East African Scholars Journal of Medicine and Surgery
Abbreviated Key Title: EAS J Med Surg
ISSN: 2663-1857 (Print) & ISSN: 2663-7332 (Online)
Published By East African Scholars Publisher, Kenya

Volume-6 | Issue-12 | Dec-2024 | DOI: https://doi.org/10.36349/easjms.2024.v06i12.003

OPEN ACCESS

Original Research Article

Role of Verhoeff's Elastic Stain to Detect Venous Invasion in Colorectal Adenocarcinoma

Dr. Dilshad Jahan[1*], Dr. Nazma Afroze[2], Dr. Abdullah Al Mukit[3], Dr. Tarim Mahmood[4]

[1]MBBS, MD (Pathology), Assistant Professor, Department of Pathology, Barind Medical College, Rajshahi, Bangladesh
[2]MBBS, M.Phil (Pathology), Professor, Department of Pathology, BIRDEM General Hospital, Dhaka, Bangladesh
[3]MBBS, MD (Hepatology), Registrar, Department of Hepatology, Rajshahi Medical College Hospital, Rajshahi, Bangladesh
[4]MBBS, MPH, CCD, Department of Maternal and Child Health, National Institute of Preventive and Social Medicine, Dhaka, Bangladesh

Article History
Received: 20.10.2024
Accepted: 26.11.2024
Published: 05.12.2024

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Background:*** Venous invasion is not only an important prognostic indicator in colorectal cancer, but also an important factor of deciding treatment plan for adjuvant therapy. Vascular invasion is usually assessed using hematoxylin and eosin (H & E). But the accuracy of detection of venous invasion using H & E is debatable. Verhoeff's elastic stain is a staining protocol used to demonstrate normal or pathologic elastic fibers, which can be used to improve the detection of venous invasion. ***Objectives****:* To evaluate the role of Verhoeff's elastic stain to detect venous invasion in colorectal adenocarcinoma. ***Methods****:* This was a cross-sectional study carried out among 91 cases of colorectal adenocarcinoma. The duration for this study was from March, 2020 to February, 2022. Demographic and histopathological variables were assessed. Venous invasion with both H& E and Verhoeff's stains were evaluated. ***Results:*** Mean age was 51.7 ± 10.9 years. The majority of the patients were males (61.5%). The most common site of the tumor was colon (74.7%). Tumors having size ≥5 cm in diameter (71.4%) were more common. Majority (78.0%) were found to be moderately differentiated neoplasm by histological grading. The rate of venous invasion detection was higher with Verhoeff's elastic stain compared to H & E stain. Positive results for venous invasion were observed in 21 (23.1%) and 40 (44.0%) cases stained with H & E and Verhoeff's elastic stain, respectively. ***Conclusion:*** This study found that Verhoeff's elastic stain is better at detecting venous invasion in colorectal adenocarcinoma than H&E stain. Therefore, Verhoeff's elastic stain can be routinely employed to detect venous invasion in resected samples of colorectal carcinoma.

Keywords: Colon cancer; adenocarcinoma; Verhoeff's elastic stain; venous invasion; histology; diagnosis.

INTRODUCTION

Colorectal cancer refers to tumour of the rectum or large bowel (including the appendix) that arise from the colorectal mucosa [1]. This cancer has been considered as one of the most common malignancies all over the world and its incidence is increasing slowly. According to Global Cancer Observatory 2020 data, more than 1.9 million new colorectal cancer cases and 935,000 deaths were recorded in 2020, representing about one death in 10 cancer cases [2]. Overall, colorectal cancer ranks third in terms of incidence, but second in terms of mortality worldwide [3]. Incidence rates are approximately 4-fold higher in developed countries compared with developing countries [2].

Besides, according to United Nations Population Fund (UNFDA), Bangladesh, with 160 million people, is the 7th most populous country in the world [4]. In cancer observatory 2020, there are about 1.5 lakh patients newly diagnosed with cancer each year [5]. It has become a hidden burden which accounts for 2.9% of cancer death in Bangladesh [4]. With 5283 new cases, incidence of colon carcinoma is 0.4% [4].

Adenocarcinoma is the most common form of colorectal cancer with the commonest presenting features of abdominal pain, change in bowel habit, rectal bleeding and microcytic anaemia [6]. Rarer subtypes include carcinoid tumour, sarcoma, and lymphoma [7]. Colorectal cancer typically develops from adenomatous polyps that undergo dysplastic changes to become

***Corresponding Author:** Dr. Dilshad Jahan
MBBS, MD (Pathology), Assistant Professor, Department of Pathology, Barind Medical College, Rajshahi, , Bangladesh

cancerous. Tumours can occur sporadically, but there are some inherited colorectal cancer syndromes like Familial adenomatous polyposis [7]. The large majority of adenomatous polyps are less than 1 cm in diameter, but larger lesions are more frequently associated with malignant changes [8].

Most colorectal cancer cannot be attributed to any single risk factor, although increasing age and male sex have consistently shown strong associations with disease incidence in epidemiological studies. Colorectal adenocarcinoma can be found in all segments of the large bowel and their frequency strongly increases after 50 years of age [7]. Among the various environmental factors, several dietary components such as animal fat, beef meat and alcoholic beverages, lack of physical activity, overweight and smoking are, somehow, related to an increased risk of colorectal cancer. In contrast, fruit, vegetables, unabsorbable fiber, antioxidant vitamins, calcium, folate, physical exercise and anti-inflammatory drugs seem to show a protective effect, and are actually under evaluation for the chemoprevention of these tumors [9]. Patients with ulcerative colitis, especially when long-lasting and involving the entire large bowel show a markedly increased risk for colorectal malignancies [10].

The prognosis of colorectal carcinoma is related to a number of clinical and pathologic parameter including location, size, edge, extent and multiplicity of tumor [11]. Tumors occurring at very early age and old age, male sex, raised carcinoembryonic antigen (CEA), obstruction, perforation, vascular invasion, involvement of lymph nodes and angiogenesis are some poor prognostic factors [10]. Again mucinous carcinoma, signet ring cell carcinoma and anaplastic carcinoma have worse prognosis than adenocarcinoma [11].

Venous invasion is an important prognostic indicator in colorectal cancer [12]. It is well established that blood vessel invasion, found in the tumor at the time of resection, is associated with a significantly increased risk of visceral metastases and a decrease in overall survival time [13]. The incidence of venous invasion is directly related to tumour stage, and inversely related to tumour differentiation [14]. The reported incidence of venous invasion in CRC specimens varies between 10% and 89.5%. Owing to the focal nature of vein invasion and to the non-continuous nature of the process of tumour embolism, it appears that pure chance also influences the identification of venous invasion [13]. For example, Minsky and Mies have demonstrated that the use of elastic tissue stains can enhance both the detection of blood vessel invasion and its differentiation from lymphatic vessel invasion [15].

Vascular invasion is assessed using hematoxylin and eosin (H&E) in different hospitals commonly [10]. The cost, time and workload of the stains are not very much favorable. The sensitivity of detection of venous invasion in colorectal cancer is not always significant, and it has been shown in different studies [12]. Abdulkader *et al.,* found the sensitivity is only 35.5% in detection of venous invasion using H&E stain [15]. So, introduction of special stains to outweigh the small extra cost and effort and increase sensitivity of venous invasion is always necessary. Vass *et al.,* showed that elastic stain significantly increases the incidence of detection of vascular invasion compared with routinely stained sections [9]. They recommended the use of elastic-stained serial sections to detect venous invasion in tumors for the reporting of colorectal carcinomas [15].

Verhoeff's stain, also known as Verhoeff's elastic stain is a staining protocol used in histology. It was developed by American ophthalmic surgeon and pathologist Frederick Herman Verhoeff (1874–1968) in 1908. The formulation is used to demonstrate elastic fibers in the wall of blood vessels [10]. Verhoeff's stain forms a variety of cationic, anionic and non-ionic bonds with elastin, the main constituent of elastic fiber tissue [13]. Elastin has a strong affinity for the iron hematoxylin complex formed by the reagents in the stain and will hence retain dye longer than other tissue elements [4]. Elastic fibers and cell nuclei stained black, collagen fibers stain red, and other tissue elements including cytoplasm stain yellow [12].

The aim of this study was to identify the role of Verhoeff's elastic stain in detecting venous invasion in adenocarcinoma. It can also guide the treatment strategy. It is cost effective too. So, in this study the sensitivity of detecting venous invasion in colorectal cancer by using Verhoeff's elastic stain and conventional H&E stain will be compared. This may help to perform more detail histological diagnosis of colorectal adenocarcinoma and thus act as an important prognostic indicator.

METHOD

Study Design, Participants & Settings

This cross-sectional study was conducted in the Department of Pathology, BIRDEM General Hospital, Dhaka. The study period was between March, 2020 to February, 2022. Resected tissue sections from the samples of histopathologically diagnosed cases of colorectal adenocarcinoma were taken. 30 samples were taken from the Department of Pathology, BIRDEM General Hospital; 8 samples were taken from Bangabandhu Sheikh Mujib Medical University (BSMMU), 10 samples were taken from Dhaka Medical College (DMC); 32 samples were taken from The Laboratory and 11 samples were taken from Medinova, Dhaka.

Purposive sampling technique was applied. Total 91 samples were used in this study.

Selection Criteria:

Inclusion Criteria

- Resected samples of histopathologically diagnosed case of colorectal adenocarcinoma.
- Patients who provided written informed consent.

Exclusion Criteria

- Patients with other colorectal diseases.
- Biopsy samples were excluded.

Some Terms

Colorectal Adenocarcinoma: The cancer arises in glandular epithelial cells of the large intestine after a series of genetic or epigenetic mutations with abnormally heightened replication and survival, these hyper-proliferative cells give rise to a benign adenoma, which may then evolve into carcinoma and metastasize over decades [11].

Vascular Invasion: Blood vessel invasion (BVI) or lymphatic vessel invasion (LVI), or both. Blood Vessel Invasion was defined as tumor within a round or ovoid vessel-like structure containing elastic tissue fibers arranged in an orderly concentric fashion [16].

Intramural Venous Invasion: The venous invasion limited to the submucosal and/or muscular layer of colorectal wall [17].

Extramural Venous Invasion: The venous invasion found to beyond the muscularis propria of colorectal wall [17].

Verhoeff's Elastic Stain: The Verhoeff stain is one of the most commonly-used stains to visualize elastic tissue, as found in blood vessel walls, elastic cartilage, lungs, skin, bladder and some ligaments [13].

H & E Stain: H & E is the combination of two histological stains: hematoxylin and eosin. The hematoxylin stains cell nuclei a purplish blue; the eosin stains extracellular matrix and cytoplasm pink, with other structures taking on different shades, hues and combinations of these colors [15].

Routine Histopathological Examination

Among 91 cases, 80 cases were taken by grossing and 11 cases by paraffin embedded tissue blocks of histologically diagnosed cases of colorectal adenocarcinoma. For each case obtained by grossing, four tumor containing sections were taken. Then paraffin blocks were made from them. From each paraffin block, two serial sections were prepared. One section was used for H&E stain and the other one for Verhoeff's elastic stain. H & E staining procedure was done in BIRDEM General Hospital. Verhoeff's elastic stain was done in BSMMU. Venous invasion was assessed in all the cases after both staining procedures. Sections were also assessed for the presence of both extramural and intramural venous invasion. If it was uncertain whether a structure was venous in origin the case was reported as being negative for venous invasion. All the Verhoeff's elastic stained and H & E-stained slides were reviewed and tumor type, grade, stage and other prognostic factors such as vascular invasion were assessed.

Histochemical Examination Procedure

Tissues were fixed in 10% buffered formalin, processed in the usual manner, and embedded in paraffin wax. Eight serial sections of 4 mm thickness were cut from each tumor containing block. Four sections were stained with H & E and the other four were stained with Verhoeff's elastic stain. All cases were examined by viewing both of the H & E and H & E/ Verhoeff's elastic-stained sections.

Venous invasion in H & E sections were defined as a tumor deposit in a space surrounded by a rim of smooth muscle and/or containing red blood corpuscles, usually lying adjacent to an artery. Venous invasion was further defined in the H & E/ Verhoeff's elastic sections as tumor seen in a vessel with elastic fibers in its adventitia, usually adjacent to an artery. Sections were assessed for the presence of both extramural and intramural venous invasion (invasion of veins in the submucosa and within the muscularis propria). If it was uncertain whether a structure was venous in origin the case was reported as being negative for invasion of this structure.

Staining Procedure

- Deparaffinize and hydrate to distilled water.
- Place in Verhoeff's staining solution for 10 minutes.
- Wash briefly in running tap water and rinse in two changes of distilled water.
- Differentiated in 2% ferric chloride for 15 seconds.
- Stop the differentiation with two changes of distilled water.
- Check microscopically for black elastic fiber staining and gray background.
- Repeat 2% ferric chloride treatment and distilled water rinses as necessary for adequate elastic fiber demonstration.
- Rinse in two changes of distilled water.
- Counterstain in Van Gieson's solution for 1 minute.
- Dehydrate in three changes of 95% alcohol (in Coplin jars) and complete dehydration in four changes of absolute alcohol.
- Clear in three or four changes of xylene.
- Mount with synthetic resin.

Data Analysis

All the data were compiled and sorted properly. Data input was given to computer with the help of excel sheet. The data was presented in tabular or diagrammatical form. Descriptive statistics, frequency and percentages were calculated to present all categorical variables. Statistical analysis was performed applying the SPSS-PC package, version 26 (Statistical Package for Social Science). An analysis plan was developed keeping

in view with the objectives of the study. P values less than 0.05 were considered significant. Association of venous invasion between two stains was performed using Chi square test. The results were published in tables, pie charts and bar diagrams.

Ethical Considerations

- The patient or guardians of the patient were informed about the nature of the study.
- Written consent was taken from patient or their legal guardians.
- Permission was taken from the respected unit head.
- Permission of the ethical committee of the institution was taken.

RESULT

This cross-sectional study included 91 patients who had colorectal adenocarcinoma. The age of the present study population ranged from 30-73 years with a mean age of 51.7 ± 10.9 years; 56 (61.54%) cases were male and 35 (38.46%) cases were female with male to female ratio of 1.6:1.

Table above illustrates the details regarding the tumors. It is clearly evident that, most of the tumors [68 (74.7%)] were situated in the colon. Maximum lesions [76 (83.5%)] were single in number. Besides, mean size of tumors was 5.85 ± 2.83 cm; ranging from 1.5-22 cm. Lastly, infiltrating tumors [67 (73.6%)] were mostly detected [Table 1].

Table 1: Tumor-related information (n=91)

Attributes	No. of cases (n)	Percentage (%)
Location of tumor		
Colon	68	74.7
Ascending colon	26	28.6
Sigmoid colon	23	25.3
Caecum	13	14.3
Transverse colon	4	4.4
Descending colon	2	2.2
Rectum	23	25.3
Number of lesions		
Single	76	83.5
Multiple	15	16.5
Size of tumor (in cm)		
<5	26	28.6
≥5	65	71.4
Mean ± Standard deviation: 5.85 ± 2.83 cm; Range: 1.5 – 22 cm		
Type of edge of tumor		
Infiltrating	67	73.6
Pushing	24	26.4

The pie chart highlights the histological grading of the colorectal carcinomas. It can be seen that, maximum [71 (78.0%)] were moderately differentiated [Figure 1].

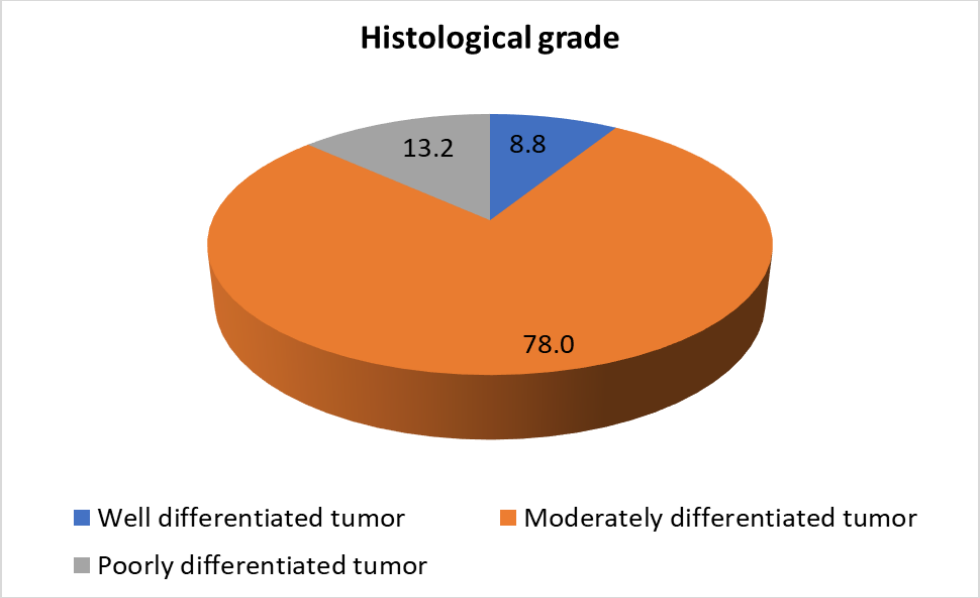

Figure 1: Pie diagram showing histological grade of colorectal carcinomas (n=91)

Table 2: TNM Staging of the participants (n=91).

T stage	No. of cases (n)	Percentage (%)
T1	6	6.6
T2	19	20.9
T3	65	71.7
T4	1	1.1
Total	**91**	**100.0**

T stage	No. of cases (n)	Percentage (%)
N stage		
N0	51	56.0
N1	19	20.9
N2	21	23.1
Total	**91**	100.0
M stage		
Mx	91	100.0
Total	**91**	100.0

Table above depicts the TNM staging of the patients. In this study, 65 cases were found in T3 stage which is 71.7% of the total number of cases (91). However, 19 (20.9%) cases were found in T2 stage, 6 (6.6%) cases were found in T1 stage and 1 (1.1%) case were found in T4 stage. On the basis of lymph nodal metastasis, 51 (56.0%) cases were found in N0 stage, 19 (20.9%) cases were in N1 stage and 21 cases were found in N2 stage which is 23.1% of the total number of cases (91). As distant metastasis was not evaluated, so all cases were in Mx stage [Table 2].

Table 3: Venous invasion and location based on type of staining.

Attributes	No. of cases (n)	Percentage (%)
Venous invasion after H & E staining (n=91)		
Positive	21	23.1
Negative	70	76.9
Location of invasion after H & E staining (n=21)		
Extramural	14	66.7
Intramural	7	33.3
Venous invasion after Verhoeff's elastic staining (n=91)		
Positive	40	44.0
Negative	51	56.0
Location of invasion after Verhoeff's stain (n=40)		
Extramural	26	65.0
Intramural	14	35.0

Table shows us the distribution of venous invasion and location according to type of staining done. In case of staining with H & E stain, 21 cases (23.1%) were positive for venous invasion and 70 (76.9%) cases were negative for venous invasion. Venous invasion was identified in intramural veins in 7 (33.3%), and in extramural veins in 14 (66.7%) of the 21 positive cases by H & E stain. In case of staining with Verhoeff's elastic stain, 40 cases (44.0%) were positive for venous invasion and 56 (56.0%) cases were negative for venous invasion. Venous invasion was identified in intramural veins in 14 (35.0%), and in extramural veins in 26 (65.0%) of the 40 positive cases by Verhoeff's elastic stain [Table 3].

Table 4: Association of detection of venous invasion by two stains (n=91)

		Verhoeff's stain		Total (n=91)	p-value
		Positive (n=40)	Negative (n=51)		
H&E stain	Positive (n=21)	20 (95.2%)	1 (4.8%)	21 (100.0%)	<0.001*
	Negative (n=70)	20 (28.6%)	50 (71.4%)	70 (100.0%)	
Total		**40 (44.0%)**	**51 (56.0%)**	**91 (100.0%)**	

p-value obtained by Chi-square test, *significant

A total of 40 cases of venous invasion were observed in Verhoeff's elastic stain compared to 21 cases in H&E stain. In 20 cases, venous invasion was observed by both stains and in 50 cases (71.4%) no venous invasion was found by any stains. Venous invasion determination was higher in Verhoeff's elastic stain group compared to H&E stain group and it was statistically significant [Table 4].

Table 5: Association between TNM staging with venous invasion by Verhoeff's elastic stain. (n=91)

Characteristics	Verhoeff's stain		p-value
	Positive N (%)	Negative N (%)	
T stage			
T1	0 (0.0)	6 (11.8)	<0.001*
T2	7 (17.5)	12 (23.5)	
T3	32 (80.0)	33 (64.7)	
T4	1 (2.5)	0 (0.0)	
N stage			
N0	17 (42.5)	34 (66.7)	<0.001*
N1	10 (25.0)	9 (17.6)	
N2	13 (32.5)	8 (15.7)	
M stage			
Mx	40 (100.0)	51 (100.0)	
Total	**40 (100.0)**	**51 (100.0)**	

p-value obtained by Chi-square test/Fishers Exact Test, *significant

In case of staining with Verhoeff's elastic stain, the number positivity for venous invasion was lower in T1 and T2 stages and the number of positivity higher in T3 and T4 stages, which was statistically significant ($p<0.001$). Again, the frequency of positivity of venous invasion was lower in N0 stage and higher in N1 and N2 stages, which was also statistically significant ($p<0.001$). As distant metastasis was not evaluated, so all cases were in Mx stage [Table 5].

DISCUSSION

Verhoeff's stain, also known as Verhoeff's elastic stain, is a staining protocol used to demonstrate normal or pathologic elastic fibers. Elastin has a strong affinity for the iron-hematoxylin complex formed by the reagents in the stain, and therefore, it retains the dye longer than other tissue elements. As a result, elastic tissue is considered effective in the diagnosis of venous invasion in colorectal carcinoma.

In this study, the mean age of 57.1 ± 10.9 years. This finding was consistent with studies [15, 18] conducted in India, Austria, and Iraq, where the mean ages were 53.9 ± 16.7 years (ranging from 19 to 88), 52.5 years (ranging from 30 to 83 years), and 56.5 years (ranging from 24 to 89 years), respectively. In this study, the highest number of samples was from 50-59 years age group. Duduyemi *et al.,* [3] also found highest incidence of carcinoma in this age group. Colorectal carcinoma is more prevalent in the older age group, and this observation is also consistent with the findings of this study.

Besides, we found that, the incidence of colorectal carcinoma was predominant in the male population. This percentage was slightly higher than that reported in other studies conducted in the UK (54.22% male) and Pakistan (52.0% male) [6, 15]. Based on the study results, it is suggested that the male gender is one of the significant risk factors for the disease [3]. The tendency among men to take less care of their health and weight than women could be a contributing factor in the development of this disease.

Furthermore, we found most of the tumors were located in the colon. This result was similar to the findings of a study conducted in the UK by Abdulkader *et al.,* [15] in 2016, where the distribution was 64.26% in the colon and 35.74% in the rectum. In addition, the number of lesions was also analyzed. Majority had a single lesion. The incidence of multiple primary cancers identified in the colon and rectum is about 2-5%. However, this incidence of multiple lesions increases to 10-20% in patients with familial adenomatous polyposis and hereditary non-polyposis colorectal cancer [19]. Besides, we found that, the size of the tumor ranged from 1.5 to 22.0 cm in maximum dimension. This finding was similar to a study [20] on colorectal carcinoma conducted by Seo and his colleagues in South Korea in 2014. They reported the median tumor size to be 5.4 cm, ranging from 2.0 to 27.0 cm. Tumor size proved to be an independent predictor, suggesting its utility as an additional parameter to guide surveillance and aid in the selection of patients for adjuvant chemotherapy.

The infiltrating edge of the tumor is considered a worse prognostic factor compared to the pushing edge. The tumor edge is mostly of infiltrating type according to our study. A study [20] conducted in the South Korean population in 2014 also described the infiltrating edge of the tumor to be more prevalent (83.8%) than the pushing edge.

In the current study, the majority of the tumors are moderately differentiated. Similarly, different studies [21-22] conducted on colorectal carcinoma in Greece (84.3%) and the UK (82.26%) also revealed higher percentages of moderately differentiated colorectal carcinoma. In addition, in a study [3] conducted by Duduyemi and his colleagues in 2020, predominantly poorly differentiated carcinoma (85%) was found.

According to the TNM stage, the majority of the cases in the present study belonged to T3 stage (71.7%) and N0 stage (56.0%). Similar findings were reported in a study [16] on colorectal carcinoma conducted by Kirsch in Poland. They performed a study on 202 patients and found that 72.0% of the cases were in T3 stage.

Regarding staining, various studies reported different percentages for venous invasion using Verhoeff's elastic stain, noted as 66.70% by Duduyemi *et al.,* 62.10% by Abdulkader *et al.,* 82.67% by Vass *et al.,* and 70.40% by Sternberg *et al.,* respectively [3, 15, 9, 14]. However, in the same studies, the percentages of venous invasion observed by H & E stain were approximately 34.10% by Duduyemi *et al.,* 54.50% by Abdulkader *et al.,* 34.67% by Vass *et al.,* and 51.90% by Sternberg *et al.,* respectively [3,15, 9, 14].

The detection of venous invasion in colorectal cancer is an important negative prognostic factor, and its identification can significantly impact patient management. Several studies, including the present study, have emphasized the role of elastic stains in detecting venous invasion in colorectal cancer.

From a clinical and therapeutic standpoint, the detection of venous invasion plays an important role in the staging of colorectal carcinoma. Venous invasion can enhance the predictive power of existing staging systems by subdividing stages based on its presence or absence, contributing to a more accurate prognosis. The significance of venous spread also impacts surgical techniques used in the treatment of colorectal cancer. In addressing the issue of blood-borne metastases, adjuvant chemotherapy has emerged as an alternative treatment approach. With the use of elastic stain, patients who are more suitable candidates for chemotherapy can now be confidently identified. Our findings indicate that the use of elastic stain improves the detection of venous invasion in colorectal carcinoma, thereby aiding in the evaluation of the disease stage.

One of our limitations would be the sensitivity and specificity of Verhoeff's elastic stain could not be calculated in this study since immunohistochemistry (considered the gold standard) could not be performed.

CONCLUSION

This study suggests that, Verhoeff's elastic stain statistically increases detection of venous invasion in colorectal adenocarcinoma than H & E stain. Therefore, serial sections of tumor blocks in colorectal adenocarcinoma can be stained with an elastic stain in addition to routine H & E for the detection of vascular invasion.

RECOMMENDATIONS

- Verhoeff's elastic stain can be done as a routine test along with H&E stain in all cases of colorectal cancer as the test cost is affordable by the patient.
- Further immunohistochemical (CD 31, CD 34, Podoplanin) investigations can be carried out for better evaluation.

Conflict of Interest Disclosure: The authors declare that they have no conflicts of interest.

Sources of Funding: None.

REFERENCES

1. Compton, C. C. (2003). Colorectal carcinoma: diagnostic, prognostic, and molecular features. *Modern Pathology*, *16*(4), 376-388.
2. Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: a cancer journal for clinicians*, *71*(3), 209-249.
3. Duduyemi, B. M., Andoh, D., Adankwah, E., Nyarko, H., & Agyemang, D. (2020). The use of special stains in the detection of vascular invasion in cases of colon cancer in resource-limited settings in Africa. *Annals of Tropical Pathology*, *11*(1), 21-24.
4. Hussain, S. A., & Sullivan, R. (2013). Cancer control in Bangladesh. *Japanese journal of clinical oncology*, *43*(12), 1159-1169.
5. Ferlay, J., Colombet, M., Soerjomataram, I., Parkin, D. M., Piñeros, M., Znaor, A., & Bray, F. (2021). Cancer statistics for the year 2020: An overview. *International journal of cancer*, *149*(4), 778-789.
6. Al-Talib, S. H., Al-Nuaimy, W. M. T., & Azooz, R. A. (2011). Detection of vascular invasion in colorectal cancer by using Weigert's stain for elastic fibers. *Annals of the College Mosul*.
7. Thrumurthy, S. G., Thrumurthy, S. S., Gilbert, C. E., Ross, P., & Haji, A. (2016). Colorectal adenocarcinoma: risks, prevention and diagnosis. *Bmj*, *354*.
8. De Leon, M. P., Benatti, P., Borghi, F., Pedroni, M., Scarselli, A., Di Gregorio, C., ... & Roncucci, L. (2004). Aetiology of colorectal cancer and relevance of monogenic inheritance. *Gut*, *53*(1), 115-122.
9. Vass, D. G., Ainsworth, R., Anderson, J. H., Murray, D., & Foulis, A. K. (2004). The value of an elastic tissue stain in detecting venous invasion in colorectal cancer. *Journal of clinical pathology*, *57*(7), 769-772.
10. Maratka, Z., Nedbal, J., Kocianova, J., Havelka, J., Kudrmann, J., & Hendl, J. (1985). Incidence of colorectal cancer in proctocolitis: a retrospective study of 959 cases over 40 years. *Gut*, *26*(1), 43-49.
11. Rosai, J. (1996). Ackerman's surgical pathology. *Mosby-Year Book*.

12. Puchtler, H., & Waldrop, F. S. (1979). On the mechanism of Verhoeff's elastica stain: a convenient stain for myelin sheaths. *Histochemistry*, *62*(3), 233-247.
13. Talbot, I. C., Ritchie, S. H. E. I. L. A., Leighton, M. O. N. I. C. A., Hughes, A. O., Bussey, H. J. R., & Morson, B. C. (1981). Invasion of veins by carcinoma of rectum: method of detection, histological features and significance. *Histopathology*, *5*(2), 141-163.
14. Sternberg, A., Amar, M., Alfici, R., & Groisman, G. (2002). Conclusions from a study of venous invasion in stage IV colorectal adenocarcinoma. *Journal of clinical pathology*, *55*(1), 17-21.
15. Abdulkader, M., Abdulla, K., Rakha, E., & Kaye, P. (2006). Routine elastic staining assists detection of vascular invasion in colorectal cancer. *Histopathology*, *49*(5), 487-492.
16. Kirsch, R., Messenger, D. E., Riddell, R. H., Pollett, A., Cook, M., Al-Haddad, S., ... & Driman, D. K. (2013). Venous invasion in colorectal cancer: impact of an elastin stain on detection and interobserver agreement among gastrointestinal and nongastrointestinal pathologists. *The American journal of surgical pathology*, *37*(2), 200-210.
17. Sato, T., Ueno, H., Mochizuki, H., Shinto, E., Hashiguchi, Y., Kajiwara, Y., ... & Hase, K. (2010). Objective criteria for the grading of venous invasion in colorectal cancer. *The American journal of surgical pathology*, *34*(4), 454-462.
18. Gill, M. K., Manjari, M., Jain, K., & Kaur, T. A. N. V. E. E. R. (2011). Expression of Her-2/neu in colon carcinoma and its correlation with the histological grades and the lymph nodes status. *JCDR*, *5*(8), 1564-8.
19. Yoon, J. W., Lee, S. H., Ahn, B. K., & Baek, S. U. (2008). Clinical characteristics of multiple primary colorectal cancers. *Cancer Research and Treatment: Official Journal of Korean Cancer Association*, *40*(2), 71-74.
20. Seo, A. N., Kwak, Y., Kim, D. W., Kang, S. B., Choe, G., Kim, W. H., & Lee, H. S. (2014). HER2 status in colorectal cancer: its clinical significance and the relationship between HER2 gene amplification and expression. *PloS one*, *9*(5), e98528.
21. Pappas, A., Lagoudianakis, E., Seretis, C., Tsiambas, E., Koronakis, N., Toutouzas, K., ... & Manouras, A. (2013). Clinical role of HER-2/neu expression in colorectal cancer. *J BUON*, *18*(1), 98-104.
22. Mei, Z., Liu, Y., Liu, C., Cui, A., Liang, Z., Wang, G., ... & Li, C. (2014). Tumour-infiltrating inflammation and prognosis in colorectal cancer: systematic review and meta-analysis. *British journal of cancer*, *110*(6), 1595-1605.

Cite This Article: Dilshad Jahan, Nazma Afroze, Abdullah Al Mukit, Tarim Mahmood (2024). Role of Verhoeff's Elastic Stain to Detect Venous Invasion in Colorectal Adenocarcinoma. *East African Scholars J Med Surg*, *6*(12), 370-377.