

Research Article

Comparative Study of Two Malaria Diagnostic Techniques in the Context of Transfusion Safety in Blood Donors at the Yaoundé University Hospital

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Abstract

Malaria is a disease caused by parasites of the genus *Plasmodium*. Screening is not systematic in blood banks although malaria is endemic in Africa and mainly in Cameroon. The reference diagnostic test for malaria is the thick smear but its performance is complex. More suitable tests for screening malaria in blood banks have been proposed including rapid diagnostic tests (RDT) and thick smear drop. This study aimed to evaluate the performance of rapid diagnostic tests (RDTs) in comparison with thick smear (TS) using thick smear as the reference test. This comparative, descriptive, prospective cross-sectional study took place from January 6, 2023 to June 29, 2023, a period of 6 months at the Yaoundé University Hospital. The target population consisted of volunteer and family blood donors from this hospital who met the selection criteria set by the blood bank. Two hundred volunteers donors were included in the study. The SD Bioline malaria Ag p. f/pan RDT Kit and the Malaria Ag P. f/pan RDT Kit were used to perform the immunochromatographic tests and microscopy was used to read the thick smear and stained smears. The prevalence of asymptomatic malaria carriage in blood donors was 39.5%. *Plasmodium falciparum* was the most prevalent species (97.5%) followed by *Plasmodium malariae* (2.5%), almost half of the donors had parasitemia greater than 200 parasites/ μ L. The factor that was significantly associated with parasitemia was the absence of use of long-lasting insecticide-treated net (LLIN). Compared with the thick smear as the reference test, both RDTs had a sensitivity of 49.4% and a specificity of 95.06%. The positive predictive value was 84.8% and the negative predictive value 50.6%. The results of this study show that the prevalence of asymptomatic carriage of plasmodium in voluntary blood donors was high, thus constituting a

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significant risk of transmission of the parasite to recipients often in poor general condition. The thick smear remains the gold standard for the reference technique in the diagnosis of malaria.

Keywords

Malaria, Blood Transfusion, Blood Donation, Thick Smear, RDTs

1. Introduction

Malaria is a disease caused by parasites of the genus *Plasmodium*. It is a parasitic protozoan where humans are a reservoir and an intermediate host [1, 2]. It occurs following a bite from a female mosquito of the genus *Anopheles* which is the vector agent and definitive host of malaria [3, 4]. The different species of *Plasmodium* that can infest are: *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium falciparum* which is the most deadly and widespread species [5]. The endemic nature of malaria in Africa and mainly in Cameroon has led to an increase in the proportion of blood donors who have been in contact with the parasite, however it is not systematically screened in blood banks [6, 7]. Blood transfusion saves lives and reduces the morbidity of many medical and surgical conditions, but it is not without danger [8]. There are various risks associated with transfusions of labile blood products, including an immunological risk and an infectious risk. Thus, blood transfusion remains the third route of transmission of the parasite responsible for malaria [9].

The general objective of this work is to compare the performance of 2 rapid diagnostic tests (RDT) with no significant difference and the thick smear (TS) in the biological diagnosis of malaria in blood donors using the thick smear as a reference test, in order to contribute to the transfusion safety of blood bags received in blood banks in Cameroon.

Materials and Methods

Type of study:

This was a comparative, cross-sectional, descriptive study with a prospective aim.

Study period:

This study took place over a period from January 6, 2023 to June 29, 2023, or approximately 6 months.

Study site:

The Yaoundé University Hospital Center (YUHC) is one of the main hospitals in the city of Yaoundé. It was founded by presidential decree on October 28, 1965. It is located in the Melen district and is an integral part of the Faculty of Medicine and Biomedical Sciences of Yaoundé. It includes a multitude of services including the hematology laboratory and the blood bank which will partially constitute our place of study.

Population:

1) Target

Voluntary and family blood donors from the Yaoundé University Hospital Center who meet the selection criteria

established by the blood bank.

2) Inclusion criteria

Donors who meet the conditions required for blood donation and have given their consent to the study.

3) Exclusion criteria

Donors who withdrew their consent during the study as well as slides whose reading showed discrepancies between the 3 technicians.

4) Data collection procedure

Data collection was carried out in the hematology and blood bank department of the Yaoundé University Hospital in order to meet blood donors. Each donor was explained the importance and purpose of the study, the conduct of the study and its advantages. A form including informed consent and the questionnaire was given to the donor. If the donor agreed to participate in the study, he signed the consent form. The thick smear was considered the reference test. First, we collected the blood bags in the EDTA tubes, then we performed a thick smear on each donor consenting to the study and finally performed a RDT. The smear and thick smear slides were performed and approved by 03 technicians. The rest of the samples were stored in the refrigerator (LIEBHER, N1X13KK2) between 2 and 8 °C.

Results

2. Sociodemographic Data

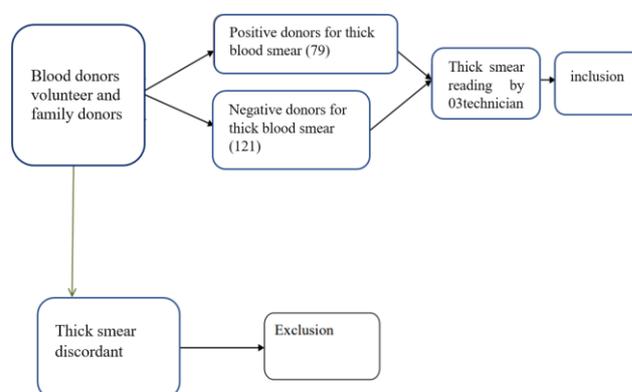


Figure 1. Study flow chart.

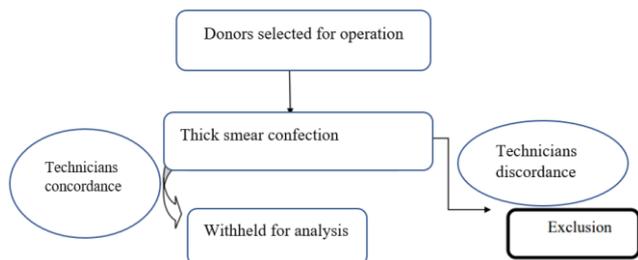


Figure 2. TS slide selection.

2.1. General Description of the Study Population

2.1.1. Distribution by Age

200 donors took part in this study, ages ranged from 18 to 62 years with an average age of 27 years and a median of 25 years. Those over 25 years represented 52.2% and those under 25 represented 47.8%.

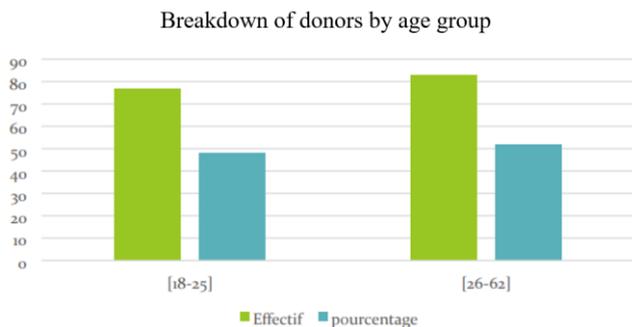


Figure 3. Distribution of donors by age.

2.1.2. Distribution by Gender

Male donors outnumbered female donors, 169/200 (84.5%, 95% CI) males versus 31/200 (15.5%, 95% CI) females. The M/F sex ratio was 5.4.

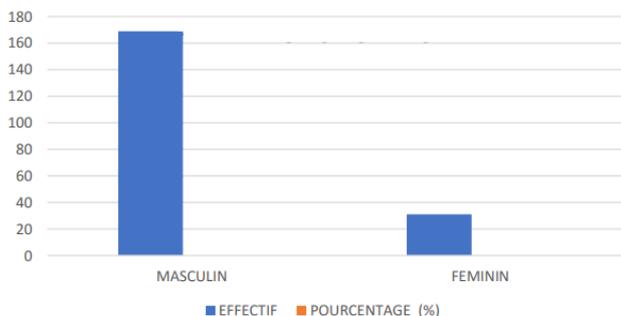


Figure 4. Distribution of donors by gender.

2.1.3. Depending on the Region of Origin

The Central and Western regions were the most represented,

representing 35.2% and 32.9% of the donor population respectively.

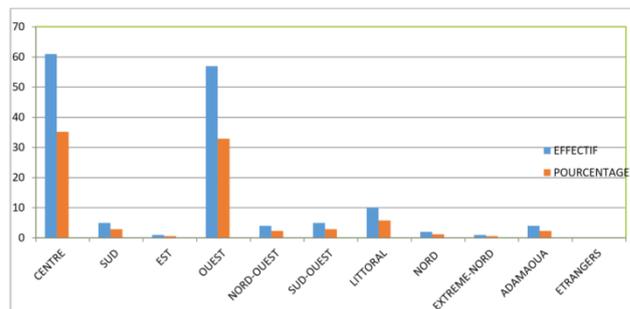


Figure 5. Distribution of donors by region of origin.

2.2. Sociodemographic Profile of Blood Donors Carrying Malaria According to Microscopy

No relationship was found between age, gender, type of donation and thick smear positivity. However, significance was found between LLIN use and thick smear. Indeed, those who sleep under LLIN have a lower risk of having a positive GE. Chi-2 = 5.747; p = 0.017; OR = 0.444.

Table 1. Variation of parasitemia in 79 donors positive for thick smear.

Parasites/ μ L	Frequency	Percentage (%)
[80-200]	40/79	50.63
[201-500]	33/79	41,8
[501-5000]	6/79	7.5

The search for plasmodium by thick smear in 200 donors revealed a positivity rate of 79, hence a prevalence of 39.5%, and a negativity rate of 121, hence a prevalence of 60.5%.

Table 2. Plasmodial species identified.

Species	Infected Donors	Percentage
P.falciparum	77	97.46
P.malariae	2	2,53
Total	79	100

In this study, we were able to observe 2 types of plasmodium, namely plasmodium falciparum and plasmodium malariae.

Table 3. Performance of RDT compared to thick smear.

Diagnostic Tests	Microscopy		Total
	Positive TS (n=79)	Negative TS (n=121)	
Positive RDT	39	81	120
Negative RDT	40	40	80
Total	79	121	200

The study involved 200 donors, including 79 thick-smear positive donors and 121 thick-smear negative donors; out of the 121 thick-smear negative donors, we obtained 81 RDT positives and 40 RDT negatives.

Of the 200 volunteer donors, 79 were positive for TS 39.5%; of the 79 donors positive for TS, we obtained 39 positive for RDT i.e. 66.95%, and 40 negative RDT, i.e. 33.05%; of the 200 volunteer donors, we had 121 donors negative for TS, i.e. 60.5%; of these 121 donors negative for TS, we obtained 81 positive RDT, i.e. 66.9%, and 40 negative RDT, i.e. 33.1%.

3. Intrinsic Characteristics of RDT

Table 4. Intrinsic characteristics of RDT.

Settings	RDT% (IC)
Sensitivity	49.4 (38,4-60,4)
Specificity	95.06 (85,8-97,6)
Positive predictive value PPV	84.8 (74,4-95,2)
Negative predictive value NPV.	50.62 (43,8-59,2)

Kappa coefficient = 0,466; $p < 0,001$ (moderate and significant agreement)

A statistically significant difference was observed between RDT positivity and malaria access in the last 3 months. Indeed, those who have malaria in the last 3 months have a high probability of having a positive RDT. (Chi-2 = 10,228; OR= 6,203; IC = 1,801-21,357).

4. Discussion

Our study involved 200 blood donors collected from the blood banks of the Yaoundé University Hospital, of whom 79 tested positive by thick smear and 121 negative, 81 positive by RDT.

This study focused on the comparison of two malaria diagnostic techniques in the context of transfusion safety in blood donors with the SD Bioline malaria RDT, the Malaria

Ag P.f/pan RDT and the thick smear as the reference test. This study showed that out of 200 donors, 79 were positive for the thick smear, giving a prevalence of 39.5% and 121 negative with a prevalence of 60.5%.

Of the 121 donors negative for thick smear, 81 donors were positive for RDT, a prevalence of 66.9% and 40 donors were negative, a prevalence of 33.05%. Males were the most represented, with a male/female ratio of 5.72 for parasitized donors. Previous studies also show a male predominance among blood donors in Africa [10]. This difference can be explained by the fact that there are many contraindications to blood donation, including menstruation, pregnancy, and breastfeeding. The age of the donors was between 18 and 62 years with an average age of 27 years and the majority of donors were over 25 years (48.6%). This significant trend in the young population could be reflected in the fact that the structure of the African population is predominantly young [11].

There is no significant difference between thick smear positivity and sex or age. This is in close line with a study conducted in Buea, Cameroon [12]. Family donors and volunteer donors represented 26% and 63.6%, respectively, data different from those reported in Gabon [13] but close to those reported in two studies in the DRC [14]. The high presence of volunteer donors in our context could be explained by the fact that the YUHC is located within the University of Yaoundé I because students represented 52% of donors. One of the factors that was significantly associated with parasitaemia was the non-use of LLINs. Indeed, those who slept under a mosquito net were less likely to have a positive thick smear. A finding that was also highlighted by Bassandja et al, 2014 [15], who mentioned in his study that the factors associated with parasitaemia were young age, first donation, non-use of MIILDA. Plasmodium falciparum was the most widespread species (97.46%) as in the study conducted in Benin where P.falciparum represented 89.9% [16], in the Democratic Republic of the Congo where represented 96.3% [17].

Limitations: The limitations of this study were related to the fact that by taking the thick smear on gold standard, we assumed from the outset that the results of this test always agree with reality (absence or presence of malaria), it would then be a perfect test with a sensitivity and specificity of 100%.

5. Conclusion

In summary, the aim was to compare the performance of thick smear (TS) and a rapid diagnostic test (RDT) in the biological diagnosis of malaria in blood donors using BG as the reference test.

Thus, it appears that out of 200 participants there were mainly men, namely 169 and 31 women, according to an age group ranging from 18 to 62 years with a population mainly from the center and the west, i.e. 35.2% and 32.9%. The prevalence of blood bags contaminated with plasmodium is 39.5%. The RDT having a sensitivity of 49.4% and a specificity of 95.06%, TS remains the gold standard for the refer-

ence technique in the diagnosis of malaria.

Abbreviations

TS	Thick Smear
RDT	Rapid Diagnostic Test
MILDA	Long-Lasting Impregnated Mosquito Net
YUHC	Yaoundé University Hospital Center
HIMT	Higher Institute of Medical Technology
EDTA	Ethyl diamine Tetra Acetyl
PPV	Positive Predictive Value
PNV	Negative Predictive Value

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Author Contributions

Généviève Danièle Ongok Ongonekal: Conceptualization, Methodology, Project administration, Validation, Writing – review & editing

Cédric Gueguim: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing

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Carole Christèle Egono Ndeme: Conceptualization, Methodology, Software, Writing – original draft

Evrard Mvele Mvomo: Conceptualization, Methodology, Software, Writing – original draft

Mariama Kaba Cherif: Conceptualization, Formal Analysis, Investigation, Project administration, Validation

Magloire Biwole Sida: Conceptualization, Formal Analysis, Investigation, Project administration, Validation

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Conflicts of Interest

The authors declare no conflicts of interest.

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