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Thesis Article

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Microbiology of Pin Site Infections in a Nigerian Tertiary Hospital: A Prospective Analysis

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Abstract

Background: Pin site infection remains the most common complication following external fixation, with reported incidence rates varying widely. Understanding the microbiological profile of these infections is crucial for developing effective prevention and treatment strategies in resource-limited settings. ***Objective:*** To determine the microbiological profile, bacterial load, and infection rates of pin sites in patients undergoing external fixation at a Nigerian tertiary hospital, comparing two dressing protocols. ***Methods:*** A randomized controlled trial was conducted over 10 months involving 50 patients undergoing external fixation at the University College Hospital, Ibadan. Patients were randomized into two groups: Medi-Honey™ dressing (n=25) and povidone-iodine gauze dressing (n=25). Pin site cultures were obtained on the 5th postoperative day for microscopy, culture, and bacterial count. Clinical monitoring for infection was performed weekly for 4 weeks using the Dahl Wire Pin Site Classification system. ***Results:*** A total of 328 pin sites were evaluated, with an overall infection rate of 7.01% (23/328). The infection rate was significantly lower in the Medi-Honey™ group (3.70%) compared to the povidone-iodine group (11.51%) (p=0.001, RR=0.32, 95%CI: 0.14-0.76). Staphylococcus aureus was the predominant organism cultured (71.4%), followed by Staphylococcus epidermidis (28.6%). All cultured organisms were gram-positive cocci. Bacterial counts ranged from 58 to 126 CFU/ml. No significant association was found between bacteriological parameters and clinical outcomes (p=0.42). ***Conclusion:*** The study demonstrates a relatively low pin site infection rate with gram-positive cocci as the predominant pathogens. Medi-Honey™ dressing showed superior antimicrobial efficacy compared to povidone-iodine. These findings support the need for targeted antimicrobial strategies against staphylococcal species in pin site care protocols.

Keywords: ***External fixation, pin site infection, Staphylococcus aureus, microbiology, Nigeria.***

Introduction

External fixation is a crucial modality in orthopaedic surgery, particularly valuable in managing open fractures, performing osteotomies, and facilitating limb reconstruction [1-6]. Despite its clinical utility, pin site infection remains the most prevalent complication, with reported incidence rates ranging from 11% to 96.6% globally [7-13].

Recent systematic reviews have highlighted the burden of pin site infections, with rates of 36% in pelvic fractures [14], 46.6% in Illizarov circular frame fixation [15], and up to 70% in knee joint distraction procedures [16]. In Africa, particularly high rates have been reported, with 87.7% in Kenya [17] and 23.7% in a previous Nigerian study [18].

The microbiological profile of pin site infections has been predominantly attributed to gram-positive cocci, particularly staphylococcal species. However, there is limited data on the specific microbiological patterns in sub-Saharan African settings, where environmental factors, patient populations, and healthcare resources differ significantly from developed countries.

This study aimed to prospectively analyze the microbiological profile of pin site infections in a Nigerian tertiary hospital, comparing the antimicrobial efficacy of two commonly used dressing protocols.

Materials and Methods

Study Design and Setting

This prospective randomized controlled trial was conducted at the Department of Orthopaedics and Trauma, University College Hospital, Ibadan, Nigeria, from September 2020 to July 2021. The study received ethical approval from the University of Ibadan/University College Hospital Ethics Committee (UI/EC/19/0602).

Participants

Fifty patients requiring external fixation for orthopaedic or traumatic indications were recruited. Inclusion criteria encompassed all consenting patients undergoing external fixation procedures. Exclusion criteria included: bleeding disorders, peripheral vascular disease, known allergies to povidone-iodine or honey, dementia or

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cognitive disorders, poorly controlled diabetes or hypertension, and active smoking.

Randomization and Intervention

Participants were allocated using block randomization into two groups:

- Group A: Medi-Honey™ dressing (n=25) figure 1
- Group B: Povidone-iodine soaked gauze dressing (n=25) figure 2

Figure 1: Medi-Honey™ dressing

Figure 2: Povidone-iodine soaked gauze dressing

Surgical Protocol

All procedures followed a standardized protocol including prophylactic antibiotics (intravenous ceftriaxone 1g and levofloxacin 500mg) administered 30 minutes before surgery. Meticulous surgical techniques included pre-drilling with sharp drill bits, manual insertion of half-pins using T-handles, and ensuring no skin tension during pin placement.

Microbiological Assessment

On the 5th postoperative day, swabs were obtained from the pin-skin interface for:

- Microscopy
- Culture and sensitivity
- Bacterial colony count (CFU/mL)

Clinical Monitoring

Pin sites were evaluated weekly for 4 weeks using the Dahl Wire Pin Site Classification System[21]:

- Grade 0: Normal
- Grade 1: Inflamed
- Grade 2: Serous drainage
- Grade 3: Purulent discharge (defined as clinical infection)
- Grade 4: Osteolysis
- Grade 5: Ring sequestrum

Statistical Analysis

Data analysis was performed using SPSS version 21. Continuous variables were presented as mean ± standard deviation, categorical variables as frequencies and percentages. Chi-square test was used for group comparisons, with risk ratios and 95% confidence intervals calculated for categorical outcomes. P-value <0.05 was considered statistically significant.

Results

Patient Demographics

The study included 50 patients (32 males, 18 females) with a mean age of 38.8±13.2 years. There were no significant differences in baseline characteristics between groups (Table 1).

Table 1: Baseline Characteristics of Study Participants

Characteristic	Medi-Honey™ (n=25)	Povidone-Iodine (n=25)	P-value
Age (years)*	41.64±14.15	35.96±12.02	0.13
Male, n (%)	14 (56.0)	18 (72.0)	0.24
BMI (kg/m²)*	25.78±5.53	24.38±2.74	0.30
Monoplanar fixator, n (%)	19 (76.0)	18 (72.0)	0.74
Ring fixator, n (%)	6 (24.0)	7 (28.0)	0.74

**Mean ± SD*

Microbiological Profile: Of 100 pin sites cultured on day 5, seven (7%) yielded positive cultures. All isolated organisms were gram-positive cocci:

- Staphylococcus aureus: 5 isolates (71.4%)
- Staphylococcus epidermidis: 2 isolates (28.6%)

The distribution between groups showed no significant difference (p=1.0), with S. aureus isolated from 3 sites in the Medi-Honey™ group and 2 in the povidone-iodine group.

Bacterial Load

Bacterial counts ranged from 58 to 126 CFU/mL, all below the threshold for significant infection (>10^5 CFU/mL). There was no significant association between bacterial count and dressing type (χ^2=6.00, p=0.31).

Clinical Infection Rates

Among 328 pin sites monitored over 4 weeks, 23 (7.01%) developed clinical infection. The infection rate was significantly lower in the Medi-Honey™ group compared to povidone-iodine (Table 2).

Table 2: Pin Site Infection Rates by Treatment Group

Group	Total Pin Sites	Infected Sites n (%)	Uninfected Sites n (%)	RR (95% CI)	P-value
Medi-Honey™	189	7 (3.70)	182 (96.30)	0.32 (0.14-0.76)	0.001
Povidone-Iodine	139	16 (11.51)	123 (88.49)	Reference	-
Total	328	23 (7.01)	305 (92.99)	-	-

Temporal Pattern of Infections

Pin site infections showed a progressive increase over the study period:

- Week 1: 3 infections (13.0%)
- Week 2: 8 infections (34.8%)
- Week 3: 7 infections (30.4%)
- Week 4: 5 infections (21.7%)

Correlation Between Microbiological and Clinical Findings

No significant association was observed between positive cultures on day 5 and subsequent clinical infection (χ^2=2.10, p=0.55). Of the 7 positive cultures (figure 3), only 3 sites developed clinical infection, while 20 clinically infected sites had negative initial cultures.

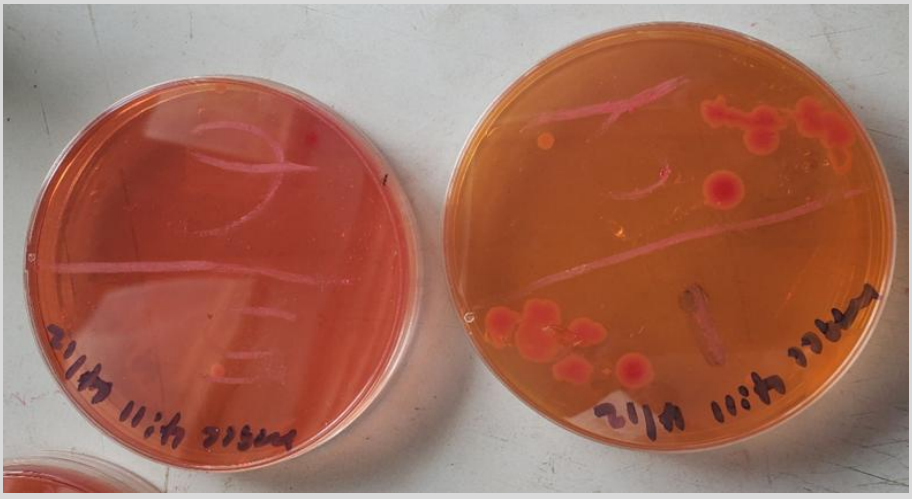

Figure 3: Pictures showing the microbiology plates (Post-culture)

Discussion

This prospective study provides important insights into the microbiological profile of pin site infections in a Nigerian tertiary hospital setting. The overall infection rate of 7.01% is considerably lower than rates reported from other African studies, including 87.7% in Kenya [17] and 23.7% in a previous Nigerian study [18]. This relatively low rate may be attributed to our standardized surgical protocol, meticulous pin site care, and close patient monitoring.

The predominance of gram-positive cocci, particularly Staphylococcus aureus (71.4%) and S. epidermidis (28.6%), aligns with international literature. These findings confirm that staphylococcal species remain the primary pathogens in pin site infections across different geographical settings. The exclusive isolation of gram-positive organisms contrasts with a Kenyan study that reported 45% gram-negative isolates [17], potentially reflecting differences in environmental factors or patient populations.

The superiority of Medi-Honey™ dressing (3.70% infection rate) over povidone-iodine (11.51%) is noteworthy. The 68% reduction in infection risk (RR=0.32) suggests that the antimicrobial properties of medical-grade honey provide effective prophylaxis against pin site colonization. The hygroscopic nature of honey may contribute by maintaining a dry pin-skin interface, while its documented immunomodulatory effects may enhance local host defenses.

Importantly, our study found no correlation between early bacterial colonization (day 5 cultures) and subsequent clinical infection. This disconnect suggests that early colonization may not be predictive of clinical infection, highlighting the complexity of pin site infection pathogenesis. The role of biofilm formation by staphylococcal species may explain why some colonized sites progress to infection while others remain clinically stable.

The temporal pattern of infections, with peak incidence in week 2-3, corresponds with the critical period when bacterial biofilms establish on foreign material. This finding supports the importance of sustained antimicrobial strategies beyond the immediate postoperative period.

Study Limitations

Several limitations warrant consideration. The relatively small sample size and single-center design limit generalizability. The 4-week follow-up period may have missed late-onset infections. Additionally, we did not perform molecular typing of bacterial isolates, which could have provided insights into whether infections resulted from endogenous or exogenous sources.

Clinical Implications

Our findings have several practical implications for pin site care in resource-limited settings:

1. Empirical antibiotic therapy should target gram-positive cocci, particularly S. aureus
2. Medi-Honey™ dressing appears superior to povidone-iodine for infection prevention
3. Weekly dressing changes appear adequate when using antimicrobial dressings
4. Early bacterial colonization may not warrant aggressive intervention in the absence of clinical signs

Conclusion

This study demonstrates a relatively low pin site infection rate of 7.01% in a Nigerian tertiary hospital, with Staphylococcus aureus as the predominant pathogen. The significant reduction in infection rates with Medi-Honey™ dressing supports its use in pin site care protocols. These findings provide valuable microbiological data for developing evidence-based guidelines for pin site management in African healthcare settings. Further multicenter studies with longer follow-up periods are recommended to validate these findings and establish standardized protocols for pin site care in resource-limited environments.

List of Abbreviations

BMI: Body Mass Index

CFU/mL: Colony Forming Units per Milliliter

CI: Confidence Interval

RR: Risk Ratio

SPSS: Statistical Package for the Social Sciences

SD: Standard Deviation

S. Aureus: Staphylococcus aureus

S. Epidermidis: Staphylococcus epidermidis

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Conflict of Interest

The authors declare no conflict of interest. There are no financial, personal, or professional relationships that could potentially bias or influence the work presented in this manuscript.

Authors' Contributions

Adeoye Allen-Taylor: Served as principal investigator, conceptualized and designed the study, coordinated the overall conduct of the research, performed surgical procedures and external fixation applications, led patient recruitment and clinical monitoring, supervised data collection and interpretation, drafted the manuscript, performed critical review and revision, and approved the final version.

Aliu Olalekan Olatunji: Designed and supervised the microbiological assessment protocol, performed microscopy, culture, and sensitivity testing of pin site specimens, analyzed and interpreted microbiological data, contributed to the microbiology sections of the manuscript, participated in critical review of the manuscript, and approved the final version.

Jemiludeen O. Morhason-Bello: Served as corresponding author, provided research assistance throughout the study period, performed statistical analysis and interpretation of results, contributed significantly to writing the manuscript, critically reviewed and revised the manuscript for important intellectual content, coordinated the submission process, and approved the final version.

Michael O. Okunola: Served as supervisor, provided expert guidance on study design and surgical protocols, supervised the overall research methodology and data collection, participated in critical review and revision of the manuscript for important intellectual content, contributed to interpretation of clinical findings, and approved the final version.

Mosimabale J. Balogun: Served as supervisor, contributed to study conceptualization and design, provided expert guidance on research methodology and clinical protocols, supervised data analysis and interpretation, participated in critical review and revision of the manuscript for important intellectual content, and approved the final version.

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