeries were performed under sterile conditions in dedicated operating theaters by board-certified neurosurgeons. Standard preoperative prophylactic antibiotic protocols included administration of intravenous cefazolin (1–2 g) within 30 minutes of skin incision, unless contraindicated or modified due to known allergies.

Postoperative Monitoring and Infection Definition

Patients were monitored postoperatively for the development of infections during their hospital stay and through clinical follow-up visits up to 30 days after surgery. Postoperative infections were defined according to Centers for Disease Control and Prevention (CDC) criteria for surgical site infections, including superficial incisional, deep incisional, and organ/space infections. All diagnoses were confirmed through clinical assessment and microbiological evidence where applicable (e.g., wound cultures, CSF analysis, imaging findings).

Data Collection and Variables

The following data were collected retrospectively from electronic medical records:

- Patient demographics (age, sex)
- Type of neurosurgical procedure
- Preoperative MRSA screening results (positive/negative)
- Postoperative infection status (yes/no, infection type if applicable)

Patients were stratified into two groups based on MRSA colonization status. The primary outcome measure was the occurrence of any postoperative infection.

Statistical Analysis

Descriptive statistics were used to summarize patient characteristics and infection rates. Categorical variables were expressed as frequencies and percentages. The association between MRSA colonization and postoperative infection was assessed using Pearson's chi-square test. A p-value < 0.05 was considered statistically significant. All statistical analyses were performed using Python (v3.10) with the scipy and pandas libraries.

RESULTS

Among the total of 120 patients included in the study, 15 individuals (12.5%) were identified as nasal carriers of MRSA based on preoperative screening. The remaining 105 patients (87.5%) were MRSA-negative.

Postoperative SSIs were observed in 5 patients overall (4.2%). When stratified according to MRSA colonization status, 3 of the 15 MRSA-positive patients (20%) developed postoperative infections, whereas only 2 of the 105 MRSA-negative patients (1.9%) experienced SSIs.

To evaluate the statistical significance of this difference, a Fisher's Exact Test was performed due to the relatively small sample size in the MRSA-positive subgroup. The analysis demonstrated a significant association between nasal MRSA carriage and the occurrence of postoperative infection, with an odds ratio of 12.88 and a p-value of 0.0138. This indicates that patients colonized with MRSA preoperatively had approximately 13 times higher odds of developing a postoperative infection compared to non-carriers (Figure 1).

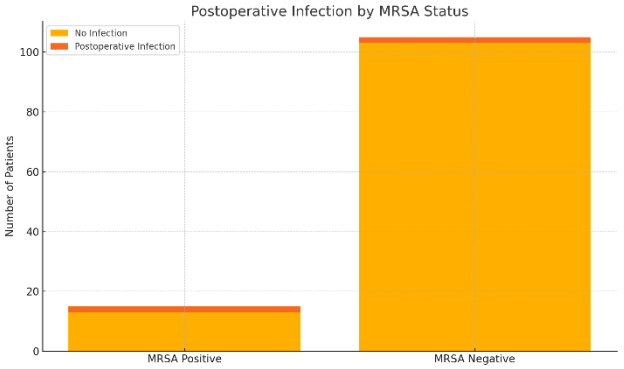

Figure 1. Diagram of postoperaive SSIR

These findings align with the existing body of literature that identifies MRSA colonization as a prominent risk factor for postoperative surgical site infections. The results underscore the importance of preoperative screening and targeted decolonization strategies in high-risk surgical populations.

DISCUSSION

Our findings indicate that MRSA-colonized individuals exhibited a postoperative infection rate markedly higher than the observed in non-colonized patients. This disparity underscores the critical role of MRSA colonization as a risk factor for postoperative infections in neurosurgical settings. SSIs in neurosurgery are generally infrequent but clinically significant, with reported rates ranging between 1% and 5% depending on the type of procedure, patient risk factors, and institutional practices (4).

In our study, the overall postoperative infection rate was 4.2%, which correlates to the expected range. The severity of SSI observed was not critical. We experienced no serious infections like menengitis or abcess. Just one patient had to be reoperated because wound closure difficulties. When stratified by MRSA colonization, the infection rate among MRSA-positive patients reached 20%, far exceeding typical background rates and highlighting the impact of colonization as a key modifiable risk factor.

Maltepe tip derg. Cilt:17 Sayı:2/2025
https://doi.org/10.35514/mtd.2025.127

The general prevalence of MRSA carriers is not well reported because there is no general screening for it. The reported incidence nasal MRSA colonization in the general hospital setting typically ranges from 1% to 6%, depending on geographic location and patient comorbidities (5).

In our cohort, the MRSA colonization rate was 12.5%, which is notably higher and may reflect underlying factors that warrant further investigation.

Our results align with prior research highlighting the impact of MRSA colonization on SSIs. Thakkar et al. reported a 12% SSI rate in MRSA-colonized spinal surgery patients compared to 5.73% in non-colonized individuals, emphasizing the heightened risk associated with MRSA colonization in neurosurgical procedures (6).

Similarly, Akins et al. found that MRSA-positive neurosurgical patients had a postoperative wound infection rate of 23.5%, significantly higher than the 4.1% observed in MRSA-negative patients. These studies corroborate our findings, reinforcing the association between MRSA colonization and increased postoperative infection rates in neurosurgical populations (7). While previous studies have established the correlation between MRSA colonization and SSIs, our research contributes to the existing literature by focusing specifically on neurosurgical patients. The high infection rate observed in MRSA-colonized individuals in our cohort underscores the necessity for targeted preoperative screening and intervention protocols in neurosurgical practices. Implementing such measures could significantly reduce postoperative infection rates and improve patient outcomes. An important clinical implication of our findings is the potential benefit of implementing a standardized MRSA decolonization strategy in neurosurgical patients. MRSA colonization, particularly in the anterior nares, is a well-established risk factor for SSIs across multiple surgical disciplines. The anterior nares serve as a primary reservoir for SA, and nasal colonization significantly increases the risk of autoinoculation during or after surgical procedures, particularly in operations involving implants or foreign bodies which is common in neurosurgery practice (2). The most widely validated decolonization protocol involves a combination of intranasal mupirocin ointment and chlorhexidine gluconate (CHG) skin washes, administered in the days leading up to surgery. Mupirocin 2% ointment is typically applied twice daily to both nostrils for five days, effectively reducing or eradicating SA nasal carriage. In parallel, daily body cleansing with CHG for 5 days reduces colonization at other body sites such as the axilla, groin, and operative field. This dual approach has been shown in multiple randomized controlled trials to significantly reduce the incidence of SSIs in surgical patients (8).

Furthermore, perioperative antibiotic prophylaxis should be tailored for MRSA-colonized patients. While cefazolin remains the standard agent for most neurosurgical procedures due to its coverage of methicillin-susceptible SA (MSSA), patients colonized with MRSA benefit from the addition of intravenous vancomycin to cover resistant strains. This dual-antibiotic approach—cefazolin plus vancomycin—has been endorsed by several infection control guidelines and has been associated with reduced MRSA-related infections in spinal and cranial surgeries (9).

Despite the proven efficacy of these interventions, MRSA decolonization protocols are not universally implemented in neurosurgery. The current study strengthens the rationale for routine preoperative MRSA screening, followed by evidence-based decolonization and antibiotic modification. Given the high cost and morbidity associated with postoperative infections in neurosurgery, these preventive measures represent a pragmatic and cost-effective strategy.

Future studies may focus on evaluating the cost-benefit ratio of universal versus targeted decolonization strategies in neurosurgical cohorts, as well as resistance patterns emerging from widespread mupirocin use. Nonetheless, existing data clearly support proactive MRSA management as a key element of SSI prevention in neurosurgical practice.

This study's retrospective design and single-center setting may limit the generalizability of the findings. Additionally, the sample size, particularly the number of MRSA-colonized patients, was relatively small. Future multicenter prospective studies with larger cohorts are warranted to validate these results and establish standardized protocols for MRSA screening and decolonization in neurosurgical patients.

CONCLUSION

This study demonstrates a statistically significant association between preoperative nasal MRSA colonization and increased rates of postoperative infections in neurosurgical patients. Individuals colonized with MRSA experienced a higher infection rate compared to non-colonized patients, highlighting the importance of colonization status as a modifiable risk factor in surgical planning.

Given the severity and consequences of postoperative infections in neurosurger, including prolonged hospitalization, neurological decline, and increased healthcare costs, routine preoperative MRSA screening represents a valuable addition to standard preoperative assessment protocols. When combined with targeted decolonization measures and appropriately adjusted antibiotic prophylaxis, such strategies have the potential to reduce infection rates and improve surgical outcomes.

Author Contributions: Working Concept/Design: AK, Data Collection: AK, Data Analysis / Interpretation: AK, Text Draft: AK, Critical Review of Content: HSB, Supervision: HSB
Conflict of Interest: The authors state that there is no conflict of interest regarding this manuscript.
Financial Disclosure: The authors declared that this study has received no financial support.

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Maltepe tıp derg. Cilt:17 Sayı:2/2025
https://doi.org/10.35514/mtd.2025.127