An observational study of synchronous/metachronous tumours in microsatellite unstable/mismatch repair deficient endometrial carcinomas

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Objective: Microsatellite instability (MSI) is one of the genetic abnormalities underlying endometrial carcinoma, especially endometrioid endometrial carcinoma (EEC). Microsatellite unstable endometrial carcinomas may be associated with multiple primary malignancies. We aimed to document the incidence and type of associated tumours in MSI/mismatch repair deficient (MMR-d) endometrial carcinomas at a single institution in South Africa. Methods: The study assessed EECs for the period 2009–2015 at a Johannesburg hospital and followed on previous research undertaken in our department in which 66/145 MSI/MMR-d EECs were identified using immunohistochemistry and polymerase chain reaction (PCR). After ethical clearance was granted, using the microsatellite unstable/MMR-d endometrial carcinoma case-specific laboratory reference numbers, a retrospective search and cross-reference for associated histologically proven tumours, was performed. Results: Three patients (4.5%) out of 66 confirmed MSI/MMR-d endometrial carcinoma cases had associated tumours, including an invasive squamous cell carcinoma of the cervix and mucinous breast carcinoma. One patient had two tumours, namely uterine leiomyosarcoma and rectal adenocarcinoma. The incidence of EEC patients with an associated tumour is significantly lower (p = 0.0045) than that documented in the United States of America (USA). Conclusion: Our study’s incidence of associated tumours in MSI/MMR-d endometrial carcinoma patients was significantly lower than studies from the USA. The associated tumours in our study included traditional Lynch syndrome tumours such as colon adenocarcinoma and demonstrated less commonly associated tumours, namely cervical adenocarcinoma and uterine leiomyosarcoma. These findings highlight the need for further research in our population to assess risk factors and the true incidence of Lynch syndrome-associated tumours.

Keywords
Lynch syndrome. Microsatellite instability. Endometrial carcinoma. South Africa. Metachronous tumours. Synchronous tumours

1. Introduction
According to the most recent GLOBOCAN 2020 database release, uterine carcinoma was the 16th most common cancer diagnosed worldwide [1]. In the USA, the American Cancer Society estimates a 7% incidence of uterine carcinoma in 2021 [2]. In 2018 the incidence of uterine cancer was 3.2% in sub-Saharan Africa [3]. According to the latest published statistics in South Africa, cancer of the uterine corpus had a similar incidence of 3.77% [4, 5].

Multiple primary malignancies are defined as the development of more than one tumour, synchronous or metachronous, in the same individual fulfilling specific criteria delineated by Warren and Gates [6, 7]. These criteria include: a malignancy must be confirmed histologically; and each tumour should be separate and not a metastasis from the other [7]. The International Association of Cancer Registries (IACR)/International Agency for Research on Cancer (IARC) guidelines recommend that a tumour is synchronous if occurring within six months after the first neoplasm, or is metachronous when occurring after six months [6]. The incidence and risk of patients with endometrial carcinoma developing other tumours is approximately 10% to 23% [8, 9]. With improved diagnostic and treatment modalities, patients may now survive longer, thus providing time for such patients to develop second or multiple tumours [10].

A genomic analysis performed by The Cancer Genome Atlas Research Network (TCGA) classified endometrial cancers into four molecular groups: copy-number low, copy-number high, POLE ultramutated and microsatellite instability hypermutated [11]. Microsatellite instability (MSI) is one of the genetic abnormalities underlying endometrial carcinoma, especially endometrioid endometrial carcinoma and is associated with inherited and sporadic endometrial carcinomas [12, 13]. It has been demonstrated that patients with POLE mutations have the best prognosis of the four categories, while those with MSI and copy-number low mutations have an intermediate prognosis and patients with p53 and copy-number high mutations have the poorest outcomes [11, 14]. MSI is present in up to 90% of endometrial carcinomas associated with the heritable Lynch syndrome and in approximately 30% of sporadic endometrial carcinomas [12]. Sporadic endometrial carcinomas are secondary to MLH1 promoter methylation via epigenetic silencing [13, 15].
Lynch syndrome is an autosomal dominant syndrome with germline mutation of DNA mismatch repair (MMR) genes resulting in a predisposition to multiple cancers, especially colorectal and endometrial tumours [16–18]. Endometrial carcinoma may be the first tumour diagnosed and may suggest underlying Lynch syndrome [19]. Endometrial carcinoma is associated with multiple primary malignancies such as cancers of the breast, ovary and most commonly, colorectum [8, 9, 13].

To the best of our knowledge, a study documenting tumours associated with microsatellite unstable endometrial carcinoma in South Africa has not been performed. The burden of these tumours on our population is currently unknown. We aimed to assess the incidence of tumours associated with MSI or MMR deficient, endometrial carcinomas at a single institution in South Africa.

2. Materials and methods

This study follows previous research undertaken in our department of Anatomical Pathology, on endometrioid endometrial carcinomas (EECs) [20]. As microsatellite instability is more frequently seen in association with endometrioid endometrial carcinomas than non-endometrioid subtypes, the study was limited to endometrioid endometrial carcinomas [20]. Previous research by Wadee and Grayson [20] identified a total of 66 mismatch repair deficient and/or microsatellite unstable EECs using immunohistochemistry and polymerase chain reaction (PCR) tests. Wadee and Grayson [20] considered a case to be mismatch repair deficient (MMR-d) if the tumour showed loss of nuclear staining of one or more of the MMR antibodies (MLH1, PMS2, MSH2 and MSH6). A case was identified as microsatellite unstable by PCR if one or more markers showed a difference in the size of the alleles [20]. A case was classified as MSI-H (microsatellite instability-high) if two or more markers showed dissimilarity in allele size, MSI-L (microsatellite instability-low) if one marker showed difference in allele size, and microsatellite stable (MSS) if none of the markers showed a difference in allele size [12]. The PCR markers used were NR-21, NR-24, NR-27, BAT-25 and BAT-26 [20].

These 66 EECs also underwent MLH1 promoter methylation analysis in the study by Wadee and Grayson [20]. Of the 66 endometrial carcinomas, 44 were methylated, 17 were not methylated and one did not have enough DNA to be tested. Four cases were not tested for MLH1 promoter methylation as they did not show loss of MLH1 immunohistochemical staining [20] (Fig. 1, Ref. [20]).

The EEC cases from 2009–2015 were from the Department of Anatomical Pathology, University of the Witwatersrand/National Health Laboratory Services (NHLS) at Charlotte Maxeke Johannesburg Academic Hospital which provides a pathology service to various hospitals and clinics in the southern Gauteng region.

After ethical clearance (certificate number: M190939) was granted, information was obtained from the LabTrak and DISA database of the NHLS using the microsatellite unstable/mismatch repair deficient proven endometrial carcinoma case-specific laboratory reference numbers. Information obtained from these reports was used to cross-reference other associated histologically proven primary tumours both before and after the endometrial carcinoma diagnosis. The following information was used to perform a retrospective search and cross-reference for associated histologically proven tumours: hospital number, name and surname, date of birth, laboratory case number and episode number.

When an associated tumour was identified, the pathology report was used to ascertain the type of tumour, site of the associated tumour and patient age at diagnosis of the associ-
ated tumour. The date of authorization or sign-out was used as the tumour diagnosis date to establish consistency as the procedure date is often not stated on the clinical request form. No personal identifiers were documented on the data collection sheet, thus ensuring patient anonymity. The slides of the identified associated tumours were retrieved, reviewed, and the diagnoses confirmed. Multicentric and metastatic tumours were excluded as per criteria delineated by Warren and Gates [6, 7].

To assess the difference in means of both the average age of patients with and without associated tumours and the average age of patients with methylated and unmethylated endometrial carcinomas, a two-tailed t-test was used. To determine any statistically significant differences between the proportion of associated tumours of our study and a previous study, a two-tailed Z-proportion test was used. A significance level of 5% was used.

In accordance with the journal’s guidelines, we will provide our data for the reproducibility of this study in other centers if such is required.

3. Results

Three patients (4.5%) out of 66 confirmed microsatellite unstable/mismatch repair deficient endometrioid endometrial carcinoma cases, had associated tumours. These tumours included an invasive, moderately to poorly differentiated, squamous cell carcinoma of the uterine cervix, uterine leiomyosarcoma, a mucin-producing rectal adenocarcinoma and a mucinous carcinoma of the breast (Fig. 2). One patient had two associated tumours, namely uterine leiomyosarcoma and rectal adenocarcinoma. Table 1 shows that of the three endometrial carcinoma patients who had associated tumours, one patient’s tumour showed retention of all MMR proteins but had microsatellite instability in one of 5 PCR markers, while one patient’s tumour showed retention of all MMR proteins but had microsatellite instability in two of the 5 PCR markers; whereas the third patient’s tumour had loss of both MLH1 and PMS2 immunohistochemical markers and had microsatellite instability in one of the 5 PCR markers used [20]. Thus, only one patient had an MSI-High EEC while 2 patients had MSI-Low tumours, which are considered more similar to the MSS status than to the MSI-high status.

One patient developed a metachronous cervical squamous cell carcinoma, which was diagnosed on a cervical punch biopsy 12 months after the patient underwent a subtotal hysterectomy for endometrial carcinoma. The exact reason for a subtotal hysterectomy having been performed was not stated. The surgery was conducted by doctors who were not gynaecologic oncologists, as this was undertaken at a small district hospital. At the time of diagnosis of another patient’s endometrial carcinoma, an associated (synchronous) uterine leiomyosarcoma was simultaneously diagnosed. This patient was also diagnosed with a metachronous rectal adenocarcinoma 9 months after the diagnosis of EEC. The third patient in our cohort who had developed an associated tumour, was diagnosed with a synchronous mucinous breast carcinoma 1 month after her diagnosis of EEC (Table 1).

Table 2 shows that the average time between the diagnosis of endometrial carcinoma and other tumours was 7.33 months, with a median of 9 months. There was no significant statistical difference between the average age of those with, and those without a second/associated tumour (p = 0.244). The average age of patients without an associated tumour, at the time of diagnosis of their endometrial carcinoma was 66 years, while patients with endometrial carcinomas who developed associated tumours had an average age of 59 years at the time of their endometrial carcinoma diagnosis.

Table 3 shows that the average age of patients with methylated endometrial carcinomas, but no associated tumour (n = 43) was 65 years, while a single patient who had a methylated EEC and an associated tumour was 55 years of age when the endometrial carcinoma was diagnosed. Patients who had unmethylated endometrial carcinomas and no associated tumours (n = 16), had an average age of 67 years, whilst a single patient with an associated tumour and an unmethylated EEC was diagnosed with the EEC at 70 years of age. There was no significant statistical difference between the average age of those with methylated endometrial carcinomas and the average age of those with unmethylated tumours (p = 0.331). Of the three endometrial carcinoma patients who had associated primary tumours, one patient had MLH1 promoter methylation of the endometrial tumour while one patient’s EEC was unmethylated. The third patient’s tumour, unfortunately, did not have enough DNA available to undergo methylation analysis.

Based on earlier research performed in our department by Wadee and Grayson [20], 41 out of 145 cases had mismatch repair protein deficiency and 46 out of 145, had microsatellite instability detected by PCR. There was MMR-d/MSI discordance identified in 25 cases [20]. Of the 41 cases shown to have MMR protein deficiency, 20 cases showed both MLH1 and PMS2 loss, 2 cases had both MSH2 and MSH6 deficiency, 16 cases demonstrated isolated MLH1 loss, 2 had isolated MSH2 deficiency and a single case showed loss of 3 markers (MLH1, MSH6 and PMS2) [20].

We compared our current results in addition to results from the previous study in our department by Wadee and Grayson, to a study by Buttin et al. [20, 21]. We found a statistically significant (p = 0.0045) difference in the incidence of associated tumours between the present study and that of Buttin et al. [21] (Table 4, Ref. [20, 21]). Furthermore, Table 4 shows a statistically significant difference (p = 0.0000) in our patient cohort when comparing the proportion of MLH1 methylated endometrial carcinoma cases to MLH1 unmethylated cases. There was no significant statistical difference between the proportion of methylated and unmethylated cases in our patient cohort compared to Buttin et al. [21].
Fig. 2. Composite photomicrograph of various tumours. (A) Demonstrates a Haematoxylin and Eosin stained endometrioid endometrial carcinoma. (B) Shows an MLH1 immunohistochemical stain on the endometrioid endometrial carcinoma, in which lymphocytes and stromal cells have retained staining (two long thin arrows) while the tumour cells show loss of staining. (C) Demonstrates loss of PMS2 staining in tumour cells from the endometrial carcinoma with retention of staining of stromal cells and lymphocytes (two long thin arrows). (D) Demonstrates a mucinous breast carcinoma with tumour cells in pools of mucin (star). (E) Shows the rectal adenocarcinoma with mucin seen at the star. (F–G) Show the uterine leiomyosarcoma. An area of necrosis is identified (block arrow) and marked cellular atypia is shown (three long thin arrows) in (F). Two mitotic figures are seen (two long thin arrows) in (G). (H) Demonstrates an invasive moderately to poorly differentiated squamous cell carcinoma of the cervix. Surface dysplasia is noted (block arrows) and islands of tumour cells within the stroma are seen (two long, thin arrows). Original magnification: (A–C,F) × 200, (D–E,H) × 100 and (G) × 400.
Table 1. Clinicopathological characteristics of patients with associated synchronous or metachronous tumours.

| Patient's study assigned case number | Age of patient at diagnosis of endometrial carcinoma (years) | Age of patient at diagnosis of associated tumour (years) | Time between diagnosis of endometrial carcinoma and associated tumour (months) | Histopathological type of synchronous or metachronous tumour | MLH1 methylation status of endometrioid endometrial carcinoma | MMR protein expression and MSI status of endometrioid endometrial carcinoma |
|-------------------------------------|------------------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------|
| 11                                 | 70                                                        | 71                                                     | 12                                                                          | Invasive, moderately to poorly differentiated squamous cell carcinoma of the cervix (metachronous tumour) | Unmethylated                                                   | All 4 MMR markers retained (MSI-Low for 1/5 PCR markers)              |
| 22                                 | 53                                                        | 54                                                     | 9                                                                           | Rectal adenocarcinoma (metachronous tumour)                 | Not enough DNA to be tested                                   | All 4 MMR markers retained (MSI-High for 2/5 PCR markers)             |
| 50                                 | 55                                                        | 55                                                     | 1                                                                           | Uterine leiomyosarcoma (synchronous tumour)                | Hypermethylated                                                | Mismatch repair deficient for both MLH1 and PMS2 (MSI-Low for 1/5 PCR markers) |

Table 2. Age of patients with endometrial carcinoma and metachronous or synchronous tumours.

| Factor                              | Metachronous or synchronous tumours | p-value |
|-------------------------------------|-------------------------------------|---------|
|                                     | Identified (n = 3/66)                | Not identified (n = 63/66) |       |
| Age at diagnosis of endometrial cancer (years) Mean ± SD | 59.33 ± 9.292 | 65.75 ± 9.225 | 0.244 |
| Time to development of metachronous or synchronous tumour (months) Mean ± SD | 7.33 ± 5.686 | 9 (1–12) |       |

Table 3. Age and methylation status of endometrial carcinomas in our study.

| Factor                              | Associated tumour | No associated tumour | Total | p-value |
|-------------------------------------|-------------------|----------------------|-------|---------|
|                                     | n = 3             | n = 63               | n = 66 |         |
| Methylated endometrial carcinomas   | 1                 | 43                   | 68.25%| 66.67%  |
| Age at diagnosis of endometrial carcinoma (years) Mean ± SD | 55                | 65.23 ± 9.486        |       | 0.331   |
| Median                              |                   | 63                   |       |         |
| Unmethylated endometrial carcinomas | 1                 | 16                   | 25.40%| 25.76%  |
| Age at diagnosis of endometrial carcinoma (years) Mean ± SD | 70                | 67.44 ± 8.794        |       |         |
| Median                              |                   | 67                   |       |         |
| Cases which did not undergo methylation assessment | 1                 | 4                    | 6.35% | 7.58%   |
| Reason                              | Insufficient DNA  | Not tested due to intact MLH1 immunohistochemistry |     |         |
Table 4. Comparison between studies undertaken at our institution and those of Buttin et al. [20, 21].

| Parameter                              | Data sources                                      | Number of cases n (%) | p-value |
|----------------------------------------|--------------------------------------------------|-----------------------|---------|
| Incidence of associated tumours        | Present study                                    | 3 (4.5)               | 0.0045  |
|                                        | Buttin et al. [21]                               | 19 (20.2)             |         |
| Number of MLH1 methylated cases        | Previous study from our department (Wadee and Grayson [20]) | 44 (72.1)             | 0.7991  |
|                                        | Buttin et al. [21]                               | 66 (70.2)             |         |
| Number of MLH1 unmethylated cases      | Previous study from our department (Wadee and Grayson [20]) | 17 (27.9)             | 0.7991  |
|                                        | Buttin et al. [21]                               | 28 (29.8)             |         |
| Present study’s cases                  | MLH1 methylated cases (Present study)            | 44 (72.1)             |         |
|                                        | MLH1 unmethylated cases (Present study)          | 17 (27.9)             | 0.0000  |

Table 5. Clinical and pathological details of the associated tumour resection specimen.

| Parameter                              | Leiomyosarcoma/Endometrial carcinoma resection specimen |
|----------------------------------------|-------------------------------------------------------|
| Age (years)                            | 53                                                    |
| Tumour size (mm)                       |                                                       |
| Leiomyosarcoma                         | 25 × 22 × 19                                         |
| Endometrial carcinoma                  | 55 × 24 × 10                                         |
| Lymph node involvement                 | No lymph nodes submitted for pathological examination |
| Pathological TNM stage                 | pT1a Nx Mx, Stage IA                                  |

Table 5 shows additional clinical and pathological details of one of the patients who had undergone an excision of an associated tumour. Unfortunately, the resection specimens for the other two patients could not be traced despite an extensive search on our laboratory computer database. This may be as a result of the patients not having undergone surgical excisions at our hospital complex or could be due to patients seeking medical attention at other hospitals which we do not provide a pathology service to, or having been lost to follow-up, or the patients may have died of their disease.

4. Discussion

Our present study showed a statistically lower incidence of associated tumours when compared to a study from a western country. We also demonstrated associated tumours that are different from those traditionally associated with Lynch syndrome.

Of the confirmed microsatellite unstable or mismatch repair deficient endometrial carcinoma patients in our study, 3 cases (4.5%) had associated tumours. These associated tumours included the well-documented colorectal carcinoma and tumours less commonly associated with Lynch syndrome, including mucinous breast carcinoma, uterine leiomyosarcoma and cervical squamous cell carcinoma [19]. The rectal adenocarcinoma and cervical squamous cell carcinoma both occurred metachronously. Synchronous tumours included mucinous breast carcinoma and uterine leiomyosarcoma, the latter having been diagnosed at the same time as the endometrial carcinoma on the excision hysterectomy specimen.

The incidence of associated primary tumours in patients with endometrial carcinoma differs in the literature. In the USA, early research from the 1960’s and 1980’s showed an incidence of approximately 10%, whilst more recent studies, including that of Uccella et al., and Buttin et al. [8, 21] show an incidence of 20–22%. The initial studies were smaller in number and hospital-based compared to recent studies that included a larger number of patients, regions and better follow-up of patients [8]. Uccella et al. [8] assessed the clinicopathological features of patients (n = 1028) with endometrial carcinoma, which included endometrioid and non-endometrioid subtypes, in addition to the associated tumours they developed; and evaluated the risk of patients developing an associated tumour. The study by Buttin et al. [21], assessed the incidence and the different types of synchronous and metachronous tumours in MSI unstable endometrial carcinoma patients (n = 94) which also included endometrioid and non-endometrioid subtypes.

Our study showed an incidence of 4.5%, which is far lower than that of the American studies (20–22%) [8, 21]. Our study and the study by Buttin et al. [21] assessed the incidence and types of associated tumours of microsatellite unstable endometrial carcinomas. A comparison of the incidence of associated tumours between our study (4.5%) and that of Buttin et al. (20.2%) showed a statistically significant difference in proportions (Table 4).

Whilst our sample size was small, both polymerase chain reaction (PCR) and immunohistochemistry were conducted during the previous study in our department by Wadee and Grayson [20], to detect microsatellite unstable/MMR deficient endometrial carcinoma cases, thus ensuring a more accurate identification of cases. A study by McConechy et al. [22] showed a high level of concordance (93.3%) between MMR protein immunohistochemistry and MSI PCR analysis, and as such, IHC may be used instead of PCR. However, a recent publication by Wadee and Grayson [20], showed that 5% of microsatellite unstable endometrial carcinoma cases would not have been identified if PCR was not used, as these
cases did not show loss of immunohistochemical staining. Similarly, Buttin et al. [21] also used both PCR and immunohistochemistry.

The low incidence in our study (4.5%) compared with American studies may be explained by the smaller study number (66 patients) and that our cohort was limited to microsatellite unstable/MMR-d, endometrioid endometrial carcinomas, which contrasts to both that of Uccella et al. and Buttin et al. [8, 21].

Other aspects that may have limited our patient sample size include the possibility of patients having been lost to follow up or having been registered on the laboratory system with different names and surnames which would not have been traceable on our laboratory database. In our setting of a developing country, loss to follow up of patients is a common occurrence as we provide a service to state/public sector patients. The patients may not have easy access to transportation to get to hospitals, or the financial means to use transport or may not be able to take time off from work to come to the hospital. In addition, patients may decide to access health care facilities closer to their homes which may be in areas that we do not provide a pathology service to. Furthermore, the possibility of patients having died exists, and such knowledge may not be conveyed to the patients’ treating physicians and this may then not be communicated to pathologists.

Buttin et al. [21] further subdivided the MSI positive group into MLH1 methylated and MLH1 unmethylated, categorizing tumours into sporadic and possible germline tumours respectively. Comparisons between MLH1 methylated and unmethylated cases in the studies by Wadee and Grayson and Buttin et al. [20, 21] showed no statistically significant differences (p = 0.7991) (Table 4).

The statistically significant difference in proportions when comparing the MLH1 methylated cases with MLH1 unmethylated cases in our present study suggests that the proportion of possible germline tumours is significantly lower than the proportion of sporadic tumours in our cohort. Germline mutations in MMR genes have been documented in 2–6% of endometrial carcinomas [19]. Currently, the incidence of Lynch syndrome differs between populations, ranging from 0–10% [15]. In South Africa, Wadee and Grayson’s study showed that 6.9% of patients with EEC may have underlying Lynch syndrome, which is slightly higher than the expected 2–6% [15]. Unfortunately, confirmatory germline testing is currently not available in the public sector of Gauteng, South Africa [15]. Another South African study by Vergouwe et al. [23] showed that in contrast to Western studies, there is a higher rate of MMR deficiency in colorectal carcinoma suggesting an increased proportion of inherited disease in regions of South Africa where the incidence of colorectal carcinoma is relatively low. As such, the incidence of possible Lynch syndrome associated tumours in South Africa was expected to be higher than the 4.5% identified in the present study.

The development of multiple tumours occurring in a patient with endometrial carcinoma, especially in the setting of Lynch syndrome, is well-established [8, 24]. These include tumours from the colorectum, ovary, small bowel, stomach, pancreaticobiliary tract, skin, brain and the urinary tract [17, 24, 25]. Endometrial and colorectal carcinomas are the most commonly described Lynch syndrome-associated tumours and the association between the two carcinomas is well documented [17, 21]. Only one patient in our study had an associated colorectal carcinoma. Although gastrointestinal tumours were the first neoplasms described in Lynch syndrome, endometrial carcinoma is the sentinel tumour in up to 50% of patients [19, 24].

One patient with endometrial carcinoma in our study had an associated mucinous breast carcinoma. The incidence of Lynch syndrome-associated breast carcinomas is marginally increasing, but the association between breast carcinoma and Lynch syndrome varies in the literature and is controversial [17, 26]. Stoll et al. [26] showed that women with Lynch syndrome do not have an increased risk of breast cancer compared to the general population, while Win et al. [27] showed that patients with MMR mutations were at a risk of developing breast carcinoma that was at least four times greater than that of the general population.

Furthermore, we identified one patient who had endometrial carcinoma and an associated uterine leiomyosarcoma. Generally, sarcomas are not commonly associated with Lynch syndrome. Sporadic sarcomas are rarely associated with microsatellite instability. However, a Brazilian study recently indicated that sarcomas, although rare, are linked to the Lynch syndrome spectrum of tumours [28, 29]. An increased lifetime incidence is reported; but the exact risk for sarcoma development has not been fully elucidated [28].

We identified one patient with an endometrial carcinoma who had an associated cervical squamous cell carcinoma, which is not considered a traditional Lynch syndrome-associated tumour [30]. However, several case studies have documented cervical carcinoma in association with germline mutations of the MMR genes [30]. Antill et al. [30] indicated that cervical carcinoma, including squamous cell carcinoma, could be considered part of the extracolonic manifestations of Lynch syndrome. Antill et al. [30] state that it is plausible that the tumour pathway of cervical carcinoma in MMR gene mutation patients may be secondary to the known carcinogenic effect of human papillomavirus (HPV) exposure, but microsatellite instability should be investigated as a possible underlying molecular pathway. In our study, microsatellite instability as an underlying molecular pathway has been confirmed for the endometrial carcinoma. While it is possible that this is the underlying pathway of the associated cervical carcinoma, such testing was not performed on any of the associated tumours, including the cervical tumour, as this was a retrospective, observational study and we did not have ethical clearance to perform any new additional studies/investigations.
The average time to development of an associated tumour was 7.33 months. A previous case series from China reporting the clinico-pathological features of multiple primary malignant tumours with endometrial carcinoma, found an interval of 51.27 months between the development of the first and second tumour [9]. Another study by Amer reported an average time to develop a second tumour after the first, was 117 months; but this study was not limited to patients with only endometrial carcinoma and associated tumours as it included a wide range of tumour types [31]. Only one month passed between the development of the breast carcinoma and the endometrial carcinoma in our study, compared to Uccella et al.’s [8] median of 6 years. In addition, the diagnosis of the rectal adenocarcinoma in our study was made 9 months after that of the endometrial carcinoma, compared to Uccella et al.’s [8] median time interval of 4 years between diagnosis of the two tumours. It is clear that the time interval between the diagnosis of an associated tumour and the primary tumour in our study is far less than those of other studies. The reason for this is unknown and although our cohort is too small to draw substantial conclusions, further studies investigating possible risk factors contributing to the reduction of the time interval between multiple tumour diagnoses are needed. Furthermore, this finding may suggest that closer follow up of patients with MSI unstable tumours is indicated.

Only 1 patient had an MSI-High EEC while 2 patients had MSI-Low tumours, which have been considered more akin to the MSS status than to the MSI-high status [22]. Methylated tumours point toward a sporadic occurrence whereas unmethylated tumours that have MMR-d may indicate an underlying germline mutation [20]. Hereditary tumours tend to present at a younger age [32]. Our study, however, illustrated that the patient with a methylated EEC and synchronously associated with Lynch syndrome. The precise reasons for this are currently unknown. Further studies, including assessing the role of HIV, the incidence of multiple primary tumours and identifying possible risk factors in our population, are needed. Such information may also evaluate the feasibility and cost-effectiveness of the possible implementation of screening programs and germline testing in a developing country. In addition, this study will contribute to global data and provide a greater knowledge base from which gynaecologic oncologists, pathologists, medical oncologists, and radiation oncologists may draw information, with the ultimate aim of optimal patient care.

5. Conclusions

To the best of our knowledge, our study is the first to document the incidence and type of associated tumours in microsatellite unstable/mismatch repair deficient (MMR-d) endometrial carcinomas in Africa. The results from our study showed a statistically lower incidence of associated tumours when compared to a western country. We have demonstrated associated tumours that are different from those traditionally associated with Lynch syndrome. The precise reasons for this are currently unknown. Further studies, including assessing the role of HIV, the incidence of multiple primary tumours and identifying possible risk factors in our population, are needed. Such information may also evaluate the feasibility and cost-effectiveness of the possible implementation of screening programs and germline testing in a developing country. In addition, this study will contribute to global data and provide a greater knowledge base from which gynaecologic oncologists, pathologists, medical oncologists, and radiation oncologists may draw information, with the ultimate aim of optimal patient care.

Author contributions

SK contributed to the design and drafting of the manuscript and critically reviewed the manuscript for relevant intellectual content. RW contributed to the conception and supervision of the study; and contributed to the drafting of the manuscript and critically reviewed the intellectual content therein. Both authors contributed to editorial changes in the manuscript. Both authors read and approved the final manuscript.
Ethics approval and consent to participate

Ethical clearance (certificate number M190939) was obtained through the Human Research Ethics Committee (Medical) of the University of Witwatersrand. Dr. Wadee had obtained ethical clearance for use of patient tissue samples (M151051) for research towards a PhD.

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Conflict of interest

The authors declare no conflict of interest.

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