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Does geography influence wound healing following revision total hip arthroplasty for periprosthetic joint infection? A retrospective comparative cohort study

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ABSTRACT

Background: Periprosthetic joint infection (PJI) after revision total hip arthroplasty (THA) poses significant wound-management challenges. Outcomes following vacuum-assisted closure (VAC) therapy vary and may be influenced by regional microbiology and host soft-tissue characteristics.
Methods: This retrospective comparative cohort study (2019-2025) included adults undergoing revision THA for chronic PJI at a tertiary center. Patients were grouped by geographic origin: India (n=20) and Democratic Republic of Congo (DRC; n=18). Demographics, microbiology, postoperative wound gaping, debridement and VAC sessions, soft-tissue reconstruction, and time to complete wound healing were analysed using non-parametric statistics.
Results: The Indian cohort was younger (60.3 vs 67.8 years; p=0.010) but required more debridement's (3.1 vs 2.3; p=0.031), VAC sessions (2.7 vs 1.6; p=0.003), and flap reconstructions (70% vs 22%). Initial wound gaping occurred at a similar postoperative interval in both cohorts; however, healing time was significantly longer in Indian patients (36.8 vs 18.2 days; p=0.002). Klebsiella predominated in the Indian cohort, whereas Pseudomonas was more common in DRC patients.
Conclusions: Geographic differences in wound behaviour following revision THA for PJI suggest that regional microbiology and host soft-tissue factors influence VAC effectiveness and healing outcomes, supporting population-specific wound management strategies.

Keywords: Periprosthetic joint infection, Revision total hip arthroplasty, Vacuum-assisted closure, Wound healing, India, Democratic republic of Congo

INTRODUCTION

Periprosthetic joint infection (PJI) following revision total hip arthroplasty (THA) remains a formidable clinical challenge, occurring in approximately 1-2% of primary procedures and rising to nearly 5% after revision surgery.[1] Management is complex and resource-intensive, frequently necessitating repeated surgical debridement, prolonged vacuum-assisted closure (VAC) therapy and in refractory cases, soft-tissue flap coverage. Despite these measures, wound-related complications and failure rates exceeding 20% have been reported in high-risk populations.[2] VAC therapy has been shown to promote granulation tissue formation, decrease local bacterial burden by approximately 40-50% and reduce hospital length of stay. However, clinical outcomes following VAC therapy are heterogeneous and appear to be influenced by

regional factors, including prevailing microbiological profiles, host soft-tissue characteristics, and comorbidity burden.[3] In the Indian subcontinent, gram-negative organisms, particularly Klebsiella species are frequently implicated in PJI, often in the setting of delayed wound healing attributed to comorbidities and compromised soft-tissue envelopes. In contrast, reports from sub-Saharan Africa describe a higher prevalence of Pseudomonas infections, with comparatively favorable wound tolerance and earlier closure observed in some cohorts.[4] This retrospective comparative study evaluates wound gaping, adjunctive interventions and time to wound healing in revision THA patients treated for PJI in two geographically distinct populations: India (n=20) and the Democratic Republic of Congo (n=18). The study aims to explore how regional microbiology and host soft-tissue factors may influence wound behaviour and the effectiveness of VAC therapy following revision hip arthroplasty.

METHODS

This retrospective comparative cohort study was conducted over a six-year period (2019-2025) at the Department of Orthopedics, M.S. Ramaiah Medical College and Hospitals, Bengaluru, Karnataka, India. The study population comprised patients originating from two referral cohorts; India (n=20) and the Democratic Republic of Congo (DRC; n=18), all of whom underwent treatment at the index center. Adult patients who underwent revision THA for confirmed chronic PJI and had complete wound-related outcome data were included. Chronic PJI was defined as infection presenting more than six weeks after the index arthroplasty. Exclusion criteria comprised acute PJI (<6 weeks), culture-negative infections and incomplete clinical or wound documentation. The diagnosis of PJI was established in accordance with the 2018 International Consensus Meeting (ICM) criteria.[5] Institutional ethics committee approval was obtained prior to study initiation. Data were retrieved from electronic medical records using a standardized data collection proforma. Variables recorded included patient demographics, microbiological profiles, postoperative day (POD) of wound gaping, number of surgical debridement's, number and duration of vacuum-assisted closure (VAC) therapy sittings, method of definitive wound closure and time to complete wound healing.

Statistical analysis was performed using SPSS software version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as means ± standard deviations and compared using the Mann–Whitney U test, given the small sample size and non-normal distribution. Categorical variables were expressed as frequencies and percentages and analyzed using Fisher's exact test. A p value of <0.05 was considered statistically significant.

RESULTS

The Indian cohort (n=20) had a mean age of 60.3±4.1 years, with males accounting for 60% of patients. In contrast, patients from the DRC cohort (n=18) were older, with a mean age of 67.8±5.2 years and a male predominance of 67%. The burden of prior surgical intervention was similar between the two groups, with a comparable mean number of previous revision procedures (1.9±0.6 in the Indian cohort vs. 1.8±0.7 in the DRC cohort), indicating broadly equivalent baseline surgical complexity (Table 1).

Table 1: Baseline patient demographics and cumulative number of revision THA procedures performed during the treatment period.

Parameters		Indian cohort (n=20)	DRC cohort (n=18)	P value
Age (mean±SD, years)		60.3±4.1	67.8±5.2	0.010
Gender N (%)	Male	12 (60)	12 (66.67)	NA
	Female	8 (40)	6 (33.33)	
Number of revision THA (mean±SD)		1.9±0.6	1.8±0.7	0.590

Table 2: Distribution of microbiologically isolated pathogens in the study cohorts.

Isolated organisms	Indian cohort (n=20)	DRC cohort (n=18)
Klebsiella pneumoniae	8 (40%)	4 (22.20%)
Staphylococcus aureus	4 (20%)	6 (33.35%)
Staphylococcus epidermidis	6 (30%)	2 (11.10%)
Pseudomonas aeruginosa	2 (10%)	6 (33.35%)

Distinct regional differences were observed in microbiological profiles. Klebsiella species constituted the most frequently isolated pathogens in the Indian cohort (40%), whereas Pseudomonas species were more prevalent among DRC patients (33%). Staphylococcus species were consistently identified in both cohorts, reflecting their ubiquitous role in periprosthetic joint infections across geographic settings (Table 2). Patients in the Indian cohort demonstrated a significantly greater requirement for wound-related interventions (Table 3). They underwent more frequent surgical debridements (3.1±0.7 vs 2.3±0.7; p=0.031) and a higher number of VAC therapy sessions (2.7±0.7 vs 1.6±0.5; p=0.003) compared with the DRC cohort. Additionally, flap-based soft-tissue reconstruction was required more often in Indian patients (70% vs 22%), although this difference was not found to be statistically significant (Figure 1). The

timing of initial wound gaping was similar between the two cohorts, occurring at a mean of 11.7±2.9 postoperative days in the Indian group and 12.3±4.1 days in the DRC group (p=0.590). Despite the comparable onset, overall wound-healing trajectory differed substantially.

Indian patients required more than twice the duration to achieve complete wound healing compared with DRC patients (36.8±13.9 vs 18.2±4.3 days; p=0.002), underscoring a markedly prolonged wound resolution course in this cohort (Table 4).

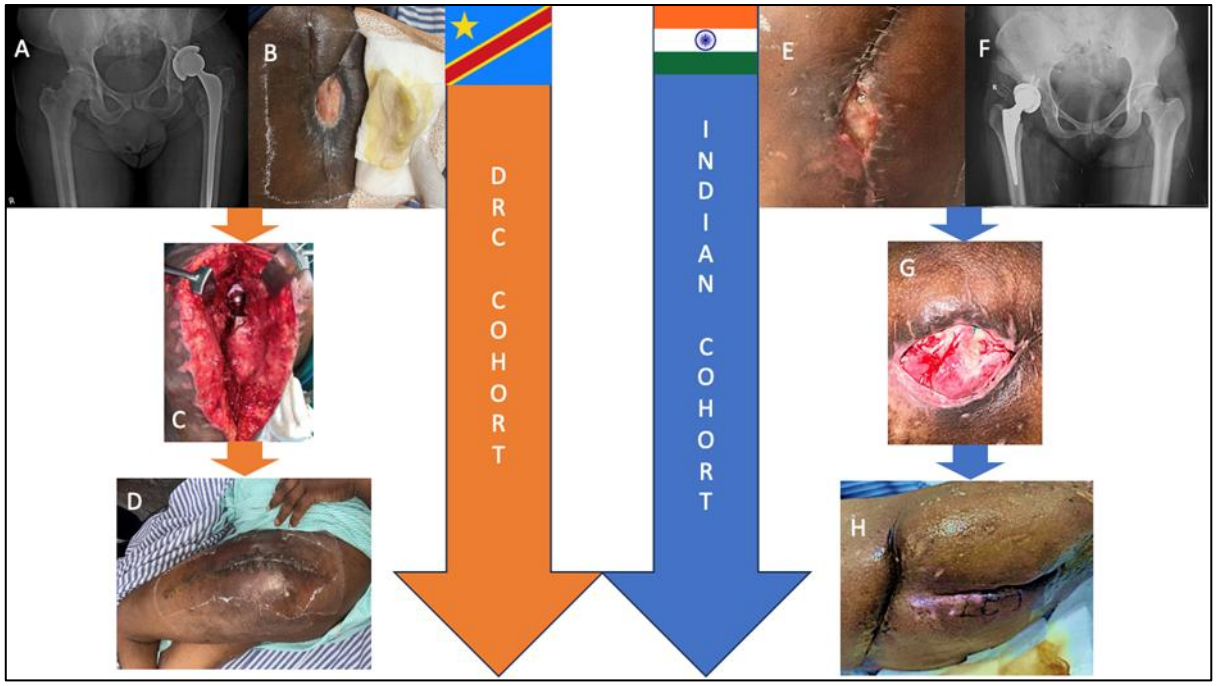

Figure 1: Comparative illustration of wound progression in patients from the democratic republic of Congo (DRC) and Indian cohorts: (A-D) depict a representative DRC patient: the preoperative radiograph and initial wound gaping are shown in panels (A) and (B), followed by thorough surgical debridement in panel (C) and successful wound healing achieved with primary closure in panel (D) and (E-H) illustrate a representative Indian patient: the preoperative radiograph and initial wound gaping are shown in panels (E) and (F), followed by surgical debridement in panel (G) and subsequent soft-tissue reconstruction using a rotation gluteus maximus flap, as shown in panel (H).

Table 3: Wound management strategies and associated soft-tissue interventions.

Procedures done	Indian cohort (n=20)	DRC cohort (n=18)	P value
Debridement sittings (mean±SD)	3.1±0.7	2.3±0.7	0.031
VAC sittings (mean±SD)	2.7±0.7	1.6±0.5	0.003
Soft tissue flap requirement, N (%)	7 (70)	2 (22.2)	0.070
Primary closure achieved, N (%)	3 (30)	7 (77.8)	0.070

Table 4: Temporal progression of wound status from initial gaping to complete healing.

Wound outcome	Indian cohort (n=20)	DRC cohort (n=18)	P value
Day of wound gaping post-operation (mean±SD)	11.7±2.9	12.3±4.1	0.590
Time to complete wound healing (mean±SD)	36.8±13.9	18.2±4.3	0.002

DISCUSSION

Revision THA for PJI is most commonly performed in older adults, with large national registries such as the American Joint Replacement Registry (AJRR) and the National Joint Registry (NJR) reporting mean patient ages ranging from 62 to 71 years at the time of revision surgery.[6,7] A consistent male predominance has also been documented across multiple series, with males demonstrating a higher risk of PJI, reflected by reported

odds ratios between 1.3 and 1.8. This predisposition has been attributed to greater exposure to occupational trauma, lifestyle-related risk factors and immunomodulatory influences.[1-8] Patients undergoing revision for chronic PJI typically have a substantial history of prior surgical intervention, with tertiary referral centers reporting an average of 1.6 to 2.3 reoperations before definitive infection control. This cumulative surgical burden is widely regarded as a surrogate marker of disease chronicity and soft-tissue compromise.[9] Advancing age has traditionally been considered an independent risk factor for impaired wound healing, with several studies demonstrating a 1.4 to 1.5-fold increase in healing delays among patients older than 65 years.[10,11] In Western populations, this risk is further accentuated in octogenarians, who have been shown to experience nearly double the rate of postoperative wound complications following revision arthroplasty.[12] In the present series, patients from the Indian cohort were younger than those from the DRC cohort (mean 60.3 vs 67.8 years; p=0.010), while both groups demonstrated a comparable male predominance (60% vs 67%) and similar prior revision burden (1.9 vs 1.8 procedures). Despite the older age profile of the DRC cohort, wound-healing outcomes in this group were not adversely affected, a finding that contrasts with age-related trends reported in Western literature and suggests the influence of population-specific host or soft-tissue factors that may modulate wound healing independent of chronological age.

The predominance of Klebsiella species in the Indian cohort (40%) is consistent with reported regional patterns of periprosthetic joint infection, where gram-negative organisms account for approximately 25-45% of isolates. This distribution has been attributed to higher rates of antimicrobial resistance, prolonged hospital exposure, and increased nosocomial transmission in the subcontinent.[13,14] In contrast, the higher prevalence of Pseudomonas species observed in the DRC cohort (33%) parallels findings from sub-Saharan African series, where reported isolation rates range from 20-40%. These trends have been linked to environmental exposure, delayed presentation, and limited early access to definitive surgical care, and stand in contrast to the relatively low prevalence reported in European cohorts (<10%).[15,16] Staphylococcus species, including Staphylococcus aureus and coagulase-negative staphylococci (S. epidermidis), were commonly identified in both cohorts, accounting for a combined prevalence of 50-60%. This finding aligns with global PJI microbiological profiles, in which staphylococcal organisms constitute approximately 45-65% of isolates, despite evolving regional shifts toward gram-negative pathogens.[5,17] Notably, all infections in the present series were monomicrobial, a rate exceeding the polymicrobial prevalence of 15-30% reported in Indian PJI literature.[18] This suggests that host-related factors and local tissue response may have exerted a greater influence on wound-healing variability than microbial synergism in this cohort. Furthermore, although Klebsiella infections have been associated with a 1.6-fold increased risk of reinfection in prior studies, Pseudomonas infections in the DRC cohort were paradoxically associated with more rapid wound closure, challenging conventional assumptions regarding pathogen virulence hierarchy in determining wound outcomes.[11] The significantly higher number of surgical debridements required in the Indian cohort (3.1 vs 2.3 sittings; p=0.031) exceeds commonly reported benchmarks for debridement, antibiotics, and implant retention (DAIR), where 1 to 2 debridement procedures are typically associated with success rates approaching 65%. This finding is consistent with reports from Indian PJI series, which frequently describe the need for 2.8 to 3.5 debridement procedures to achieve infection control in gram-negative infections, largely attributed to biofilm persistence and antimicrobial resistance.[13-19] A similar disparity was observed in the utilization of VAC therapy, with Indian patients requiring a significantly greater number of VAC sessions compared with the DRC cohort (2.7 vs 1.6 sessions; p=0.003). While negative-pressure wound therapy has been shown to reduce wound bio-burden by up to four logarithmic units, the efficiency observed in the DRC cohort closely approximates VAC utilization reported in elective orthopedic procedures (1.2 to 1.8 sessions) rather than the higher averages typically described in revision arthroplasty settings (mean~2.4 sessions).[2,20] The requirement for flap-based soft-tissue reconstruction was substantially higher in the Indian cohort (70-22%), aligning with published PJI series in which compromised soft-tissue envelopes necessitate flap coverage in approximately 45-65% of cases. In contrast, the lower flap rate observed in the DRC cohort may reflect more robust local tissue characteristics, where fibrotic wound responses have been associated with higher rates of successful primary closure, reported to reach up to 78% in selected series.[21] Although the flap utilization in the present study exceeds rates typically reported for DAIR-based implant retention strategies, where flap requirements are generally below 20%, these findings underscore the potential for optimized VAC therapy to facilitate wound closure in cohorts with relatively resilient soft-tissue profiles.[22]

Despite a comparable timing of initial wound gaping, the Indian cohort demonstrated a significantly prolonged duration to complete wound healing compared with the DRC cohort (36.8 vs 18.2 days; p=0.002). The similarity in postoperative day of wound dehiscence, occurring at approximately 12 days in both groups, effectively excludes differences in early wound severity or timing as confounding factors and is consistent with prior PJI series reporting dehiscence between 10 and 15 days postoperatively.[23] The accelerated healing observed in the DRC cohort aligns with evidence from chronic wound and dermatologic literature, where pigmented skin has been shown to exhibit 1.7 to 2.1-fold faster re-epithelialization, mediated through enhanced fibroblast activity and upregulation of key growth factors involved in tissue repair.[24,25] Notably, wound-healing timelines in the DRC cohort compared favorably with published benchmarks for revision THA, which typically range from 28 to 42 days,

and were accompanied by a high rate of successful primary closure (78%). This contrasts with the Indian cohort, where primary closure was achieved in only 30% of cases and overall healing duration exceeded expected norms.[20,21] These findings parallel prior studies examining ethnic and phototype-related differences in postoperative wound behaviour, in which darker skin phototypes have been associated with substantially shorter closure times following arthroplasty procedures. Collectively, this suggests that host-related dermal and reparative characteristics may exert a more pronounced influence on wound-healing trajectories than chronological age or pathogen profile alone, particularly in the setting of complex revision surgery for periprosthetic joint infection.[22-26]

This study has several limitations inherent to its retrospective design and relatively small sample size. Reliance on medical record review may have introduced selection and documentation bias, particularly with respect to unrecorded comorbidities, perioperative variables, and reinfection outcomes beyond the point of wound closure. The modest cohort size (n=19) limits statistical power for detailed subgroup or multivariable analyses, although statistically significant differences were still observed for several key clinical outcomes. The absence of histological assessment, quantitative dermal thickness measurements, or objective soft-tissue perfusion analysis precludes direct validation of proposed host-related or ethnic soft-tissue mechanisms underlying the observed differences in wound behaviour. Additionally, as this was a single-center study with uniform surgical decision-making and VAC protocols, the findings may not be fully generalizable to other practice settings.

Nevertheless, this study provides comparative, real-world insights into the management of complex periprosthetic joint infections in referral populations. The observed geographic differences in wound response and treatment requirements should be regarded as hypothesis-generating and underscore the need for larger, multicenter prospective studies incorporating standardized wound management protocols to better inform tailored soft-tissue strategies following revision hip arthroplasty.

CONCLUSION

This retrospective comparative study demonstrates significant geographic variation in wound behaviour and management requirements following revision THA for PJI. Despite comparable timing of wound dehiscence and similar surgical complexity, patients in the Indian cohort required more frequent debridement's, greater utilization of VAC therapy, higher rates of flap reconstruction and experienced substantially prolonged wound-healing times compared with patients from the DRC. These differences appear to reflect an interplay between regional microbiological patterns and host-related soft-tissue characteristics rather than chronological age or initial wound severity alone. While limited by sample size and retrospective design, the findings highlight the potential importance of population-specific wound biology in determining outcomes after revision arthroplasty and suggest that VAC-based strategies may be optimized according to host tissue resilience. Larger, multicentre prospective studies are warranted to validate these observations and to guide individualized soft-tissue management protocols for complex periprosthetic joint infections.

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