

ORIGINAL RESEARCH

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Prostate volume and its relationship with anthropometric variables among different ethnic groups of South-Kivu, DR Congo

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Abstract

Background: The prevalence of benign prostate hyperplasia (BPH) varies among individuals from different races or ethnic groups. South-Kivu province (DR Congo) has several morphologically different ethnic groups. Our aim was to compare prostate volume and assess its possible association with specific anthropometric measurements among major ethnic groups.

Methods: This is a cross-sectional study of male subjects, ≥ 40 year old, enrolled in 10 different sites of South-Kivu allowing both easy access and ethnic diversity. We compared urological features, anthropometric parameters, and body fat composition among 979 subjects who met study criteria: Shi ($n: 233$), Lega ($n: 212$), Havu ($n: 204$), Bembe–Fuliru ($n: 172$), and minority ethnic groups ($n: 158$).

Results: Prostate volume was statistically different among ethnic groups. Median (interquartile range) size of prostate gland was significantly larger in Lega: 55 (38–81) cc, and smaller in Havu, 20 (17, 24) cc; $p < 0.001$. Overall, an enlarged prostate (≥ 30 cc) was documented in 91% of Lega men, in 59% of intermediate class men (Shi, Bembe–Fuliru, others), and in a mere 11% of Havu men. In multivariate analysis, prostate volume was significantly associated with age ($p < 0.001$), ethnic group ($p < 0.001$), residence ($p: 0.046$), and fasting blood glucose ($p: 0.001$). Conversely, prostate volume was neither associated with anthropometric parameters, nor with body fat composition.

Conclusion: Prostatic size varies widely among men from different ethnic origins in South-Kivu. Different genetic determinants and cellular composition of prostatic gland could represent risk factors that need to be examined in forthcoming studies.

Keywords: Prostate volume, Ethnic groups, Anthropometric parameters, Body fat, South-Kivu

1 Background

Prostate volume is modulated by numerous factors, the best documented being aging and androgen levels [1]. The prevalence of benign prostate hyperplasia (BPH) varies widely among individuals from different races or ethnicities [2].

However, most of the available literature describes separately associations between BPH and anthropometrics [3–5], or ethnicity [2, 6, 7].

Genetic and parental factors, cellular prostatic composition, socioeconomic status, and dietary habits vary considerably among different ethnic groups and are considered as additional risk factors for prostate enlargement [6–14].

The province of South-Kivu (DR Congo) is inhabited by many ethnic groups that differ in sociocultural as well as anthropo-morphological and geographical parameters [15–20].

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This study aimed to compare the prostatic volume in major representative ethnic groups of South-Kivu and assess its possible association with anthropometric parameters and body fat composition to document candidate risk factors for prostate enlargement specific to that area.

2 Methods

2.1 Study population

South-Kivu province has 13 major ethnic groups among which the most numerically important are the Shi, Lega, Havu, Fuliru, and Bembe. These groups differ by culture, dietary habits, geographical location, and morphological characteristics [15–22].

2.2 Data collection

The screening team visited 10 different sites given their ease of access, security, and ethnic diversity. Advertisement for the prostate screening project was made on local radios, using posters, and during worship ceremonies in churches, with announcements made by officiants 6 weeks prior to data gathering.

The recruitment of participants was based on opportunity sampling. Men ≥ 40 years of age were offered free prostatic screening, research team members having settled in major local urban hospitals and stayed for at least three days at each center.

The language used in the field was Swahili, since it is the commonest language in this part of Eastern DR Congo. Trained physician examiners used a structured questionnaire to gather ethno-tribal data, as well as medical history collection, urological scores [International Prostate Symptom Score (IPSS), quality of life score (QOL)], and duration of urological symptoms.

The French versions of the IPSS and QOL scores were translated into Swahili by a panel of professional translators. The translated versions were successively tested on an arbitrary sample of 50 subjects to ensure a good understanding of the different points addressed.

Fasting blood was collected, and each participant had a clinical examination, including blood pressure measurement, anthropometric parameters (body weight, height, and waist circumference), and body fat composition (fat mass, visceral fat) using a bioelectrical tetrapodal body fat analyzer OMRON BF 508 impedance meter. The fat mass categorization and visceral fat scale were provided in the manufacturer's manual.

The conicity index (CI), which evaluates the statural distribution of body fat, was calculated using the Valdez formula [23, 24]:

$$CI = \frac{WC}{0.109 \times \sqrt{W/H}}$$

WC = waist circumference (m); W weight (kg); H height (m); 0.109: constant.

A cutoff of 1.25 was used to classify CI into normal and high categories [24].

Urological features of BPH were assessed from lower urinary tract symptoms severity, peak flow rates at uroflowmetry, post-voiding residual (PVR) urine volume measured by suprapubic ultrasonography, and prostate volume (PV) estimated by pelvic ultrasonography.

Men with a prostate volume ≥ 30 cc were considered to have an enlarged gland [25–27]. The prostate volume was categorized as follows: <30 cc (normal volume), 30–60 cc (moderately high volume), and >60 cc (very high volume).

Subjects with a medical history of prostate surgery, ongoing medication(s) for BPH, prostate abnormality on digital rectal examination (DRE), and/or pelvic ultrasonography, suggesting prostate cancer or prostatitis, were excluded from the study.

2.3 Statistical analyses

Statistical analyses were carried on using Stata 14. Categorical data were summarized into frequencies and proportions. The distribution of continuous data was assessed graphically and statistically. Normally distributed data are reported as means with standard deviations (SD), while medians with interquartile ranges (IQR) were used for reporting non-Gaussian data.

The bivariable association between dependent and independent variables was examined using analysis of variance (ANOVA) for Gaussian data. When assumptions of normality or equality of variances were not met, a Kruskal–Wallis rank test was used. Variables were selected in the multivariable regression model based either on a p value below ≤ 0.2 and/or on biological plausibility. We report the β -coefficients (average expected mean differences) with 95% confidence intervals (CIs) as measure of association. The significance level for all the analyses was set to an α type 1 error value $< 5\%$.

2.4 Ethics

Informed consent was obtained from each participant, and the study protocol was approved by the local ethical committee.

3 Results

Data were obtained from 979 subjects from five ethnic groups. There was no significant difference regarding age between ethnicities. However, prostatic volume was statistically different among ethnic groups. Average

prostate gland size was significantly larger in Lega men, and smaller in Havu men. Urological features of the studied population are listed in Table 1.

Obesity markers including waist circumference, BMI, body fat, and visceral fat were significantly higher in Bembe–Fuliru men, whereas metabolic correlates of BPH (conicity index and fasting glucose) were significantly higher in Lega men. There was no statistical difference in blood pressure between groups (Table 2).

About prostatic volume, Lega and Havu men showed the greatest ethnic difference, and the other ethnic groups were intermediate in size.

Thus, 91% of Lega men, 59% of subjects from intermediate ethnicities, and 11% of Havu men had an enlarged prostate.

In addition, among BPH subjects (prostatic volume ≥ 30 cc) younger than 60 years ($n = 184$), Lega men amounted to 71 (39%) versus 9 (5%) among Havu men (Table 3).

In unadjusted analysis, prostate volume was associated with age, ethnic group, place of residence, conicity index, BMI, waist circumference, visceral fat, fasting blood glucose, and quality of life score.

However, following adjustment, age, ethnic group, place of residence, and fasting blood glucose were significantly associated with prostatic volume (Table 4).

4 Discussion

In this population-based study, we assessed the interrelationships between anthropometric parameters, including body composition, with prostate volume in major ethnic groups of South-Kivu.

Among these groups, the Shi ethnonym [15, 18, 21, 22] concerns the major ethnic group in the province. They are in the center and the western part of the province. The works of Hiernaux [15] in 1953 noted an average height of 163, 5 cm among male adult Shi individuals. Their habitual diet is varied.

The Lega [17, 19] is the second largest group; they live in the southwestern part of the province [19].

The Lega are constitutively of smaller height: 160, 4 cm according to the data of Hiernaux in 1953 [15, 17].

Their diet is saltier, meat-based, and richer in fat. Fish are eaten mostly as salty or smoked.

The Bembe and Fuliru live in Southern Kivu, on a territory neighboring Burundi. Their morphological characteristics are like those of Burundian Hutu. By extrapolation, their average height would approach 165, 9 cm according to Hiernaux's data [16, 17].

Their diet is characterized by low fat and animal proteins intakes and a high proportion of carbohydrates and vegetable proteins, akin to their counterparts in Burundi.

The Havu [16, 20, 21] live in north of the province, mainly along the shores of Lake Kivu and on Idjwi Island.

Table 1 Urological features

Parameter	All population	SHI	LEGA	HAVU	BEMBE–Fuliru	Others	<i>p</i> value
AGE (years)	<i>n</i> : 979 61.12 ± 10.7	<i>n</i> : 233 61.9 ± 11.06	<i>n</i> : 212 61.5 ± 9.8	<i>n</i> : 204 60.5 ± 10.8	<i>n</i> : 172 60.6 ± 11.12	<i>n</i> : 158 60.8 ± 10.4	.62 ^a
Duration of symptoms (years)	<i>n</i> : 979 2 (1, 5)	<i>n</i> : 233 2 (1, 5)	<i>n</i> : 212 2 (1, 4)	<i>n</i> : 203 2 (1, 5)	<i>n</i> : 172 2 (1, 5)	<i>n</i> : 157	.39
IPSS	<i>n</i> : 979	<i>n</i> : 233	<i>n</i> : 212	<i>n</i> : 204	<i>n</i> : 172	<i>n</i> : 158	.043
(0–35)	15 (5, 24)	19 (7, 27)	15 (5, 25)	15 (5, 22)	14 (8, 20)	15 (5, 25)	
QOL score	<i>n</i> : 979	<i>n</i> : 233	<i>n</i> : 212	<i>n</i> : 204	<i>n</i> : 172	<i>n</i> : 158	.0543
(1–7)	5 (2, 6)	6 (2, 7)	5 (2, 6)	5 (2, 6)	5 (2, 6)	5 (2, 6)	
IIEF score	<i>n</i> : 971	<i>n</i> : 233	<i>n</i> : 209	<i>n</i> : 200	<i>n</i> : 172	<i>n</i> : 157	.85
(0–25)	17 (10, 23)	16 (10, 23)	16 (10, 25)	17 (11, 25)	15 (14, 20)	18 (11, 23)	
QMAX (mL/s)	<i>n</i> : 979 14 (8.9, 19.8)	<i>n</i> : 233 14.3 (8.5, 21.6)	<i>n</i> : 212 10.7 (7.4, 16.8)	<i>n</i> : 204 15.35 (10.05, 22.3)	<i>n</i> : 172 14.7 (10.85, 19.8)	<i>n</i> : 158 14.79 (9, 20.1)	<.001
Micturition duration (Sec)	<i>n</i> : 959 17.2 (12.8, 24.5)	<i>n</i> : 229 16.6 (12.8, 22.9)	<i>n</i> : 204 16.55 (12.5, 23.4)	<i>n</i> : 200 16.45 (12.55, 23.7)	<i>n</i> : 169 19.1 (14, 27.2)	<i>n</i> : 157 18 (13, 24.3)	.076
PVR (mL)	<i>n</i> : 958 5 (5, 12)	<i>n</i> : 228 5 (5, 17)	<i>n</i> : 204 5 (5, 5)	<i>n</i> : 200 5 (5, 5)	<i>n</i> : 169 5 (5, 16)	<i>n</i> : 157 5 (5, 15)	<.001
Prostate volume (cc)	<i>n</i> : 979 32 (22, 49)	<i>n</i> : 233 33 (24, 46)	<i>n</i> : 212 55 (38, 81)	<i>n</i> : 204 20 (17, 24)	<i>n</i> : 172 30 (23, 42)	<i>n</i> : 158 34 (24, 52)	<.001

^a Comparison was done using ANOVA

IPSS International Prostate Symptoms Score (0–35), QOL score quality of life score (1–7), IIEF score International Index of Erectile Function Score (0–25), QMAX peak uroflowmetry (mL/s), PVR post-voiding residual (mL)

Table 2 Anthropometric parameters and metabolic correlates of BPH

Parameter	All population	SHI	LEGA	HAVU	BEMBE-Fuliru	Other	p value
Weight (kg)	n:979 58.17 ± 11.35	n: 233 57.9 ± 12.53	n: 212 55.94 ± 10.17	n: 204 56.73 ± 9.39	n: 172 61.68 ± 12.77	n: 158 59.59 ± 10.68	<.001 ^a
Height (m)	n: 979 1.62 (1.57, 1.67)	n: 233 1.63 (1.6, 1.67)	n: 212 1.59 (1.54, 1.62)	n: 204 1.62 (1.57, 1.66)	n: 172 1.64 (1.59, 1.69)	n: 158 1.63 (1.58, 1.68)	<.001
WC (cm)	n: 979 82.73 ± 11.08	n: 233 83.17 ± 12.58	n: 212 80.89 ± 10.34	n: 204 80.93 ± 8.56	n: 172 86.18 ± 12.21	n: 158 83.08 ± 10.4	<.001 ^a
BMI (kg/m ²)	n: 979 22.26 ± 3.76	n: 233 21.86 ± 4.19	n: 212 22.20 ± 3.57	n: 204 21.75 ± 3.03	n: 172 23.11 ± 4.23	n: 158 22.65 ± 3.5	.0011 ^a
Conicity index	n: 979 1.26 (1.20, 1.32)	n: 233 1.29 (1.23, 1.35)	n: 212 1.29 (1.24, 1.36)	n: 204 1.26 (1.20, 1.32)	n: 172 1.22 (1.18, 1.28)	n: 158 1.21 (1.18, 1.27)	<.001
Systolic BP (mm Hg)	n: 979 139.97 ± 25.03	n: 233 136.94 ± 24.29	n: 212 140.43 ± 26.64	n: 204 142.64 ± 25.48	n: 172 142.9 ± 24.52	n: 158 137.11 ± 23.29	.42 ^a
Diastolic BP (mm Hg)	n: 979 84.59 ± 14.90	n: 233 83.93 ± 14.82	n: 212 85.56 ± 15.43	n: 204 84.58 ± 16.32	n: 172 84.94 ± 13.05	n: 158 83.87 ± 14.35	.85 ^a
FBG (mg/dL)	n: 979 92.68 ± 12.64	n: 233 92.13 ± 12.92	n: 212 98.16 ± 12.55	n: 204 91.11 ± 10.32	n: 172 89.42 ± 11.32	n: 158 91.7 ± 14.22	<.001 ^a
BODY FAT (%)	n: 979 14.3 (10, 20.4)	n: 233 12.4 (10, 20.2)	n: 212 12.95 (10, 18.3)	n: 204 14 (10, 18.4)	n: 172 17.8 (11, 24.05)	n: 158 15.6 (10, 20.7)	<.001
VFS (0-30)	n: 979 5 (4,8)	n: 233 5 (4,9)	n: 212 5 (4,8)	n: 204 5 (4,8)	n: 172 7 (5,10)	n: 158 6 (4,8)	<.001

^a Comparison was done using ANOVA

WC Waist circumference (cm), BMI Body mass index (kg/m²), Systolic BP systolic blood pressure (mm Hg), Diastolic BP diastolic blood pressure (mm Hg), FBG fasting blood glucose (mg/dL), VFS visceral fat score (0–30 scale)

Table 3 Prostate volume by ethnic origin

Ethnic group	Prostate volume			Total
	Normal (< 30 cc)	Moderately high (30–60 cc)	Very high (> 60 cc)	
Havu	183 (89.71%)	21 (10.89%)	0 (0%)	204 (20.84)
Intermediate group*	231 (41.03%)	267 (47.42%)	65 (11.55%)	563 (57.51)
Lega	21 (9.91%)	95 (44.81%)	96 (45.28%)	212 (21.65)
p value				<.001

*Shi, Bembe, Fuliru, and other ethnic groups

They are morphologically like Rwandan Tutsi, whose history they share. By nature, Havu individuals are taller; by extrapolation, average height of 176, 5 cm would correspond to that of Rwandan Tutsi.

Their diet is enriched in fresh fish and dairy products. Cattle are a sign of wealth, thus intended for sale or prestige, and livestock is rarely used for meat consumption.

Other tribal groups have intermediate characteristics to these majority groups.

Interethnic marriages produce individuals whose morphological characteristics are the result of those of the two parents, whereas they inherit the paternal ethnonym and accordingly patrilineal sociocultural traits.

This study highlighted a significant variability of prostate volume among South-Kivu ethnic groups regardless of anthropometric parameters and body composition (Tables 1 and 2). In addition, increased prostatic volume was independently associated with ethno-geographic origin (Table 4), confirming previous reports [5, 6, 13, 28].

Among Lega men, prostate volume was significantly larger than in other ethnic groups. Conversely, among Havu men, prostate volume was significantly smaller than in other groups. It was unusual to measure prostate sizes < 30 cc among Lega subjects, and > 20 cc among Havu subjects (Table 3).

Table 4 Bivariate and multivariate analyses of the association between ethnic groups and prostate volume

Variable	Unadjusted mean difference (95% CI)	p value	Adjusted mean difference (95% CI)	p value
Ethnic group				
Havu	Ref.		Ref.	
Intermediate group*	16.14 (14.37, 17.90)	<.001	12.42 (9.96, 14.88)	<.001
Lega	44.46 (39.50, 49.42)	<.001	41.52 (37.09, 45.94)	<.001
Age				
< 60 years	Ref.		Ref.	
≥ 60 years	11.14 (7.92, 14.35)	.002	8.99 (6.37, 11.61)	<.001
Residence				
Rural	Ref.		Ref.	
Urban	8.62 (4.35, 12.90)	<.001	6.69 (2.49, 10.89)	.002
Conicity index				
Normal (< 1.25)	Ref.		Ref.	
High (≥ 1.25)	5.07 (1.72, 8.41)	.003	.711 (-.82, .24)	.363
BMI (kg/m ²)				
Normal	Ref.		Ref.	
Underweight	- 1.70 (- 6.71, 3.30)	<.001	- 3.22 (- 7.41, 0.97)	.132
Overweight/obese	8.54 (4.10, 12.98)	.504	5.59 (- .64, 11.83)	.079
WC (cm)				
Normal (< 94 cm)	Ref.		Ref.	
High (≥ 94 cm)	10.73 (5.93, 15.53)	<.001	1.65 (- 3.68, 6.98)	.54
FBG (mg/dL)				
< 100	Ref.		Ref.	
≥ 100	11.11 (5.81, 16.41)	<.001	6.08 (1.68, 10.47)	.007

BMI body mass index (kg/m²), WC Waist circumference (cm), FBG fasting blood glucose (mg/dL)

*Shi, Bembe, Fuliru, and other ethnic groups

As noted by Colon et al. [6], genetic variations between patients of different ethnicities represent additional modulators for the development of BPH.

Several genetic factors putatively involved in the development of BPH have been extensively studied. One of them is related to androgen receptor cytosin adenosin Guanidin (CAG) repeats [8, 10]. The frequency of CAG repeats in the androgen receptor (AR) gene was hypothesized to contribute to BPH incidence. In addition, Mitsumori et al. [8] found an association between short CAG repeat length and larger prostatic gland. Further, altered gene expression was proposed in driving BPH [10]. Luo et al. [29] reported a subset of 76 genes consistently upregulated in BPH when compared to normal prostate tissue, while Stamey et al. [10] identified 22 genes. These genes are involved at various levels of cell proliferation and growth factors regulation [10].

Interestingly, BPH in men younger than 60 years was overrepresented among the Lega subgroup. Similarly, Patel and Parsons [30] noted that 50% of patients who underwent surgical treatment for BPH before 60 years of age had an inherited autosomal dominant form of the disease. In addition, these subjects had massively

enlarged prostate glands. A genetic cause will be considered even more than BPH occurs in younger patients (under 50 years) [12]. Pearson et al. [31] demonstrated that a strong familial history of early onset and marked prostate enlargement was more likely associated with risk inheritance rather than with symptom severity.

The genetic contribution to BPH is also revealed by cellular composition analysis of prostate cells and/or androgenic expression. Henderson et al. [7] noted a difference in the cellular composition of prostatic biopsies performed in the transition zone among populations from different origins, namely African-Americans, European-Americans, and Japanese. African-Americans had a higher stroma/epithelium ratio. Further, these authors observed variability in dihydrotestosterone (DHT) concentration among subjects of different races. We hypothesize that racial differences in cellular composition of the prostate and DHT concentration could be at play in the variation of prostate parameters among different ethnic groups in the present study.

Conversely, no study has yet been able to demonstrate a protective influence of one or more genes. A study of Mehta and Vezina [32] highlighted the

potential protective role of aryl hydrocarbon receptor (AHR) signaling in delaying the onset of BPH. They reported the putative mechanisms by which AHR-signaling activation interferes with pathological processes involved in driving BPH.

Similarly, the smaller prostate volume found among Havu subjects in the present study suggests the existence of ethnically derived and likely genetic intrinsic protective factor(s) to prostate enlargement.

Lifestyle and dietary habits contribute substantially to BPH pathogenesis [33]. Lega peoples are used to consume a fattier and saltier diet, with high amount of red meat, considered as driving up the odds for BPH. Espinosa [14] suggested that dietary patterns associated with increased risks of BPH include high consumption of starch and red meat. Parsons [34] also suggested that meat and fat consumption were associated with increased odds of BPH. Wang et al. [13] demonstrated the role of diet on difference in prostatic characteristics between Mongolians and Han Chinese. They observed that Mongolian men had a significantly greater consumption of meat, and consequently a higher incidence of intraprostatic chronic inflammation and intraglandular calcification than Han men.

Conversely, Havu subjects live along Lake Kivu and on Idjwi Island. This ethnic group has a high consumption of fresh fish, vegetables, and pulses. They also raise cattle for sale. Vegetables and fruits are known to have protective effects against prostate enlargement. Cold sea fish are also rich in polyunsaturated fatty acids (PUFAs), which also have a beneficial effect on BPH [35, 36]. We did not assess the amount of PUFAs provided by traditional fishing in the Great African lakes region.

Despite less healthy dietary habits, Lega subjects did not exhibit higher prevalence of obesity markers or body fat, and the anthropometric parameters (height, weight, BMI, waist circumference) and body composition (total fat and visceral fat) were not higher in the Lega group but in the intermediate group consisting of Bembe and Fuliru men (Table 2). Further, none of these parameters were associated with prostate volume in multivariable analyses.

Even though cultural characteristics are more prevalent in rural areas, differences in prostate volume between the two extreme groups (Lega and Havu) were consistent across rural and urban areas.

We consider that either individuals conserved their dietary habits wherever they live or genetics have more influence than dietary variables on determining prostate volume.

4.1 Study limitations

This survey has several obvious and theoretical limitations. One is the genetic mixing of populations from

interethnic marriages which may produce offspring with intermediate ethnic characteristics. Another is the lack of prostate biopsies to rule out undiagnosed prostate cancer and/or analyze prostatic cellular distribution.

5 Conclusion

Our data provide clear evidence of considerable interethnic variability in prostatic size among men living in South-Kivu. Further, prostate volume was neither associated with anthropometric parameters nor with body fat composition. Thus, genetics and adverse modulators of cellular composition of the prostatic gland are candidate risk factors that need further investigation as to their potential role in the pathogenesis of BPH in sub-Saharan Africa.

Abbreviations

AHR: aryl hydrocarbon receptor; AR: androgen receptor; BMI: body mass index; BP: blood pressure; BPH: benign prostate hyperplasia; CAG: cytosin adenosin Guanidin; CI: conicity index; DHT: dihydrotestosterone; DRE: digital rectal examination; FBG: fasting blood glucose; H: height; IIEF score: International Index of Erectile Function Score; IPSS: International Prostate Symptom Score; IQR: interquartile range; PUFAs: polyunsaturated fatty acids; PV: prostate volume; PVR: post-voiding residual; Qmax: peak uroflowmetry; QOL score: quality of life score; SD: standard deviation; VFS: visceral fat score; W: weight; WC: waist circumference.

Acknowledgements

The authors are grateful to the South-Kivu Provincial Health Division, and to the medical staff of host hospitals in Katana, Kalehe, Nyabibwe, Birava, Uvira, Walungu, Luhwinja, Kaziba, Bukavu, and Kamituga for helping to carry out this study.

Authors' contributions

LEM provided a substantial contribution to conception and design, acquisition of data, and drafting the article. MPH revised critically the manuscript. DC actively participated in documentary research, participants' follow-up, and data collection. LM actively participated in documentary research and data collection. EB performed statistical analyses and interpretation of data. BT assessed the manuscript and provided final approval of the version to be submitted. All authors read and approved the final manuscript.

Funding

This study was funded by research Grants from the "Société Belge d'Urologie" (SBU), and the Vlaamse Interuniversitaire Raad (VLIR).

Availability of data and materials

Supplementary data to this article are available and can be obtained if needed.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

The study was approved by the Catholic University of Bukavu Ethics and Research Committee (Reference: UCB/CIE/NC/002/2016). Each participant approved to participate in this study. At each step of the present study, confidentiality and anonymity rules were observed.

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Received: 13 February 2020 Accepted: 10 June 2020

Published online: 14 September 2020

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