

Immunohistochemical Expression of 40S Ribosomal Protein SA and Fibronectin-1 in Breast Cancer Tissues from Sudanese Patients

ABSTRACT

Laminin-1 receptor (40S ribosomal protein SA) and fibronectin-1 belong to the extracellular matrix (ECM) proteins which are involved in cell adhesion, migration and growth. This study was implemented for the purpose of investigating the expression of 40S ribosomal protein SA and fibronectin-1 in breast cancer tissues from Sudanese patients. One hundred and eight cancerous breast tissues and 42 normal breast tissues were involved in this study from the Histopathology laboratory of the Radiotherapy and Isotopes Center in Khartoum (RICK). The expression of 40S ribosomal protein SA and fibronectin-1 was investigated using the immunohistochemistry (IHC) Technique. The 40S ribosomal protein SA was positively expressed in 101 cancerous tissues (93.5%) compared to 15 normal breast tissues (35.7%). The fibronectin-1 staining was positive in 92 cancerous tissues (85.2%) compared to 14 normal breast tissues (33.3%). The expression of the laminin-1 receptor and fibronectin-1 together was positive in 88 cancerous tissues (81.5%) and the two were negative in 3 cancerous tissues (2.8%). The 40S ribosomal protein SA and fibronectin-1 together were positive in 6 normal breast tissues (14.3%) compared to 18 negative normal tissues (42.9%). When the mean ranks of the 40S ribosomal protein SA and the fibronectin-1 in the cancerous tissues were compared to their mean ranks in the normal tissues using the Mann-Whitney test, their differences were significant ($p \leq 0.000$). The collective expression of fibronectin-1 and 40S ribosomal protein SA may be used as targets in trial for the treatment of breast cancer since their expression was positive in 81.5% of the cancerous tissues compared 14.3% of the normal tissues.

Keywords: Cancerous breast tissues, , IHC, ECM, 40S ribosomal protein SA, Fibronectin

INTRODUCTION

Extracellular Matrix (ECM) is a group of proteins and polysaccharides, which fill the intercellular spaces. They connect cells to cells and tissues to tissues. The Functions of the Extracellular Matrix include binding of cells and tissues to each others, cell migration, adhesion, differentiation and proliferation [1, 2].

The Extracellular matrix has variable structure and composition between people. The proteins of the ECM are classified to binding proteins and their receptors, ECM modifying enzymes, ECM binding growth factors and other ECM associated proteins [3].

40S ribosomal protein SA (Laminin- 1 receptor) is a one polypeptide glycoprotein with a molecular weight of 67 kDa and with high affinity for laminin -1 glycoprotein of basement membrane. It is expressed on the surface of different cell types. It is registered that laminin-1 receptor and its binding protein are highly expressed in some cases of cancer where they may be associated with tumor metastasis and invasion [4, 5, 6].

Fibronectin-1 is a glycoprotein found in the plasma, cellular surface and ECM. It is composed of two polypeptides with a molecular weight of 220 kDa. It plays a major role in cell adhesion and migration in different vital process like immunity, blood clotting, wound healing, angiogenesis and metastasis [7, 8, 9, 10].

The aim of this article is to investigate the expression of 40S ribosomal protein SA (laminin-1 receptor) and fibronectin-1 in cancerous and normal breast tissues from Sudanese patients.

MATERIAL AND METHODS

Study Population

Hundred and eight formalin fixed cancerous breast tissues from Sudanese patients were involved in this study compared to forty two formalin fixed normal breast tissues. The formalin fixed tissues were obtained from the Radiotherapy and Isotopes Center in Khartoum (RICK) during 2014 and 2015.

Ethical License

This study was implemented after academic and ethical approval from the Sudan Academy of Sciences. A license was obtained from the RICK authorities to use the samples for the conduct of this study.

Study Design

This study can be classified as quantitative, descriptive, laboratory based and case control research design.

Sampling

108 Cancerous tissues form formalin fixed tissues were cut and embedded in paraffin to be ready for the immunohistochemistry. From the hundred and eight formalin fixed tissues, only forty two samples contained normal tissues. The forty two samples were also embedded in paraffin.

Methods

The immunohistochemical staining for laminin-1 receptor was done according to the manufacturer instructions (Thermo Scientific, Rev 120502J). Regarding the staining of fibronectin-1 in the paraffin embedded tissues, the USBiological Life Sciences kit number 030235 was used.

The results were statistically analysed by Mann-Whitney test using SPSS software (version 20).

RESULTS AND DISCUSSION

Results

This study involved 108 cancerous breast tissues, 32 of cancerous tissues were with cancer free margins. The total number of the control tissues were 42; 32 of them were from the margins of the cancerous tissues and 10 were normal tissues from benign tumors.

The majority of the cancerous tissues were classified as ductal carcinoma (94), lobular carcinoma (6) and others (8). The other histological types were multicentric tubular carcinoma, mucinous carcinoma, metaplastic carcinoma, terminal carcinoma and papillary carcinoma. The grades and their numbers of the cancer tissues were grade I (13), II (33) and III (61). However, one of the cancerous tissues grades was missing, so the sum of the three grades is 107 rather than 108. The ages of the study subjects were located under three age groups (20- 40; 39, 41- 64; 51 and $\leq$ 65; 18).

Regarding the staining results of 40S ribosomal protein SA of the cancerous and control (normal) tissues; it was positive in 101 of the cancerous tissues (93.5%) and in 15 of the control tissues (35.7%). The negative tissues were 7 from the cancerous tissues (6.5%) and 27 from the normal tissues (64%) (Fig.1, Fig.2 and Fig.3). It can be concluded that laminin- 1 receptor was positive in the majority of the cancerous tissues while it was positive in one third of the normal tissues (Fig.1, Fig.2 and Fig.3).

The fibronectin- 1 staining showed that 92 (85.2%) of the cancerous tissues were positive compared to 14 of the normal tissues (33.3%). The conclusion of the fibronectin-1 results is that

the fibronectin- 1 was positive in the majority of the cancerous tissues compared to one third of the normal tissues (Fig.1, Fig.2 and Fig.3).

The collective staining results of the 40S ribosomal protein SA and Fibronectin-1 showed that 81.5% (88) of the cancerous tissues were positive for both the 40S ribosomal protein SA and the fibronectin-1 compared to 14.3% (6) of the normal tissues. The negative results of the cancerous tissues were 3 (2.8%) while 42.9% (18) of the normal tissues were negative (Table.1).

The majority of the diagnosed breast cancer were classified as ductal carcinoma (94, 87%). 27 of the 94 ductal carcinoma tissues contained cancer free margins (control tissues). The staining results showed that 40S ribosomal protein SA was positive in 89 (94.7%) of the ductal carcinoma tissues compared 8 (29.6%) of the normal margin tissues. The fibronectin-1 positive cases in the cancerous and normal tissues were 82 (87.2%) and 9 (33.3%) respectively. Both laminin-1 receptor and fibronectin-1 were positive in 79 (84%) of the ductal carcinoma tissues and one normal tissue (3.7%) was positive for both of the analytes. The collective results in the ductal carcinoma tissues showed that combining the results of 40S ribosomal protein SA and fibronectin-1 gave a useful result since 79 samples of the cancerous tissues were positive compared only 1 normal tissue (Table.2).

With regard to the IHC staining of the different breast cancer grades, it was clear that only one tissue in each grade was negative for both of the parameters. The highest percentage of the both positive results was seen in Grade II (Table.3).

The non parametric Mann-Whitney test was used to compare between the expression of the 40S ribosomal protein SA and fibronectin-1 in the cancerous and normal breast tissues. Regarding the expression of the laminin-1 receptor (40S ribosomal protein SA), the mean ranks in the cancerous and normal tissues were 88.14 and 43 respectively, the Mann-Whitney U was 903 and the 2-tailed significance was ≤ 0.000 (Table.4). The fibronectin-1 expression in the cancerous and normal tissues showed that the mean ranks were 86.39 and 47.50 respectively, Mann-Whitney U was 1092 and the significance was ≤ 0.000 (Table.4). We can conclude that the expression of the 40S ribosomal protein SA and fibronectin-1 was significantly increased in the cancerous breast tissues compared to their expression in the normal breast tissues.

Discussion

This study registered that 81.5% of the cancerous tissues were positive for both 40S ribosomal protein SA and fibronectin-1 compared 14.3% of the normal tissues. However, their expression was significantly increased in the cancerous breast tissues compared to their expression in the normal breast tissues (2-tailed significance ≤ 0.000). The ductal carcinoma staining results were comparable to the results of the all types since 87% of the ductal carcinoma samples were positive for the two parameters compared to 3.7% of the normal tissues. However, the 40S ribosomal protein SA and fibronectin-1 expression are better to be used in treatment trials of ductal carcinoma patients since only 3.7% of the normal tissues were positive for both of them.

The normal tissues positives percentages were 35.7% for 40S ribosomal protein SA and 33.3% for fibronectin-1. The positive normal tissues for both laminin-1 receptor and fibronectin-1 were 3.7% .i.e. the collective results of 40S ribosomal protein SA and fibronectin-1 are better for the prediction of prognosis and they can targeted to treat breast cancer and fight metastasis.

Grade wise, grade II was characterized by the highest expression of both of the parameters in all the samples and in the ductal carcinoma tissues.

We have noted that Reidar Albrechtsen and his colleagues in 1981 concluded that malignant breast cells were strongly positive for laminin and that the epithelial cells of the ducts of the

normal breast tissues were slightly positive for laminin [11]. However, our results showed that only 14.3% of the normal tissues were positive for laminin-1 receptor (40S ribosomal protein SA). Jonathan Scheiman and colleagues stated that Laminin Receptor was over expressed in many cancers and expressed the possibility of using it as a target for gene therapy [12]. Our study registered that laminin receptor was positive in (93.5%) of the study populations and in (94.7%) of the ductal carcinoma tissues which indicate the possibility of using it as a target for any type of cancer therapy or in vaccination trials. Lourdes A. Marques research group studied the prognostic value of laminin receptor and 49.8% of their study samples were positive for laminin receptor [13]. In a comparison of integrative pathway analysis of Integrins, Laminin and EGFR in pre menopause and post menopause breast cancer, Serena Liao concluded that pre menopause breast cancer is characterized by elevated level of integrin\ laminin and EGFR signaling [14].

Regarding the Axillary Node Negative (ANN) breast carcinoma, Yun NIU and his colleagues in 2002 mentioned that Laminin receptor together with EGFR may be used as biological markers to predict metastasis in ANN breast cancer [15].

Lise Christensen study group found that 55% of invasive breast carcinoma cases were positive for fibronectin-1 [8], however, we have registered that fibronectin was positive in 85.2% of all of our study subjects and in 87.2% of the ductal carcinoma cases.

We have found that Bae YK in 2013 studied the expression of epithelial and stromal fibronectins in invasive breast cancer samples and he found that the epithelial form of fibronectin was moderate or highly positive in 76.1% of his study subjects compared to 85.2% positive for fibronectin-1 of our study subjects [16]. In another study Takei H registered 65.7% positivity of fibronectin in invasive breast carcinomas compared to 34.3% negative tissues [17].

A French study revealed that oncofetal fibronectin was positive in 60% of adenocarcinoma cases and it was not expressed in the normal glands and benign tumors while similar to our findings normal fibronectin was expressed in the normal, benign and carcinoma tissues [18].

Concerning the ductal carcinoma results Lawrence F. Brown et al in 1999 stated that 35 out 43 (81.4%) of invasive ducatal carcinoma tissues were strongly positive for fibronectin compared to low and moderate expression in 19 samples out of 28 (67.9%) normal tissues [19], while we registered 82 out 94 (87.2%) positive ductal carcinoma tissues for fibronectin-1 and 9 out of 32 (28.1%) of the normal tissues were positive for fibrnectin-1.

Similar to our findings that laminin Receptor (40S ribosomal protein SA) and fibronectin are both expressed by cancerous and normal breast tissues, Lise Christensen group stated that laminin and fibronectin are expressed by normal and cancerous cultured human breast cells [20].

The conclusion of this study is that the 40S ribosomal protein SA and fibronectin-1, collectively, may be useful as targets for future breast cancer therapies or in vaccination trials since their expression was significantly increased in the cancerous tissues compared to the normal tissues. The laminin-1 receptor and fibronectin-1 were positively expressed in the majority of the cancerous breast tissues (81.5%) while they were expressed in less than 15% of the normal breast tissues.

REFERENCES

- 1- Anna Teti. Regulation of cellular functions by extracellular matrix. *J.Am.Soc.Nephrol* 1992; 2: S83- S87.

- 2- **Pengfei Lu**, Ken Takai, Valerie M. Weaver, Zena Werb. Extracellular Matrix Degradation and Remodeling in Development and Disease. *Cold Spring Harb Perspect Biol* 2011; 3: a005058.
- 3- **Richard O. Hynes** and Alexandra Naba. Overview of the Matrisome—An Inventory of Extracellular Matrix Constituents and Functions. *Cold Spring Harb Perspect Biol* 2012;4:a004903. doi: 10.1101/cshperspect.a004903.
- 4- **Marina Ferrarini**, Silvia Heltai, Serenella M. Pupa, Sylvie, Menard, M. Raffaella Zocchi. Killing of Laminin Receptor-Positive Human Lung Cancers by Tumor-Infiltrating Lymphocytes Bearing $\gamma\delta$ T-Cell Receptors. *Journal of the National Cancer Institute* 1996; 88 (7) : 436- 441.
- 5- **Ulla M. Wewer**, Giulia Taraboletti, Mark E. Sobel, Reidar Albrechtsen, and Lance A. Lina. Role of Laminin Receptor in Tumor Cell Migration. *CANCER RESEARCH* 1987; 47: 5691-5698.
- 6- **V Berno**, D Porrini, F Castiglioni, M Campiglio, P Casalini, S M Pupa, A Balsari, S Me´nard and E Tagliabue. The 67 kDa laminin receptor increases tumor aggressiveness by remodeling laminin-1. *Endocrine-Related Cancer* 2005; 12: 393–406. DOI:10.1677/erc.1.00870.
- 7- **V. P. Terranova, C. N. Rao, T. Kalebic, I. M. Margulies, L. A. Liotta**. Laminin receptor on human breast carcinoma cells. *Proc. Natl Acad. Sci* 1983; 80: 444- 448.
- 8- **Lise Christensen**, Maja Nielsen, Johan Andersen, Inge Clemmensen. Stromal Fibronectin Staining Pattern and Metastasizing Ability of Human Breast Carcinoma. *CANCER RESEARCH* 1988; 48: 6227-6233.
- 9- **George Sitterley**. Attachment and matrix factors. *Life Science BIOFILES* 2008; 3(8). SIGMA- ALDRICH Prints- USA.
- 10- **UNIPROTKB**. P02751 (FINC_HUMAN) Fibronectin. Retrieved from: <http://www.uniprot.org/uniprot/P02751>. Accessed on 11 march 2016 at 14:32.
- 11- **Reidar Albrechtsen**, Maja Nielsen, Ulla Wewer, Eva Engvall, and Erkki Ruoslahti. Basement Membrane Changes in Breast Cancer Detected by Immunohistochemical Staining for Laminin1. *CANCER RESEARCH* 1981; 41: 5076-5081.
- 12- **Jonathan Scheiman**, Jen-Chieh Tseng, Yun Zheng1 and Daniel Meruelo. Multiple Functions of the 37/67-kd Laminin Receptor Make It a Suitable Target for Novel Cancer Gene Therapy. *Molecular Therapy* 2010; 18(1): 63- 74.
- 13- **Lourdes A. Marques**,¹ Eduardo L. F. Franco,² Humberto Torloni, M. Mitzi Brentani, J. Baptista da Silva-Neto, Ricardo R. Brentani³. Independent Prognostic Value of Laminin Receptor Expression in Breast Cancer Survival. *CANCER RESEARCH* 1990; 50: 1479-1483.
- 14- **Serena Liao**, Ryan J. Hartmaier, Kandace P. McGuire, Shannon L. Puhalla, Soumya Luthra, Uma R. Chandran, Tianzhou Ma, Rohit Bhargava, Francesmary Modugno, Nancy E. Davidson, Steve Benz, Adrian V. Lee, George C. Tseng, Steffi Oesterreich. The molecular landscape of premenopausal breast cancer. *Breast Cancer Research* 2015; 17:104. DOI 10.1186/s13058-015-0618-8.
- 15- **Yun Niu**, Xilin FU, Ajuan LV, Yu Fan, Ying Wang. Potensial Markers Predicting Distant Metastasis in Axillary Node-Negative Breast Carcinoma. *Int. J. Cancer* 2002; 98: 754–760. DOI 10.1002/ijc.10136.
- 16- **Bae YK**, Kim A, Kim MK, Choi JE, Kang SH, Lee SJ. Fibronectin expression in carcinoma cells correlates with tumor aggressiveness and poor clinical outcome in

patients with invasive breast cancer. *Hum Pathol* 2013 Oct;44(10):2028-37. doi: 10.1016/j.humpath.2013.03.006.

17- Takei H, Iino Y, Horiguchi J, Yokoe T. Immunohistochemical fibronectin staining pattern and prognosis in invasive breast carcinoma. *Oncology* 1995; 52(2):106-11.

18- Brigitte Loridon-Rosa, Philippe Vielh, Hidemitsu Matsuura, Henrik Clausen, Corinne Cuadrado, and Pierre Burtin. Distribution of Oncofetal Fibronectin in Human Mammary Tumors: Immunofluorescence Study on Histological Sections. *CANCER RESEARCH* 1990; 50: 1608- 1612.

19- Lawrence F. Brown, Anthony J. Guidi, Stuart J. Schnitt, Livingston Van De Water, Maria Luisa Iruela-Arispe, Tet-Kin Yeo, Kathi Tognazzi, Harold F. Dvorak. Vascular Stroma Formation in Carcinoma in Situ, Invasive Carcinoma, and Metastatic Carcinoma of the Breast. *Clinical Cancer Research* 1999; 5: 1041- 1056.

20- Lise Christensen, Maja Nielsen, Inge Clemmensen, Esther Hage. The Immunohistochemical Distribution of Laminin and Fibronectin in Human Female Breast Cancer. Chapter in: Progress in Surgical Pathology- Volume IX 1989. Pp 97- 114. DOI 10.1007/978-3-662-12814-5_6.

Table.1: Collective Staining Results of the 40S Ribosomal Protein SA and Fibronectin-1

IHC staining	Tumor		Normal	
	No	%	No	%
Both positive	88	81.5	6	14.3
Both negative	3	2.8	18	42.9
40S Ribosomal Protein SA positive and Fibronectin-1 negative	13	12.0	10	23.8
40S Ribosomal Protein SA negative and Fibronectin-1 positive	4	3.7	8	19.0
Total	108	100	42	100

The 40S ribosomal protein SA and fibronectin-1 were both positive in the majority of the cancerous tissues (81.5%) while they were positive in 14.3% of the normal tissues. This result reflected the possibility of using both of them as targets for future drugs or in vaccination trials

Table.2: The Histological Types of the Breast Cancer and their Staining Results

Histological type	No		40S ribosomal protein SA Positive		Fibronectin-1 Positive		Both positive		Both negative	
	T	N	T	N	T	N	T	N	T	N
Ductal carcinoma	94	27	89	8	82	9	79	1	2	11
Lobular carcinoma	6	2	5	2	4	1	3	1	0	0
Others	8	3	7	1	6	1	6	1	1	2
Totals	108	32	101	11	92	11	88	3	3	13

The 40S ribosomal protein SA and the fibronectin-1 were both positive in 84% of the ductal carcinoma cases while they were positive in one normal tissue (3.7%).

Table.3: The Staining result of the 40S Ribosomal Protein SA and Fibronectin-1 in the Different Breast Cancer Grades

Grade	40S ribosomal protein SA				Fibronectin-1				Both results			
	Positive		Negative		Positive		Negative		Positive		Negative	
	No	%	No	%	No	%	No	%	No	%	No	%
I	10	76.9	3	23.1	9	69.2	4	30.8	7	53.8	1	7.7
II	32	97.0	1	3.0	28	84.8	5	15.2	28	84.8	1	3.0
III	58	95.1	3	4.9	54	88.5	7	11.5	41	67.2	1	1.6

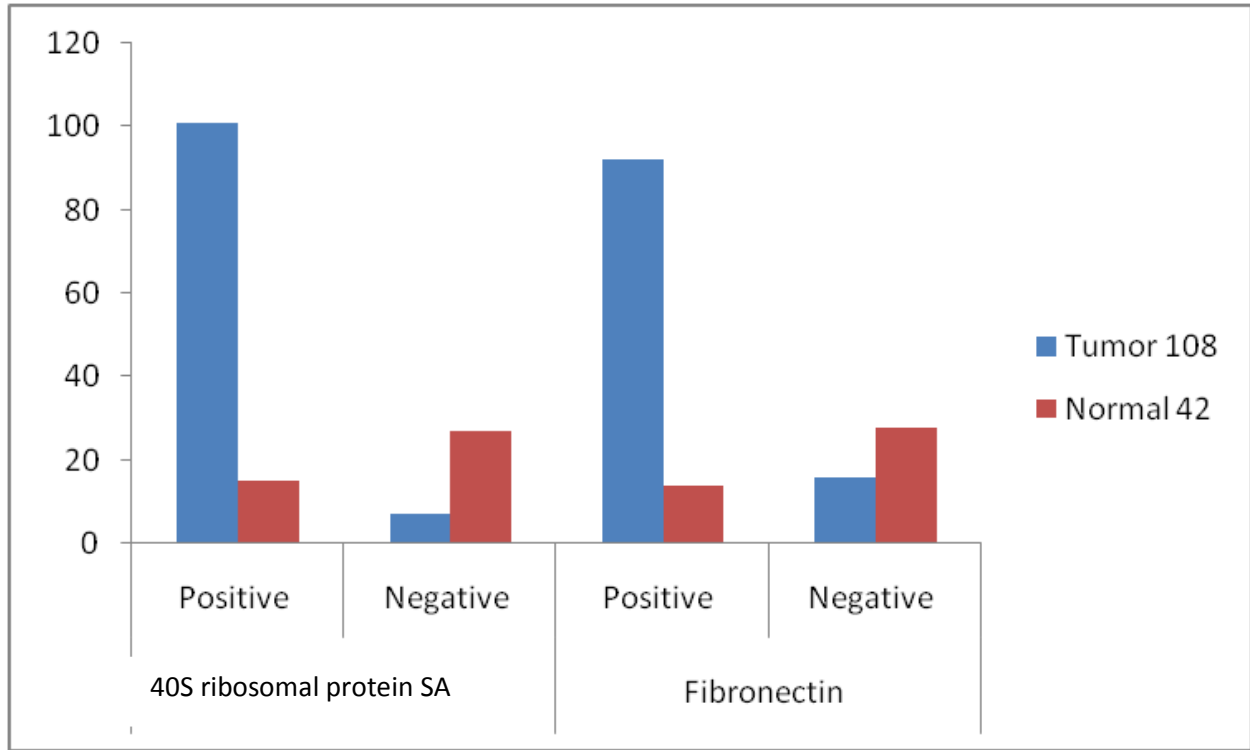
Grade II was associated with the highest expression in 40S ribosomal protein SA and fibronectin-1 collectively. The expression of the 40S ribosomal protein SA was highly positive in grade II compared to the other grades while fibronectin-1 was highly positive in grade III.

Table.4: Comparison between the Study Groups using the Mann-Whitney U Test

	40S ribosomal protein SA		Fibronectin-1	
	Number	Mean rank	Number	Mean rank
Cancerous tissues	108	88.14	108	86.39
Normal tissues	42	43	42	47.50
Mann-Whitney U	903		1092	
Significance (2-tailed)	0.000		0.000	

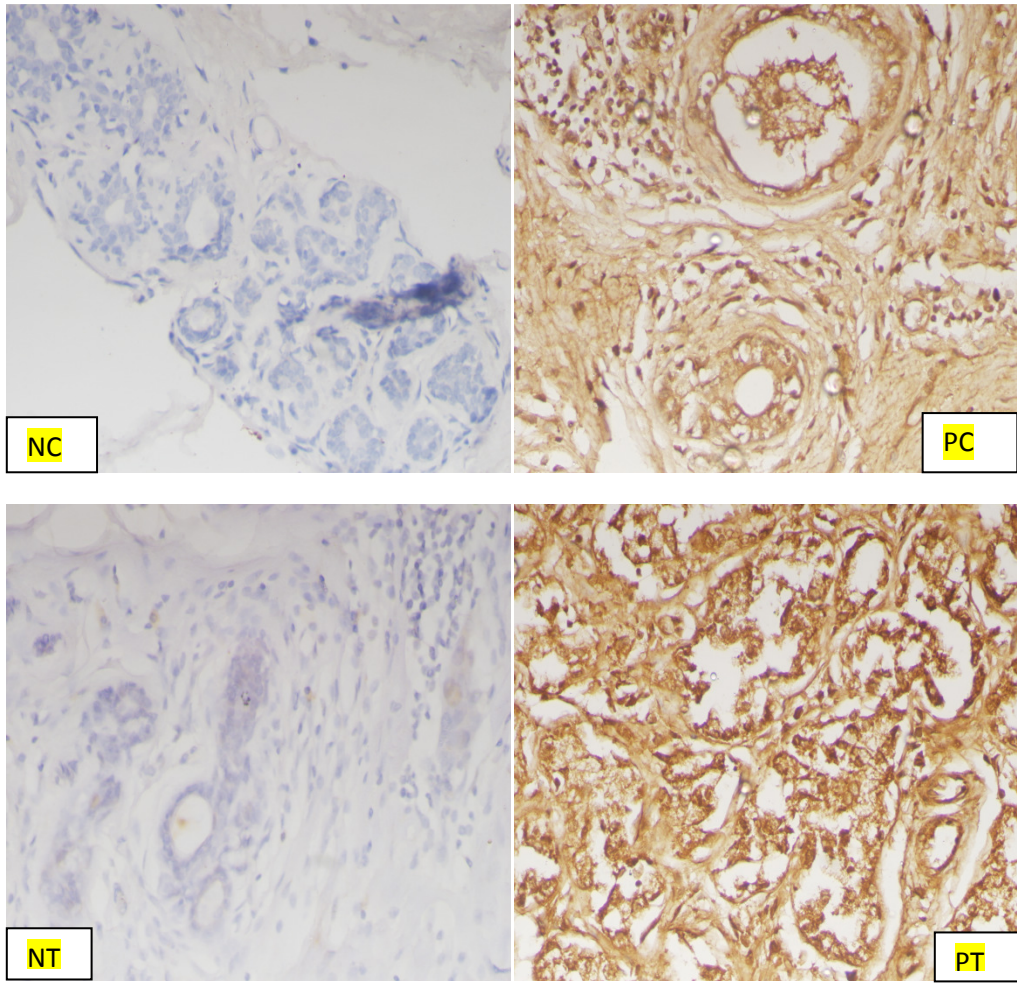
The Mann-Whitney non parametric test showed that there was significant difference between the expression of the study parameters in the cancerous and normal breast tissues

Fig.1: The Staining Results of 40S Ribosomal Protein SA and Fibronectin-1 in the Study Subjects



The staining results of the 40S ribosomal protein SA and fibronectin-1 were highly expressed in the majority of the tumor tissues compared to the normal tissues

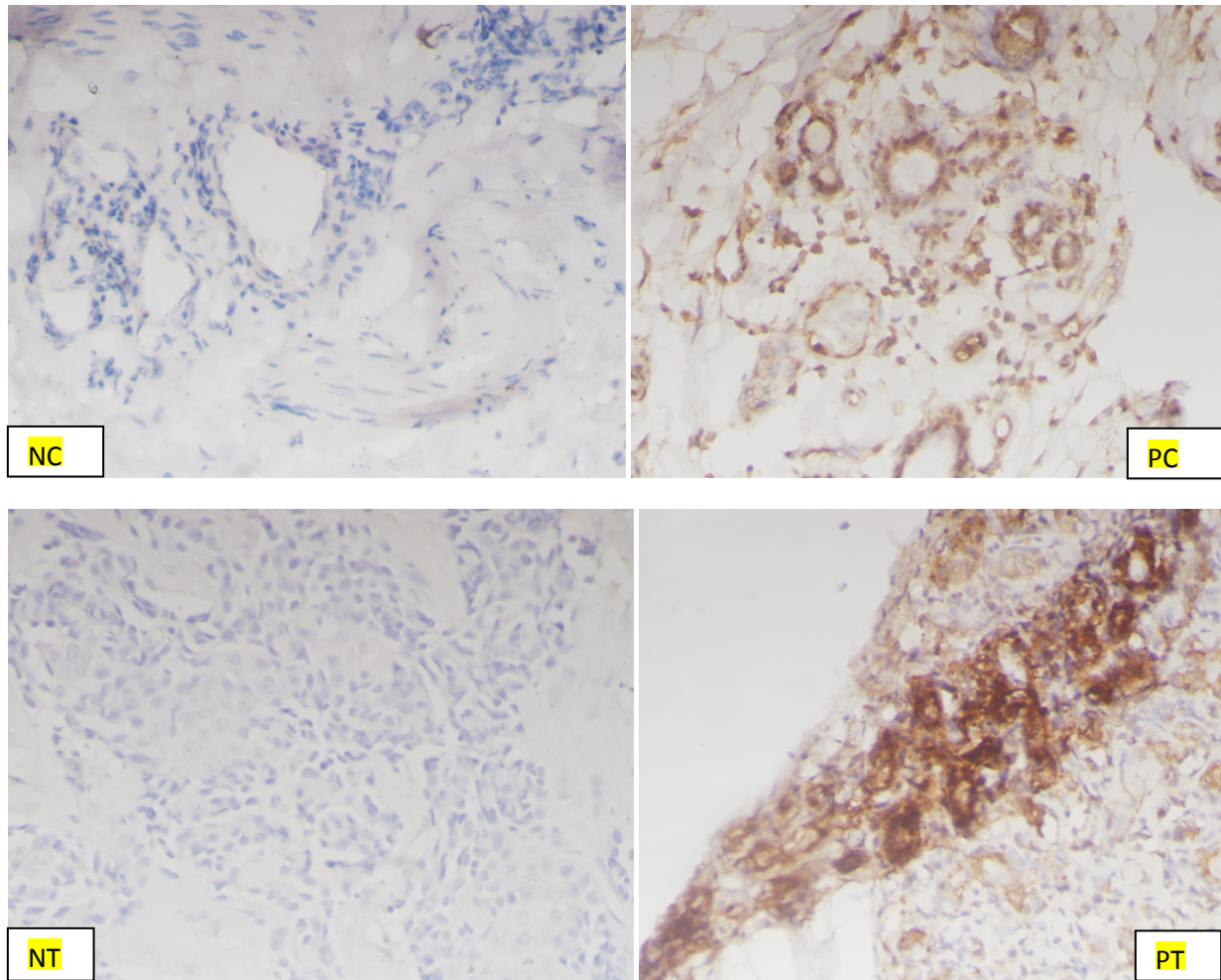
Fig.2: Representative Staining Results of the 40S Ribosomal Protein SA



The 40S ribosomal protein SA was positively and negatively stained in both the tumor and the normal breast tissues. The expression of the 40S ribosomal protein SA was positive in 93.5% of the cancerous tissues compared to 35.7% of the normal tissues.

NC; Negative Control, PC; Positive Control, NT; Negative Tumor and PT; Positive Tumor

Fig.3: Staining Results of Fibronectin -1 in the Cancerous and Normal Tissues



The expression of fibronectin- 1 was positive and negative in the control and tumor breast tissues with different frequencies. It was positive in 85.2% of the cancerous tissues compared to 33.3% of the normal breast tissues.

NC; Negative Control, PC; Positive Control, NT; Negative Tumor and PT; Positive Tumor