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The Ponseti method for the management of congenital clubfoot patients at a training hospital in KwaZulu-Natal, South Africa. A retrospective observational study.

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ABSTRACT

Background

Clubfoot affects 1.55–6.93 per 1,000 live births in developing countries, making it a common congenital condition. However, awareness and knowledge of clubfoot management, particularly using the Ponseti method, remain limited in district and regional hospitals in rural South Africa.

Objective

This study examines the epidemiology, patient profile, clinical presentation, and Ponseti casting outcomes of congenital clubfoot at Ngwelezana Hospital to enhance understanding and optimize management of the condition.

Methods

A retrospective observational study was conducted at Ngwelezana Hospital in KwaZulu-Natal on patients' records who visited the facility from January 2018 -June 2022. Data was collected on the profile of patients with congenital clubfoot deformity from the clinical records of patients attending the clubfoot clinic at Ngwelezana Hospital during this time.

Results

The median age of the cohort at presentation was 30.5 days (IQR: 7–92 days), with 58 % being seen in the first month and 25 % after three months. Males comprised 67% of the cases; bilateral deformities accounted for 61%. The mean initial Pirani score was 4.3 ± 1.4. The percutaneous Achilles tenotomy was enacted in 68.8 % of the infants. With biweekly casting, 8.3 % of feet never progressed to the bracing stage without surgical release. There were missed appointments among 12 % of families, and minor cast-related complications affected less than 4 % of casts. The completeness of data was compromised by 6.8 % missing outcome data.

Conclusion

Congenital clubfoot at Ngwelezana Hospital is treated with a modified Ponseti method. Delays, non-compliance, and socioeconomic challenges affect outcomes, highlighting the need for education and improved referrals.

Recommendations

Community education should be intensified for early detection, consequently decreasing the late presentation rate and compliance rate. Better data capturing, such as electronic, may add value to education, quality improvement, and further research on this topic.

Keywords: *Congenital clubfoot, Ponseti casting method, clubfoot South Africa, clubfoot low-income country, clubfoot epidemiology.*

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INTRODUCTION

Congenital talipes equinovarus, or clubfoot, is a common musculoskeletal birth defect across the world. (1-4) It affects every 1 in 1,000 children and mostly afflicts lower- and middle-income areas, with 80% of cases occurring there (2, 5,8). There is, however, a sporadic lack of consistency in much epidemiological data emerging from South Africa, with widely contrasting incidence rates registering anywhere from 1.55 to 6.93 per 1,000 live births. That variation might be due to some real geographical difference coupled with a lack of systematic data collection in places. (2) Males are predominantly affected, with a male: female ratio of 2:1 (1, 2). 80 % of this condition is idiopathic, and 20% is associated with other conditions(1, 2).

If the deformity is left untreated, the burden of disease increases(3). This is due to the deformity persisting into adulthood and resulting in abnormalities with weight-bearing, gait, and a decrease in quality of life. (1, 3). Potential complications of untreated clubfoot deformity consist of callus formation, skin breakdown, potential sites of infection (due to children walking on the sides of their feet), chronic pain, impaired mobility, and limited employment opportunities. (1, 3)In resource-limited countries, it has been documented that these children are confined to a life of poverty with a lack of education, as well as difficulty with finding a marriage partner due to cultural bias and prejudice. (1)

Dr. Ignacio Ponseti developed the Ponseti method for the treatment of clubfoot in 1948. This method is still regarded as the gold standard for the treatment of clubfoot. (1, 5,11) It consists of three phases of management. The first phase is manipulation and casting, which generally lasts for 5- 8 casts that are changed weekly. The second phase is a percutaneous Achilles tendon tenotomy to correct the equinus of the foot once all other elements have been corrected. Approximately 90% of patients will require an Achilles tendon tenotomy (1). The final phase, which is regarded as the most important phase, is maintenance of the correction by bracing and lasts until the age of 4 – 5(1, 3). Treatment should be started early in the neonatal period, preferably between weeks 1 - 3, to ensure good results(1,11). Treatment aims to produce pliable plantigrade feet with normal function and pain-free. Good results have been achieved using the Ponseti method in both developed and underdeveloped countries(3)

Although clubfoot is a common congenital condition globally and more so in developing countries, there is a lack of information found in the literature about the epidemiology of clubfoot in South Africa(2). Epidemiological studies have been described as crucial for improving treatment and ensuring equal care, regardless of the environment. Treatment plans can be evaluated, and outcomes compared with different regions, with the use of epidemiology data. Furthermore, this data will aid in identifying factors influencing clubfoot(4)

A lack of knowledge of clubfoot and its management using the Ponseti method seems to be present in the surrounding rural hospitals that make up the catchment area of Ngwelezane Hospital in KwaZulu-Natal, South Africa. This lack of knowledge of the condition and its management then leads to late presentation, patients defaulting on treatment, and some parents not seeking help at all(8,11). This study aimed to determine the epidemiology and clinical presentation of congenital clubfoot at Ngwelezana Hospital, as well as the management and results for the Ponseti method of treatment. Such information specific to the diverse population at Ngwelezana Hospital is needed to help address the knowledge gap within the club foot population and amongst medical colleagues. This information may lead to additional studies, which will enhance overall knowledge and understanding of clubfoot, as well as its management.

METHODS

Study design

This was a retrospective observational study that was conducted on patients' records who visited the facility from January 2018 -June 2022.

Study setting

This study was conducted at Ngwelezana Hospital, a public-sector tertiary hospital serving the King Cetshwayo, Zululand, and Umkhanyakude Districts in KwaZulu-Natal, South Africa. It is the only hospital in the Umlalazi Sub-District that provides Level I, Level II, and Level III services. The hospital receives referrals from 18 hospitals and delivers healthcare services to a catchment population exceeding 2.5 million people. The Orthopaedic Department is affiliated with the University of KwaZulu-Natal and provides both undergraduate and postgraduate training.

Patients

Two hundred thirty-eight patient files were screened for inclusion in the study. These consisted of patients with congenital clubfoot deformity who attended the clubfoot clinic at Ngwelezana Hospital from 2018 to 2022. All patients with congenital clubfoot deformity presenting to Ngwelezana Hospital or transferred to Ngwelezana Hospital

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during the casting phase of management were included. Patients were excluded from the study if they had acquired clubfoot deformity or apparent clubfoot deformity. Patients transferred to Ngwelezana Hospital during the bracing phase of management, and patients transferred out of Ngwelezana Hospital before the completion of the casting phase of management were also excluded. Patients who demised before the completion of the casting phase of management, and patients with inadequate records, formed part of the exclusion criteria.

Measurements

Data about the patient profiles of each patient included in the study were obtained from their clinical records. The aim was to assess and describe the patient profile of congenital clubfoot and the outcome of the casting phase of the Ponseti management method.

The Pirani score is a documentation of the severity of each component of the deformity (15). This score is also used to monitor progress during treatment. The Pirani score of initial presentations was captured to identify the severity of the clubfoot at initial presentation.

Clubfoot was classified as described by the Global-HELP Publication (15), where a typical clubfoot is described as a clubfoot found in an otherwise normal infant. Atypical clubfoot is described in infants with other congenital problems and includes rigid, syndromic, teratologic, neurogenic, and acquired clubfoot (15). For the aim of this study, acquired clubfoot was not included.

Due to the long distance patients must travel to reach Ngwelezana Hospital, casting is done every two weeks instead of weekly as described in the literature. By measuring the number of casts needed for correction at Ngwelezana Hospital, we can identify if this change in the management protocol affects the overall outcome in the casting phase of the Ponseti management.

The desired outcome of the Ponseti management method is to produce pliable plantigrade feet with normal function, without the need for extensive surgery. Failed casting was therefore defined as feet that, after casting and percutaneous tenotomy, were unable to graduate to the bracing phase and required extensive surgery to obtain pliable plantigrade feet. The most common complications observed with casting include pressure wounds, plaster burns, and extensive rashes. These complications were captured under "complication during casting".

Study Variables

The patient variables that were captured included: the age at presentation, gender, bilateral clubfoot, unilateral clubfoot, Pirani score, family history of clubfoot, multiple pregnancies, typical clubfoot, atypical clubfoot, number of casts needed, number of missed clinic appointments, failed casting, tenotomy needed, and complications due to casting.

Data handling and analysis

All data was captured on an Excel sheet that was password-protected and saved on the cloud by two doctors. IBM SPSS version 29 was used to analyse the data by a biostatistician. Categorical variables were summarized using frequency tables and percentages. Descriptive statistics such as median and interquartile range were used to summarize continuous data that was not normally distributed, and mean and standard deviation for normally distributed variables. A two-sided t-test was used to compare two independent means. A p-value <0.05 was considered statistically significant.

Ethical considerations

The study was approved by the University of KwaZulu-Natal Biomedical Research Ethics Committee of the University of KwaZulu-Natal on 27 April 2024 (BREC/0006088/2023). Institutional permission was also granted by Ngwelezana Hospital to conduct research at their facility. Approval was also obtained by the KwaZulu-Natal Department of Health to undertake this study, with NHRD Ref: KZ_202312_034.

RESULTS

Two hundred and thirty-eight files were screened for inclusion in the study. Of these, 38 (16%) were excluded for not containing sufficient information, and 8 (3.4%) were excluded as not being clubfoot. The remaining 192 (80.7%) patients were analysed in this study.

The median age of presentation was 30.5 days, with a range from 2 days to 1826.25 days (5 years)- Table 1. The 25th percentile was 7 days, meaning that 25% of patients presented at 7 days or younger. The 75th percentile was 91.5 days (3 months), meaning that 25% of patients presented at 3 months or older. Age group analysis showed that more than half the sample were up to one month old (58%), while 16% were between 1 and 2 months, 13% 3 and 4 months, and a small proportion was older than this. Figure 1 shows that the age groups were similar in the male and female patients.

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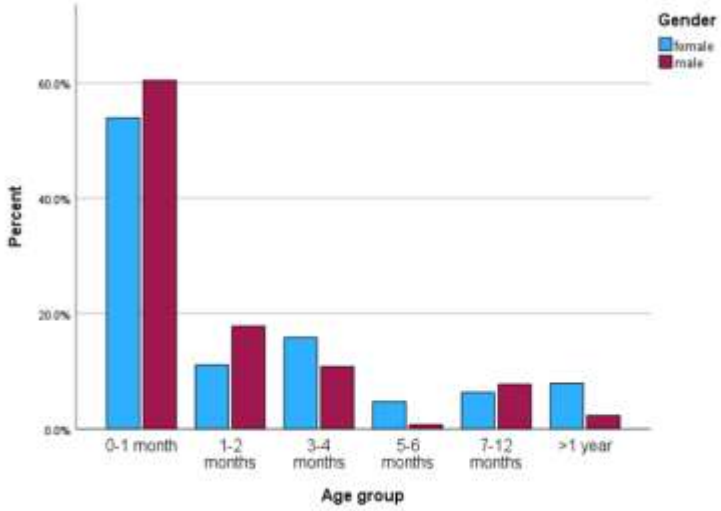
Table 1: Age at presentation in patient sample (in days and in age groups)

Age of presentation in days	Valid N	192
	Median	30.50
	Percentile 25	7.00
	Percentile 75	91.50
	Minimum	2.00
	Maximum	1826.25

Figure 1: Bar chart of age group by gender



There were 67% males in the sample. 61% were bilateral. Only 9% had a positive family history, and 3.6% were from multiple pregnancies. Only 148 patients of the 192 in the sample had a Pirani score value. The mean score was 4.3 with a standard deviation of 1.4 and ranged from 1 to 6. Figure 2 shows that males had slightly higher scores than females, although the difference was not statistically significant (p=0.101). There was little variation between age groups, as shown in Figure 3.

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Figure 2: Pirani score by gender

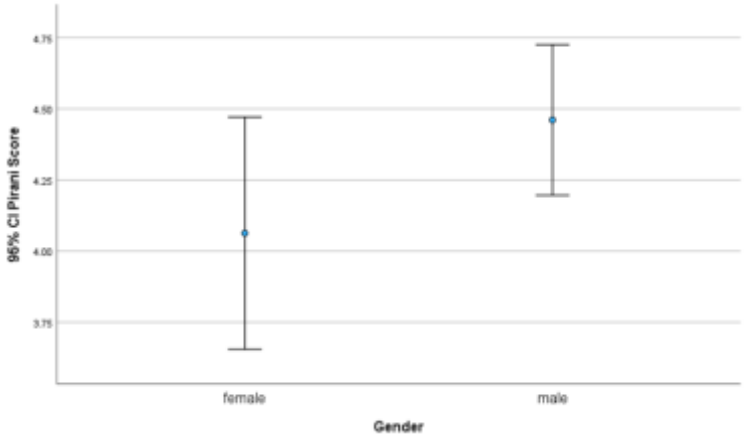
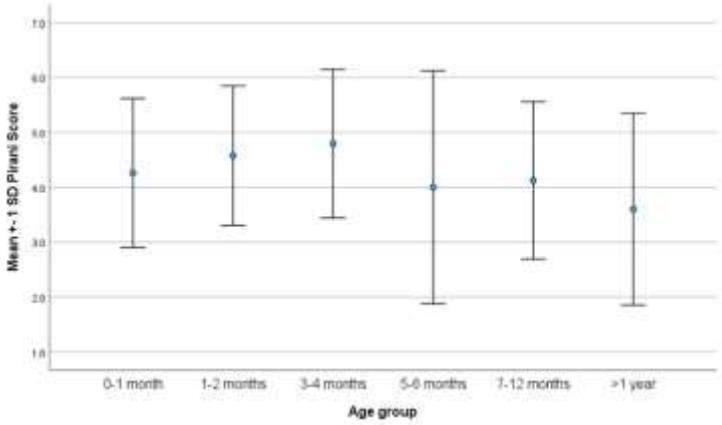


Figure 3: Pirani score by age group



There was an 8.3% prevalence of failed casts overall. Failed casts by age group and gender are shown in Figure 4. Failure was similar in all groups. 6.8% of entries had outstanding information concerning the success of the casting stage.

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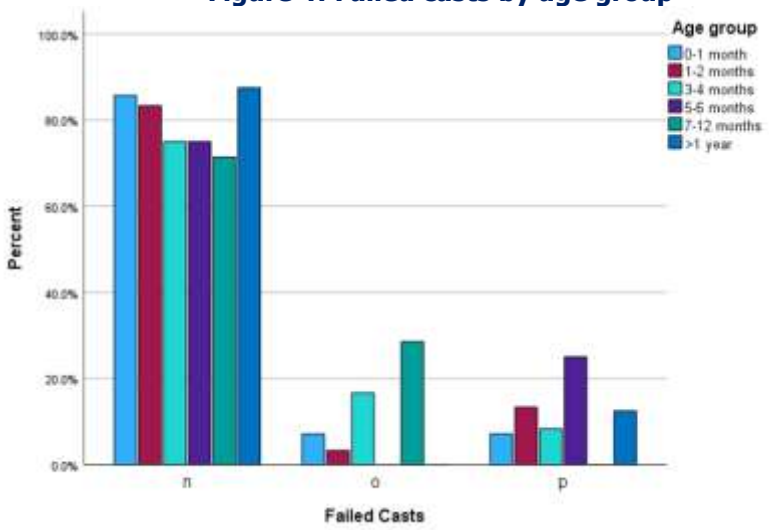
Figure 4: Failed casts by age group



N= successful casts, O= information outstanding, P= unsuccessful casts

Missed appointments were seen in 12% of the sample. 68.8% of the patients required tenotomies. Typical presentation was seen in 71.9%, while atypical presentation was seen in 20.8%, and the remaining 7.3% were not classified.

Complications captured included blisters (2.6%), burns (0.5%), pressure wounds (0.5%), and swelling of the foot (0.5%).

DISCUSSION

From the study period of five years, 192 infants presenting with idiopathic clubfoot at Ngwelezana Hospital were evaluated. This confirmed that while conforming to global patterns, some challenges were specific to rural South African settings. The median age of presentation was 30.5 days, with only twenty-five percent of patients presenting at seven days or younger, and twenty-five percent of patients presenting at three months of age or older. These findings were similar to those found in the Western Cape, South Africa. (1), and could be due to low caregiver awareness, transport challenges, and other socioeconomic priorities. This was contrary to what is found in high-income settings, where treatment begins within the first two weeks of life for more than seventy-five percent of patients. (2,11). Such delays, as shown in other studies(3), lead to patients requiring more casts in order to achieve a plantar grade foot, and are a contributing factor to the 8.3% failed casting seen in this study. Another contributing factor to the failed casting seen in this study could be the adapted biweekly casting schedule, which was necessary, taking into account that Ngwelezane Hospital has a catchment area of over 200 km of rural terrain. Weekly serial manipulations produce relatively consistent corrective forces with reduced risk of relapse (2,14); this is not possible in all hospital settings and has been adapted to fit the patient profile. The South Asian experience, where similar logistical constraints warrant modified casting intervals, showed a 5-12% failure rate if combined with stringent follow-up and timely tenotomy. (4). The data demonstrate that, provided with robust follow-up systems and access to tenotomy, biweekly casting attains broadly acceptable early correction rates. However, due to the retrospective nature of the study and the circumstance of lacking stringent prospective protocols for casting and outcome assessment, 6.8% of cases had incomplete data on casting results, which undermines confidence in the precision of our estimate of failure rates.

Adherence to appointments was an important predictor of outcomes. Twelve percent of families missed at least one scheduled clinic visit, a percentage comparable to those reported previously in South Africa, in which such missed visits were linked to travel distances, loss of income, and mistaken beliefs by caregivers as to the need for serial casts. (1,8). Serial casting is a cumulative process: each session makes an incremental correction to the deformity; hence, any absence for even two weeks could allow at least a partial relapse of what was corrected. The high tenotomy rate of

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68.8 % in this study fits well within the range of sixty to ninety percent worldwide and reflects correct adherence to Ponseti indications for residual equinus greater than ten degrees post casting (15). However, bearing in mind the marginally increased failure rate, reinstitution of weekly casting wherever feasible, especially for infants with high initial Pirani scores, might be expected to contribute towards more efficient correction.

In assessing severity, the mean initial Pirani score of 4.3 (SD 1.4) reveals an index skewed toward moderate deformities. International tertiary-centre series frequently report mean scores between 4.5 and 5.0 (3, 5), which may imply that the slightly lower mean is due to an active district-level screening capturing mild presentations at an earlier stage. The value of the standard deviation indicates, however, huge variability between individuals, with some infants approaching a maximal score of 6.0. Significantly, a higher initial score was associated with more casts required for correction ($p < 0.01$), thus reiterating established knowledge that a severe presentation remains the best predictor of treatment intensity and duration. However, once the initial Pirani score was accounted for, we found that age at presentation had no direct relation to the number of casting sessions, implying that initial severity more strongly influences the treatment trajectory than the infant's age (3).

Gender and laterality distributions in this cohort were closely aligned with global epidemiology: a male-to-female ratio of about 2:1 (67 % male)(8) and bilateral in 61 % of cases. Such numbers reflected reports of male predominance internationally, with about half of the cases bilateral. (6, 7,10) Suggesting that genetic and environmental influences on clubfoot in KwaZulu-Natal are consistent with broader trends. The relatively low rate of positive family history (9 %) further points to the largely sporadic nature of idiopathic clubfoot in this setting, which is also shown in other parts of South Africa and other countries (1,10,13). Interestingly, no statistically significant difference was found in Pirani scores at initial assessment when the unilateral and bilateral presentations were compared or among age at presentation groups. This denotes that while timing influences tissue pliability, inherent tissue characteristics and varying deformity morphology also significantly impact initial severity. (5). This cohort also showed that 3,6% of patients were a result of a multiple pregnancy, further emphasizing the latter point(12).

Minor cast-related complications, including blisters (2.6%), superficial burns (0.5%), pressure sores (0.5%), and swelling (0.5%), totaled fewer than 4% of all the casts applied. These rates of 1–4.5% are similar to those given in international series. (3) Although these infrequent and mostly self-limiting adverse events may compromise the application process and undermine the willingness of parents to continue treatment, our review failed to identify any severe infections or neurovascular compromise. Nevertheless, such minor skin breakdowns highlight the need for caregiver education on cast care, compliance with follow-ups, and possibly the deployment of mobile outreach teams for complex cases, in particular during the hot months. (3).

Generalizability

This study was conducted at a single tertiary public-sector hospital in South Africa. The hospital serves as a referral center for 18 hospitals within the region and provides care to a catchment population exceeding 2.5 million people, making it an appropriate setting for an epidemiological investigation. As the referring hospitals are predominantly located in rural areas, the findings are broadly generalizable to low-income and resource-limited settings. However, some findings may not be directly comparable to studies conducted in high-income countries or within the private healthcare sector, where contextual challenges such as long travel distances to healthcare facilities, limited patient education, and resource constraints are less prevalent.

Conclusion

The management of congenital clubfoot at Ngwelezana Hospital is based on the Ponseti method, with context-specific adaptations to accommodate the constraints of a rural South African setting. Although biweekly casting yielded acceptable early outcomes, it was not possible to determine its comparability with standard weekly casting owing to the retrospective design of the study and incomplete records in 6.8% of patient files. The observed failure rate of 8.3% was attributed to delayed presentation, limited caregiver awareness, transportation challenges, non-compliance with treatment protocols, and competing socioeconomic priorities. The findings of this study highlight opportunities to improve the timeliness of referrals, strengthen patient attendance, enhance caregiver education regarding cast care, and improve data collection and management systems. The distribution of gender and laterality within this cohort was consistent with global epidemiological trends.

Strengths and limitations of the study

Several strengths of this study include its relatively large sample size and its capture of data from a resource-limited,

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under-researched rural population, with standardized data-capture methodology subjected to outsider biostatistical analysis, a combination that weighs heavily on the internal validity and reliability of our results. Some limitations remain: First, the single-centre design of this study hampers its generalizability to either urban centers or better-resourced settings, which have higher socioeconomic status, differences in patient population, and medical infrastructure. Consistency of assessment and casting by the same provider is not always available or documented. Secondly, the inability to determine relapse rates beyond the casting phase, which ultimately defines the long-term success of Ponseti management, is of concern because this long-term follow-up has not been possible. Thirdly, there were areas of missing data and poor record-keeping, which may have influenced some results. Finally, none of the socioeconomic or educational variables that undoubtedly influence treatment adherence were gathered prospectively; hence, our inability to specify and quantify their actual effects.

Recommendation

Several practice-related recommendations arise from the study. First, in tandem with district-wide screening and improved education of medical personnel on recognizing clubfoot, community education should be intensified for early detection, consequently decreasing the late presentation rate of twenty-five percent (1). The second intervention could be to reduce the compliance rate of twelve percent within the study group during appointments by encouraging reminders, or by offering transport vouchers, and even by initiating follow-up casting at coastal peripheral clinics (9). Thirdly, a formal process for the delivery of cast-care training to caregivers at treatment outset could be instituted, along with interim telehealth check-ins, to provide for a reduction in complications occurring at present, albeit at low rates (3). Fourth, set up an electronic data capture platform requiring mandatory fields covering Pirani score, number of casts, tenotomy, complications, and attendance records. This would lead to fewer missing data, with the bonus of allowing the initiation of a quality-improvement circle in good time.

Future Research

Future research should involve prospective, randomized trials that compare weekly versus biweekly casting intervals in similar rural settings, aiming to quantify in a robust manner the trade-offs between total casts, duration of treatment, failure rates, and cost-effectiveness. Furthermore, qualitative investigators researching caregiver beliefs, financial burdens, and planning constraints will substantiate the tailoring of context-specific interventions for promoting adherence. Long-term cohorts, following through bracing and early childhood, will have to record relapse rates, functional outcomes, and quality of life measures, ultimately considered the gold standard for assessing the long-term impact of Ponseti treatment in low-resource settings.

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List of abbreviations

No abbreviations were used in this paper.

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No financial support or funding was received by the authors for conducting this study.

Conflict of Interest

The authors declare no conflict of interest

Author Biography

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Dr MM Keetse: Supervision of the study, revision of the manuscript's intellectual content, and approval of the submitted version
Dr. A. Naidoo: Co-supervision of the study. Contribution to concept, design, and protocol of study. Revision of the manuscript and approval of the submitted version.
Dr PH Maré: Conception, design, and protocol of the study
Dr PD Rollinson: Conception, design, and protocol of the study
Dr NS Ndimande: data collection

Data Availability:

The data supporting this study are available from the primary investigator upon request. Patient identity will, however, not be made available due to patient confidentiality regulations.

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