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Original Research Article

COMPARATIVE ANALYSIS OF CLINICAL OUTCOMES IN NECROTIZING FASCIITIS PATIENTS WITH TISSUE BIOPSY VS. PUS CULTURE-GUIDED TREATMENT

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ABSTRACT

Background: Necrotizing Fasciitis (NF) is a rapidly progressive infection characterized by severe tissue necrosis and systemic toxicity. Identifying the causative pathogens through accurate microbiological diagnosis is critical for initiating appropriate antibiotic therapy. This study compares the bacterial profiles obtained from tissue biopsy culture and pus culture in NF to determine the superior diagnostic method.

Material and Methods: A prospective study was conducted involving 80 patients diagnosed with NF. Simultaneous tissue biopsy and pus cultures were obtained from each patient for microbiological analysis. Pathogen identification and antibiotic sensitivity patterns were recorded and analyzed. The study employed a minimum sample size of 80, calculated based on previous studies. Statistical analysis was performed using SPSS version 26 to determine the agreement between the two methods.

Results: Tissue biopsy culture showed higher microbial growth (95%) compared to pus culture (90%). The most commonly identified pathogens were Klebsiella species and Methicillin-Sensitive Staphylococcus Aureus (MSSA). A 93.75% agreement was observed between the two methods, but tissue biopsy detected more anaerobic organisms. Antibiotic sensitivity revealed high efficacy of Ciprofloxacin, Piperacillin-Tazobactam, and Meropenem against the isolated pathogens.

Conclusion: Tissue biopsy culture is a more reliable diagnostic method for detecting the causative pathogens in NF, especially anaerobic organisms, and should be preferred over pus culture for guiding targeted antibiotic therapy.

Key Words: Necrotizing Fasciitis, Tissue Biopsy Culture, Pus Culture, Klebsiella species, Methicillin-Sensitive Staphylococcus Aureus, Antibiotic Sensitivity, Pathogen Identification, Statistical Package for the Social Sciences (SPSS).

INTRODUCTION

Necrotizing Fasciitis (NF) is a severe, life-threatening bacterial infection that spreads rapidly through the fascia and subcutaneous tissues, resulting in extensive necrosis. The disease has a high mortality rate, especially when diagnosis and treatment are delayed. NF can be caused by both mono-microbial and poly-microbial infections, with pathogens ranging from Streptococcus pyogenes to Klebsiella species and anaerobic organisms such as Clostridium species.[1] The condition often manifests with fever, intense pain, and tissue necrosis, requiring immediate surgical intervention and broad-spectrum antibiotics.[2]

Microbiological diagnosis plays a crucial role in managing NF by identifying the causative organisms and guiding targeted antibiotic therapy.[3] The most commonly employed methods for microbial identification include tissue biopsy culture and pus culture. Tissue biopsy, which involves collecting a deep sample from the infected tissue, is

often regarded as the gold standard because it allows for the detection of both aerobic and anaerobic organisms present in deeper tissues.[4] On the other hand, pus culture, which involves collecting superficial material from the wound, is easier to perform but may miss deeper pathogens and be contaminated with skin flora.[5]

Given the severity of NF and the need for rapid diagnosis and treatment, it is essential to determine the most effective method for pathogen identification. Previous studies have highlighted discrepancies in pathogen detection rates between tissue biopsy and pus cultures, with tissue biopsy often demonstrating superior sensitivity.[6,7] However, the role of pus culture should not be entirely dismissed, as it remains a useful tool in certain clinical settings.

This study aims to compare the bacterial profile obtained from tissue biopsy culture versus pus culture in patients with Necrotizing Fasciitis. It evaluates the agreement between the two methods and determines which approach provides more accurate and comprehensive microbial identification.

MATERIALS AND METHODS

Sample Size Estimation

The sample size for this study was calculated based on a previous study by Huang Y, which reported a 92% sensitivity in detecting pathogens in NF.[8] Using the formula for sample size calculation with a 95% confidence interval, the required sample size was calculated as 80 patients:

N=Z2×Sn×(100−Sn)D2N = \frac{Z^2 \times \text{Sn} \times (100-\text{Sn})}{D^2}N=D2Z2×Sn×(100−Sn)

Where:

- Z=1.96Z = 1.96Z=1.96 (standard value for 95% Confidence Interval)
- Sn=92%\text{Sn} = 92\%Sn=92% (sensitivity)
- D=6%D = 6\%D=6% (precision)

Substituting the Values

N=(1.96)2×92×862=78.54N = \frac{(1.96)^2 \times 92 \times 8}{6^2} = 78.54N=62(1.96)2×92×8=78.54

The final sample size was rounded up to 80 patients.

Study Design

This was a prospective observational study conducted over 12 months at a tertiary care center. A total of 80 patients diagnosed with Necrotizing Fasciitis were enrolled. Both tissue biopsy and pus samples were collected from each patient for microbiological analysis.

Inclusion Criteria

- Patients aged 18–80 years with a confirmed diagnosis of Necrotizing Fasciitis.
- No prior antibiotic use within one week before sample collection.

Exclusion Criteria

- Patients with other soft tissue infections, such as cellulitis.
- Immunocompromised patients (e.g., those with HIV or uncontrolled diabetes).

Sample Collection

- Tissue Biopsy Culture: Deep tissue samples were obtained from necrotic areas of the wound, reaching the fascia.
- Pus Culture: Pus was aspirated from the infected wound using sterile techniques.

Laboratory Analysis

Both tissue biopsy and pus samples were cultured under aerobic and anaerobic conditions to identify the causative pathogens. Antibiotic sensitivity testing was performed using standard protocols to guide clinical management.[9]

Outcome Measures

- Microbial Growth Rates: Percentage of positive cultures in tissue biopsy and pus samples.
- Agreement Rates: Concordance between tissue biopsy and pus cultures in identifying the same organisms.
- Antibiotic Sensitivity Patterns: Resistance and sensitivity profiles for identified pathogens.

Statistical Analysis

Statistical analysis was performed using SPSS version 26. Kappa statistics were used to assess agreement between the two culture methods. A p-value of <0.05 was considered statistically significant.

RESULTS

The majority of patients were male, and the mean age was 57.4 years. The most common site of infection was the lower limb. [Table 1]

Tissue biopsy culture demonstrated a higher rate of microbial growth compared to pus culture. [Table 2]

Both tissue biopsy and pus cultures identified Klebsiella species and MSSA as the most prevalent pathogens. [Table 3]

There was a 93.75% agreement between the two methods in identifying pathogens, with 6.25% disagreement. [Table 4]

The identified pathogens showed high sensitivity to Ciprofloxacin, Piperacillin-Tazobactam, and Meropenem. [Table 5]

Anaerobic organisms were detected more frequently in tissue biopsy cultures compared to pus cultures. [Table 6]

Patients diagnosed using tissue biopsy cultures had fewer recurrences compared to those diagnosed with pus cultures. [Table 7]

Tissue biopsy cultures identified pathogens faster than pus cultures, ensuring quicker treatment initiation in critical cases of Necrotizing Fasciitis. [Table 8]

Tissue biopsy culture was more effective in identifying polymicrobial infections compared to

pus culture. The agreement rate was higher in monomicrobial infections. [Table 9]

Patients diagnosed using tissue biopsy culture had better clinical outcomes, including faster recovery and fewer complications, compared to those diagnosed using pus culture. [Table 10]

Table 1: Demographics of Study Participants

Characteristic	N = 80
Mean Age (years)	57.4 ± 9.2
Male (%)	65
Female (%)	35
Most Common Infection Site	Lower Limb (48%)

Table 2: Microbial Growth in Tissue Biopsy vs. Pus Culture

Culture Type	Positive Growth (%)
Tissue Biopsy Culture	95
Pus Culture	90

Table 3: Common Pathogens Identified

Pathogen	Tissue Biopsy (%)	Pus Culture (%)
Klebsiella sp.	32	29
MSSA	24	22
Escherichia coli	15	17

Table 4: Agreement between Tissue Biopsy and Pus Culture

Agreement	Percentage (%)
Agreement	93.75
Disagreement	6.25

Table 5: Antibiotic Sensitivity

Antibiotic	Sensitivity (%)
Ciprofloxacin	88
Piperacillin-Tazobactam	91
Meropenem	86

Table 6: Anaerobic Pathogen Detection in Tissue Biopsy

Pathogen	Tissue Biopsy (%)	Pus Culture (%)
Clostridium sp.	10	3
Bacteroides sp.	5	2

Table 7: Recurrence of Infection Based on Culture Method

Diagnosis Method	Recurrence Rate (%)
Tissue Biopsy Culture	15
Pus Culture	25

Table 8: Time to Pathogen Identification

Culture Method	Time to Identification (hours)
Tissue Biopsy Culture	24-36
Pus Culture	36-48

Table 9: Agreement in Polymicrobial Infections

Infection Type	Agreement (%)
Monomicrobial Infections	95
Polymicrobial Infections	80

Table 10: Patient Outcomes Based on Culture Type

Culture Type	Clinical Improvement (%)
Tissue Biopsy Culture	90
Pus Culture	75

DISCUSSION

This study demonstrates the superiority of tissue biopsy culture over pus culture in the identification of pathogens in patients with Necrotizing Fasciitis (NF). The tissue biopsy culture consistently provided higher positive microbial growth rates (95%) compared to pus culture (90%), likely due to its ability to sample deeper tissue, where the true infection resides. Tissue biopsy cultures were particularly more effective in detecting anaerobic organisms, such as Clostridium and Bacteroides

species, which were frequently missed in pus culture.[10,11]

Polymicrobial infections, which are common in Necrotizing Fasciitis, pose a significant challenge in treatment.[12] This study showed that tissue biopsy culture had a higher agreement rate (80%) in detecting polymicrobial infections compared to pus culture. In cases of monomicrobial infections, both methods performed well, with an agreement rate of 95%, but pus cultures were less reliable for complex infections. Previous studies have indicated that polymicrobial NF is associated with a worse prognosis, making accurate microbial detection even more critical.[13,14]

The findings of this study also indicate that tissue biopsy cultures provided faster identification of pathogens (within 24–36 hours) compared to pus cultures (36–48 hours). Rapid identification is crucial for initiating targeted antibiotic therapy, which is known to improve clinical outcomes and reduce the risk of complications.[15] In patients diagnosed using tissue biopsy cultures, the recurrence rate of infection was significantly lower (15%) compared to those diagnosed using pus cultures (25%).[16] This underscores the importance of using tissue biopsy cultures for more accurate and comprehensive microbial identification.

Moreover, the high sensitivity of the identified pathogens to broad-spectrum antibiotics such as Ciprofloxacin, Piperacillin-Tazobactam, and Meropenem suggests that these antibiotics should remain the first-line choices in the empirical treatment of Necrotizing Fasciitis.[17,18] Once the causative organisms are identified, clinicians can adjust the therapy based on antibiotic sensitivity patterns to ensure more targeted and effective treatment.

Tissue biopsy culture also demonstrated a higher agreement with clinical improvement rates (90%) compared to pus culture (75%), reinforcing its diagnostic value in improving patient outcomes.[19] Given the rapid progression of NF, the ability to detect both aerobic and anaerobic pathogens quickly and accurately can significantly impact the overall prognosis and reduce mortality rates.

The study's findings are consistent with previous research that highlights the limitations of pus cultures, particularly in detecting anaerobes and in cases of deep-seated infections like Necrotizing Fasciitis.[20] While pus cultures remain useful, particularly in settings where biopsy may not be feasible, tissue biopsy culture is clearly the preferred method for diagnosing and managing NF.

CONCLUSION

Tissue biopsy culture is more accurate and effective in identifying the pathogens responsible for Necrotizing Fasciitis compared to pus culture. Its ability to detect both aerobic and anaerobic organisms, as well as polymicrobial infections, makes it the preferred diagnostic method. Early and accurate diagnosis through tissue biopsy culture can significantly improve patient outcomes by enabling targeted antibiotic therapy and reducing the recurrence of infections. Given the rapid progression of NF, tissue biopsy should be the first-line diagnostic tool in clinical practice to guide appropriate treatment and improve survival rates.

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