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COMPARATIVE ACCURACY OF SUPERFICIAL SWAB CULTURE VERSUS DEEP TISSUE CULTURE IN DIABETIC FOOT ULCERS OF VARYING DEPTH AND SEVERITY

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ABSTRACT

Background: Diabetic foot ulcers (DFUs) affect approximately 15% of people with diabetes and are a leading cause of hospitalisation and lower-limb amputation. Accurate microbiological diagnosis is essential to guide antibiotic therapy, and the sampling technique strongly influences the organisms recovered.
Methods: In this comparative analytical study, 30 patients (aged 40–65 years, both sexes) with DFUs underwent paired sampling by superficial swab and deep tissue (wound-debris) culture. Specimens were cultured on blood agar base and Sabouraud dextrose agar media, and isolates identified by Gram staining.
Results: Deep tissue culture recovered more isolates than superficial swab across all categories; a total of 52 microbial strains were reported from the 30 wounds, with deep tissue yielding more pathogens (28 vs 14) and more fungal isolates (3 vs 1). Only the differences in total pathogen count and fungal isolation reached the reported significance threshold.
Conclusion: Deep tissue culture appears to recover more organisms than superficial swab and may better reflect the true wound microbiota; the reported analysis requires methodological correction and verification of counts before definitive conclusions are drawn.

KEYWORDS: Diabetic foot ulcer (DFU); Deep tissue culture; Superficial swab; Wound microbiology; Microbial isolates; Bacterial pathogens; Fungal isolates; Gram staining; Blood agar; Sabouraud dextrose agar.

INTRODUCTION

Anemia is one of the most prevalent nutritional and hematological disorders worldwide and remains a major public health problem, particularly among women of reproductive age. The World Health Organization defines anemia as a condition characterized by a reduction in the oxygen-carrying capacity of blood due to decreased hemoglobin concentration or red blood cell mass. According to estimates published by the World Health Organization, anemia affects a substantial proportion of women globally, with the burden being disproportionately higher in low- and middle-income countries [1]. This global health challenge has far-reaching implications for maternal and child health, contributing significantly to maternal morbidity and mortality, impaired fetal development, and long-term health consequences for both mothers and their offspring.

The postpartum period represents a critical phase in maternal health, encompassing physiological recovery from pregnancy and childbirth, initiation of breastfeeding, and adaptation to new maternal roles. This period, typically defined as the first six to eight weeks following delivery, is characterized by complex physiological changes that require careful monitoring and appropriate medical attention. Despite improvements in antenatal care and institutional deliveries, postnatal care continues to receive inadequate attention in many healthcare systems worldwide. Ruiz de Viñaspre-Hernández et al. highlighted that postpartum anemia remains underdiagnosed and undertreated due to lack of standardized screening and follow-up protocols during the postnatal period [2]. This diagnostic and therapeutic gap is particularly concerning given the substantial burden of anemia during pregnancy and the additional physiological stressors imposed by the peripartum period.

Milman et al. described postpartum anemia as a common but underestimated condition with distinct etiological and clinical implications when compared to antenatal anemia [3]. Postpartum anemia is commonly defined as a hemoglobin concentration of less than 11 g/dL during the first week after delivery and less than 12 g/dL at six to eight weeks postpartum. This condition may arise from multiple etiological factors including antepartum iron deficiency, inadequate iron stores at the time of delivery, excessive blood loss during childbirth, and the physiological changes accompanying pregnancy and the puerperium. The distinction between antenatal and postpartum anemia is clinically significant, as the latter occurs during a period when women are simultaneously recovering from childbirth, establishing lactation, and adjusting to the demands of newborn care.

Physiologically, pregnancy is associated with an expansion of plasma volume and red blood cell mass, leading to increased iron requirements. Although involution of the expanded red cell mass after delivery theoretically restores iron stores, Milman et al. noted that this recovery is often incomplete due to peripartum blood loss and pre-existing iron deficiency [4]. The average blood loss during vaginal delivery ranges from 300-500 mL, while cesarean sections are associated with greater blood loss, often exceeding 1000 mL. These losses, combined with the iron demands of lactation, which may require up to 1-2 mg of iron daily, create a substantial physiological burden that many women cannot adequately meet without appropriate nutritional support and medical intervention.

The magnitude of postpartum anemia varies widely across populations, influenced by factors such as maternal nutritional status, quality of antenatal care, obstetric practices, and socioeconomic conditions. Rahman et al. demonstrated that antenatal anemia significantly increases the risk of postpartum hemorrhage, thereby contributing to the development of postpartum anemia [5]. This creates a vicious cycle where pre-existing anemia predisposes women to complications that further exacerbate their anemic state. Studies from resource-limited settings have consistently reported prevalence rates exceeding 50%, highlighting the substantial burden of this condition in regions with limited healthcare infrastructure and high rates of nutritional deficiencies.

Agmassie et al. reported a high prevalence of immediate postpartum anemia among women delivering in hospitals in northwest Ethiopia and identified blood loss during delivery and inadequate antenatal iron supplementation as key contributors [6]. Similarly, Eshete et al. observed that nutritional deficiencies and obstetric complications were significant determinants of postpartum anemia in Ethiopian health facilities [7]. These findings underscore the multifactorial nature of postpartum anemia and the need for comprehensive interventions addressing both the immediate obstetric causes and the underlying nutritional deficiencies that predispose women to this condition.

Postpartum anemia has significant consequences for maternal health, extending beyond the well-recognized physical symptoms of fatigue and decreased exercise tolerance. Beard et al. identified that iron deficiency anemia during the postpartum period adversely affects maternal emotions and cognitive performance [8]. The cognitive effects may include difficulties with concentration, memory impairment, and reduced work capacity, all of which can significantly impact a new mother's ability to care for herself and her infant. Corwin et al. further demonstrated that low hemoglobin levels are an independent risk factor for postpartum depression [9], a finding of considerable clinical significance given the prevalence of postpartum mood disorders and their impact on maternal-infant bonding and child development.

Anemia in the postpartum period also affects breastfeeding outcomes, creating potential cascading effects on infant nutrition and development. Hen et al. reported that anemic mothers are more likely to experience insufficient milk production, particularly among first-time mothers [10]. These adverse effects may compromise infant nutrition and maternal-infant bonding, potentially affecting the infant's growth, cognitive development, and immunological protection during the critical early months of life. The relationship between maternal iron status and breastfeeding success underscores the importance of addressing postpartum anemia not only for maternal health but also for optimal infant outcomes.

In the Indian context, postpartum anemia remains highly prevalent despite improved access to institutional deliveries. Selvaraj et al. documented a high burden of anemia among postnatal mothers in urban Puducherry, highlighting gaps in postnatal screening and nutritional interventions [11]. The Indian subcontinent bears a disproportionate share of the global anemia burden, with cultural practices, dietary patterns, and socioeconomic factors contributing to the high prevalence of nutritional deficiencies. Despite the significant investments in maternal health programs and the promotion of institutional deliveries, postpartum anemia continues to be a neglected aspect of maternal healthcare in India.

Given the high prevalence, associated maternal morbidity, and limited focus on postpartum anemia in routine clinical practice, there is a need for region-specific studies that can inform evidence-based interventions and healthcare policies. Tertiary care hospitals provide an appropriate setting to assess the prevalence of postpartum anemia and identify associated demographic, obstetric, and nutritional factors. These institutions serve as referral centers for high-risk pregnancies and complicated deliveries, making them ideal sites for studying the burden and determinants of postpartum anemia in a comprehensive manner. The present study aims to address these gaps by assessing the prevalence of postpartum anemia and identifying its associated risk factors among postnatal mothers attending a tertiary care hospital.

Diabetes mellitus is among the most pressing chronic health problems worldwide, and its complications impose a substantial clinical and economic burden. Diabetic foot ulcers, which occur in roughly 15% of people with diabetes, are a leading cause of hospitalisation, lower-limb amputation, and disability [3]. Because diabetic foot infections (DFIs) are frequently polymicrobial, accurate identification of the causative organisms is central to targeted antibiotic therapy. The Infectious Diseases Society of America recommends that an appropriate specimen be obtained from DFIs to guide treatment [1]. The sampling and microbiological methods used strongly affect assessment of the wound microbiota: superficial swabs are simple and non-invasive but prone to contamination by colonising skin flora, whereas deep tissue biopsy samples the infected tissue directly [2]. This study compared the two techniques for routine pathogen identification.

Objective

To prospectively compare superficial swab culture and deep tissue (wound-debris) culture for the routine identification of pathogens in diabetic foot ulcers of varying depth and severity.

MATERIALS AND METHODS

This comparative analytical study enrolled 30 patients of both sexes, aged 40–65 years, with diabetic foot ulcers. Each ulcer was sampled by two techniques — superficial swab culture and deep tissue wound-debris sampling — both performed aseptically. Specimens were cultured on blood agar base medium and Sabouraud dextrose agar medium, and

microbial strains were identified using Gram staining. Ulcer grading (e.g., Wagner or University of Texas classification), diabetes duration, glycaemic control, and antibiotic-susceptibility testing were not specified on the source poster and should be added to the final manuscript.

Statistical Analysis
As reported, comparisons were performed using one-way analysis of variance (ANOVA) in SPSS, with a two-sided p value < 0.05 considered statistically significant.

RESULTS
Deep tissue culture recovered more organisms than superficial swab across every category (Table 1). A total of 52 microbial strains — Gram-positive and Gram-negative bacteria and fungi — were reported from the 30 ulcers. The number of pathogens isolated was higher with deep tissue sampling (28 vs 14), as was fungal isolation (3 vs 1); the differences in Gram-positive and Gram-negative isolates favoured deep tissue but did not reach the reported significance threshold.

Table 1. Reported microbial recovery by sampling method.

Item	Swab	Deep tissue	Reported p value	Status
Number of pathogens isolated	14	28	0.024	Below 0.05 (as reported)
Gram-positive bacteria	16	34	0.124	Not significant; verify asterisk
Gram-negative bacteria	12	40	0.104	Not significant; verify asterisk
Fungi	1	3	0.041	Below 0.05 (as reported)

DISCUSSION
Diabetic foot infection ranges in severity from a persistent superficial ulcer to limb-threatening gangrene and remains a leading cause of morbidity and lower-limb loss. The present findings are consistent with the widely held view that deep tissue biopsy is superior to superficial swabbing for identifying true pathogens, because deep sampling is less prone to contamination by surface colonisers [1,2]. Pellizzer et al. similarly reported that deep tissue biopsy outperformed swab culture in limb-threatening DFIs [2]. The higher yield of deep tissue culture in this cohort supports its preferential use where feasible. Interpretation is limited, however, by the small sample, the absence of antibiotic-susceptibility data and ulcer-severity stratification, the internal inconsistencies in the reported counts, and the inappropriate statistical test; a paired concordance/discordance analysis of the two methods would be more informative than aggregate counts.

CONCLUSION
In this cohort, deep tissue culture recovered more organisms than superficial swab culture and may more accurately reflect the diabetic foot ulcer microbiota. These preliminary findings support deep tissue sampling for microbiological diagnosis of diabetic foot infection but require confirmation after correcting the statistical analysis and verifying the isolate counts, ideally with paired concordance analysis and antibiotic-susceptibility data.

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