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Original Research Article

Role of Imprint Cytology in Diagnosis and Assessment of Surgical Margin Clearance of Tumours Compared to Frozen Section

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Abstract: ***Introduction:*** Touch imprint cytology is an economical, simple and quick intraoperative diagnostic procedure with good cytological clarity but cannot provide information on the depth of invasion. Frozen section is the standard method but is limited by its cost, need of qualified technical staff and the freezing arte facts. Thus, both the techniques have their own limitations and the combination of these two methods helps in achieving high diagnostic accuracy rates. ***Objectives:*** To assess the combined role of imprint cytology and frozen section in the diagnosis of tumours and surgical margin clearance of various organs and to compare the diagnostic accuracy of imprint cytology to frozen section individually verified by subsequent histopathological examination. ***Material and Methods*****:** The present study was done in the pathology department of Dhaka Medical College Hospital for a period of one year. A total of 72 surgical specimens from various organs were received for imprint cytology and frozen section. The results of both the techniques were verified by the subsequent histopathological diagnosis as "gold standard''. ***Results:*** Out of 72 cases, majority were ovarian neoplasms comprising of 29(40.3%) cases followed by soft tissue tumours (16.7%), breast (9.7%) and brain (8.3%) neoplasms. The majority of the cases were malignant (70.83% including metastatic) followed by benign (20.83%), and borderline (8.33%). The overall diagnostic accuracy of imprint cytology and frozen section in various organs were 95.8% and 97.2% respectively. The combined diagnostic accuracy was 98.6%. The combined accuracy of surgical margin clearance in epithelial tumours was 91.66% and it was higher than the accuracy of 66.66% in non-epithelial tumours. ***Conclusion:*** The combination of imprint cytology and frozen section helps in achieving high diagnostic accuracy rates in distinguishing benign and malignant lesions and the accuracy rate for assessment of surgical margin clearance is higher in epithelial neoplasms than that in non-epithelial neoplasms in intraoperative diagnosis.

Keywords: Imprint cytology, frozen section, Intraoperative diagnosis, Malignant, Benign, Surgical margin clearance.

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INTRODUCTION

Touch imprint cytology serves surgeons in identifying lesions whether it is malignant or not [1]. It was introduced in 1927 by Leonard S. Dudgeon and Vincent Patrick at the University of London raising the horizons of the rapid cytological diagnosis of freshly cut specimens with reliable accuracy rates [2, 3]. Imprints prepared from fresh surgical specimens give excellent cytological clarity. It provides valuable information when frozen section interpretation is equivocal [4]. The method is simple, rapid, and inexpensive and does not require special techniques or instruments [5, 6]. It does not alter the utility of the specimen for subsequent histopathological examination [7]. The limitation of imprint cytology is its inability to distinguish in-situ from infiltrating carcinomas and to evaluate the depth of invasion. Also, it gives poor cellular yield in cases with extensive fibrosis and poses difficulty in the diagnosis. Frozen section examination was established as a highly reliable procedure for intraoperative diagnosis of tumours during surgery following the introduction of cryostat in 1860 [8]. There are some specific limitations that allow errors to occur such as the initial selection of tissue by the surgeon, the sampling of the tissue by the pathologist, and the technical expertise required to prepare the slides [9]. The frozen section method was standardized in 1905 by Dr. Louis B Wilson. It is the standard method for intraoperative diagnosis of tumours and provides information on the depth of infiltration but is limited by some disadvantages like unavoidable freezing arte facts [10, 11]. Surgical resection of any malignancy aims at the removal of all the malignant tissue with a clear surgical margin without malignant cell or dysplasia and examined for the absence of malignant cells by various methods such as frozen section, touch imprint cytology or histopathological examination. Negative surgical margin prevents local recurrence and positive margins which are identified later by subsequent histopathology necessitate repeated surgeries and causing delay in starting adjuvant therapy [12]. During touch imprint cytology, surface irregularity, haemorrhage or presence of fibrous tissue in the specimen may influence on the quality of smear and there is a variation of yields of epithelial and mesenchymal malignancies for cytological examination [13]. The variation of yields from epithelial tumours and mesenchymal tumours in intraoperative imprint preparation is a conjecture and exploration of this variation is important to evaluate the reliability of imprint cytology in diagnosis and assessment of surgical margin clearance.

MATERIALS AND METHODS

A total of 72 cases were included in this prospective study during the period from July 2015 to June 2016 in the Pathology department of Dhaka Medical College Hospital. All the cases were selected after communicating with the patients and prior appointment to the concern departments. All the relevant clinical and radiological details were obtained usually at least one day before the procedure. The fresh unfixed specimens were sent in clean, airtight and properly labelled containers along with the requisition forms. The specimens were grossly examined by inspection and palpation. The specimen was then dissected with a sharp scalpel into two halves. The cut surface was examined for the presence of any tumour. The representative areas were selected and clean glass slides were placed on them for taking the imprint smears. Depending upon the type and consistency of the tissue, touch imprints, scrape or crush techniques were used to prepare the smears. Touch imprints covering all six surfaces of the surgical margins were taken and frozen sections were cut from the same. Both these slides were immediately fixed in 95% alcohol and stained with haematoxyline and eosin stain [14]. Air dried smears were stained with Leishman's stain. Simultaneously, bits from the representative areas were taken for frozen section examination. The tissue was embedded in OCT (Optimal Cutting Temperature) compound and sectioning was done using the Leica CM1850UV cryostat followed by rapid haematoxyline and eosin staining. The remaining tissue was fixed in 10% neutral buffered formalin for routine histopathological processing. The results were interpreted on microscopic examination and the data from observations of touch imprint, frozen section and histopathological examinations as well as positive and negative results of surgical margins were recorded and were entered in the excel sheet for calculation of accuracy, sensitivity and predictive values of two intraoperative procedures using histopathological diagnoses as gold standard. For calculation of accuracy and sensitivity of diagnoses of the intraoperative procedures, all the cases were classified into benign, malignant, metastatic and equivocal groups, equivocal and borderline cases were included in negative results. For comparison, all the cases were divided into epithelial and non-epithelial groups and for surgical margin clearance, only malignant cases diagnosed histologically were considered for calculation. Variable number of smears were prepared on the basis of types of the specimen from one to six during touch imprint cytology for margin clearance and for calculation of accuracy and predictive value, and all the malignant cases were classified into positive, negative and

nondiagnostic categories. There is no definite criteria for adequacy of smear preparation during imprint cytology and because of haemorrhage, fibrosis, surface irregularity or sampling error, these may lead to yield inadequate or obscured smears which might be difficult for a conclusive decision. So, therefore the nondiagnostic smears were included in negative group. All observations and results were recorded and data were summarized and tabulated.

STATISTICAL TOOL

The data obtained from observations were analysed by using the computer software 'Statistical Package for the Social Sciences (SPSS Inc; Chicago, IL, USA)'.

RESULTS

A total of 72 surgically resected specimens from various organs were included in this study. The aim of the study was to emphasize on the variation of outcome of touch imprint cytology of epithelial and mesenchymal malignancies considering the surgical margin clearance as well as the comparison of diagnostic accuracy of various lesions between cytology and frozen section. For this purpose, the diagnoses by intraoperative procedures were broadly classified into benign, equivocal, malignant and metastatic categories (Table-2) and for the comparison of assessment of surgical margin clearance; the tumours were divided into epithelial and non-epithelial groups (Table-6).

Table-1: Distribution of the patients according to organ specific lesions with their diagnoses (n=72).

Name of organ involved by tumour	Histopathological diagnoses	No. of cases	No. of cases in Specific organ	Percentage
Ovary	Benign serous cystadenoma	10	29	40.3%
	Papillary serous cystadenocarcinoma	06		
	Mucinous cystadenocarcinoma	05		
	Borderline mucinous tumour	04		
	Granulosa cell tumour	01		
	Metastatic adenocarcinoma	03		
Soft tissue tumour	Fibrosarcoma	05	12	16.7%
	Dermatofibrosarcoma	02		
	Hemangioma	02		
	MPNST	02		
	Liposarcoma	01		
Brain	Pilocytic astrocytoma	02	06	8.3%
	Glioblastoma multiforme	02		
	Metastatic adenocarcinoma	02		
Breast	Invasive duct cell carcinoma	06	07	9.7%
	Invasive lobular carcinoma	01		
Thyroid	Papillary carcinoma	02	03	4.2%
	Follicular carcinoma	01		
Skin	Squamous cell carcinoma	02	05	6.9%
	Basal cell carcinoma	02		
	Malignant melanoma	01		
Stomach	Adenocarcinoma	02	02	2.8%
Salivary gland	Pleomorphic adenoma	01	05	6.9%
	Warthin's tumour	02		
	Adenoid cystic carcinoma	02		
Uterus	Leiomyosarcoma	03	03	4.2%
Total	72		72	100%

The majority of 72 cases were ovarian neoplasms comprising of 29 (40.3%) cases followed by soft tissue tumour 12(16.7%), breast 7 (9.7%), brain neoplasm 6 (8.3%), skin 5 (6.9%), salivary gland 5 (6.9%), and thyroid tumours 3 (4.2%),(Table-1). The most of the cases were malignant (51/70.83%, including metastatic), followed by benign (15/20.83%), and borderline (6/8.33%), (Table-2).

Table-2: Distribution of the patients into various categories of intraoperative diagnosis & histopathology (n=72).

Categories	No. of cases diagnosed By Imprint cytology	No. of cases diagnosed By Frozen section	Diagnosis by follow-up Histologic examination
Benign	16	15	15
Equivocal	8	7	6(Borderline)
Malignant	44	47	46
Metastatic	4	3	5
Total	72	72	72

Three imprint cytology missed the diagnoses of malignancy and overall one frozen section missed the diagnosis of metastatic tumour. One metastatic case was misinterpreted by frozen section as primary malignancy and another was reported negatively but corrected by imprint cytology.

Table-3: Overall diagnostic accuracy, sensitivity, specificity, positive and negative predictive values of imprint cytology and frozen section (n=72).

Procedure	Accuracy	Specificity	Sensitivity	Positive Predictive value	Negative Predictive value
Imprint cytology	95.8%	100%	94.1%	100%	87.5%
Frozen section	97.2%	95.5%	98%	98%	95.4%
Combined	98.6%	100%	98%	100%	95.4%

The overall diagnostic accuracy rate of imprint cytology in various organs was 95.8% and that of frozen section was 97.2% (Table-3). The combined diagnosis accuracy rate was 98.6%. The false-negative and false-positive rates of imprint cytology were 4.2% and 0% respectively. The false-negative rate of frozen section was 1.38%. In three of the misinterpreted cases by cytology, frozen section was helpful to arrive at the final diagnosis and in distinguishing between the benign and malignant tumour. One misinterpreted case of metastatic carcinoma was considered as false-positive result in frozen section which was reported negatively by cytology. No false-positive diagnosis was seen in imprint cytology (p=<0.01).

Table-4: Comparison between the different categories diagnosed by cytology and frozen section of epithelial lesions and that of non-epithelial lesions.

Epithelial tumours(N=52)				Non-epithelial tumours(N=20)			
No. of cases	Diagnoses By imprint cytology	Diagnoses By frozen section	Histologic Diagnosis	No. of cases	Diagnoses By imprint cytology	Diagnoses By frozen section	Histologic Diagnosis
35	Malignant	Malignant	Malignant	12	Malignant	Malignant	Malignant
01	Benign	Equivocal	Borderline	01	Malignant	Equivocal	Malignant
03	Equivocal	Equivocal	Borderline	02	Equivocal	Equivocal	Borderline
01	Equivocal	Malignant	Malignant	02	Equivocal	Malignant	Malignant
12	Benign	Benign	Benign	03	Benign	Benign	Benign
Total	52	52	52	Total	20	20	20

Two cases of ovarian neoplasm were missed on imprint cytology and reported negatively, but these were reported by frozen section positively, and these were due to inadequacy of smear preparation. In one case, there were seen many prominent thin-walled blood vessels and marked interlobular fibrosis, a differential diagnosis of sclerosing stromal tumour and fibrothecoma was given. Finally, the histopathological examination showed cellular pseudotubules separated by thick fibrous bands and composed of two types of cells (spindle shaped cells and vacuolated cells resembling signet-ring cells). In another ovarian neoplasm the imprint smears were cellular with many papillary structures showing the uniform epithelial cells, therefore, an equivocal result was given false-negatively. The frozen section revealed the foci of stromal invasion and so, a diagnosis of cystadenocarcinoma was made which was finally diagnosed metastatic adenocarcinoma histologically (Table-4). In the five metastatic cases, frozen section missed two cases, one was misinterpreted and

reported as primary malignancy and another was reported as equivocal, but revealed by imprint smears as metastatic adenocarcinoma in ovary (Table-4). One follicular carcinoma was missed by imprint cytology and diagnosed by frozen section which revealed capsular invasion and finally was confirmed by histopathology (Table-2).

In 52 epithelial tumours, 47(90.38%) cases were concordant in three modalities, and in 20 non-epithelial tumours, 15(75%) cases were concordant in three test modalities, (Table-4).

Table-5: Diagnostic accuracy, sensitivity, positive and negative predictive values of imprint cytology and frozen section of epithelial and non-epithelial tumours using subsequent histology as "gold standard"(n=72).

	Epithelial tumours (N=52)					Non-epithelial tumours(N=20)				
Procedures	Accuracy	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Imprint Cytology	98.07 %	97.2%	100%	100%	94.1%	90%	86.6 %	100%	100%	71.4%
Frozen Section	100%	100%	100%	100%	100%	95%	93.3 %	100%	100%	83.3%
Combined	100%	100%	100%	100%	100%	100 %	100 %	100%	100%	100%

Accuracy of cytology and frozen section in epithelial tumours were 98.07% and 100% respectively, on the other hand, accuracy of cytology and frozen section in non-epithelial tumours were 90% and 95% respectively, although the combined accuracy in epithelial tumours is 100%, similar to non-epithelial tumours, (Table-5).

Accuracy of both the intraoperative methods were evaluated for surgical margin clearance in epithelial and non-epithelial groups and variable number of negative, positive or nondiagnostic cases were verified by subsequent histopathological diagnoses (Table-6).

Table-6: Comparison between the different categories diagnosed by cytology and frozen section on surgical margin clearance of epithelial lesions and that of non-epithelial lesions.

Epithelial tumours(N=36)				Non-epithelial tumours(N=15)			
No. of cases	Diagnoses By imprint Cytology	Diagnoses By Frozen Section	Histologic Diagnosis	No. of cases	Diagnoses By Imprint Cytology	Diagnoses By Frozen Section	Histologic Diagnosis
25	Negative	Negative	Negative	04	Negative	Negative	Negative
02	Negative	Positive	Negative	02	Negative	Positive	Negative
01	Negative	Positive	Positive	01	Negative	Negative	Positive
02	Nondiagnostic	Positive	Positive	01	Nondiagnostic	Positive	Positive
01	Nondiagnostic	Nondiagnostic	Negative	01	Nondiagnostic	Nondiagnostic	Positive
01	Nondiagnostic	Negative	Positive	02	Nondiagnostic	Nondiagnostic	Negative
02	Positive	Nondiagnostic	Positive	01	Positive	Nondiagnostic	Positive
01	Positive	Negative	Negative	01	Positive	Negative	Negative
01	Positive	Positive	Positive	02	Positive	Positive	Positive
Total	36	36	36	Total	15	15	15

Among 36 epithelial cases, 26 (72.22%) results were concordant in three test modalities, and in 10 cases the results were discordant. In 32 (88.9%) cases, imprint results were conclusive, and 4 cases were inconclusive. On the other hand, in 33(91.7%) cases, frozen section results were conclusive and 3 cases were inconclusive. Among the 32 imprint conclusive results, 30 (93.75%) cases were concordant with histologic diagnosis, and among 33 frozen section conclusive results, 30 (90.9%) cases were concordant with histologic diagnosis (Table-6).

Among 15 non-epithelial cases, 6 (40%) results were concordant in three test modalities, and in 9 cases the results were discordant. In 11 (73.33%) cases, imprint results were conclusive, and 4 cases were inconclusive, and also in 11(73.33%) cases, frozen section results were conclusive and 4 cases were inconclusive results. In the 11 conclusive imprint results, 9(81.81%) cases were concordant with histologic diagnosis, and in the 11 conclusive frozen section results, 8 (72.72%) cases were concordant with histologic diagnosis (Table-6).

Table-7: Diagnostic accuracy, sensitivity, specificity, adequacy, positive and negative predictive values of imprint cytology and frozen section for margin clearance of epithelial and non-epithelial lesions (N=51).

Procedures	Epithelial Tumours (N=36)						Non-epithelial Tumours (N=15)					
	Accuracy	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Adequacy	Accuracy	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Adequacy
Imprint Cytology	86.1 %	42.8 %	96.5 %	75%	87.5%	88.8 %	73.3 %	50%	88.8 %	75%	72.7%	72.7 %
Frozen Section	86.1 %	57.1 %	93.1 %	66.6%	90%	91.6 %	66.6 %	50%	77.7 %	60%	70%	88.8 %
Combined	91.6 %	75%	96.4 %	85.7%	93.1%	97.2 %	66.6 %	66.7 %	66.6 %	57.1%	57.1%	80%

Accuracy rates of both imprint cytology and frozen section for epithelial tumours were 86.1% and higher than 73.33% and 66.66% in non-epithelial tumours respectively (Table-7). Negative predictive value of cytology and frozen section for epithelial tumours were 87.5% and 90% respectively, which were higher than that for non-epithelial tumours (72.7% and 70% respectively). Combined accuracy of cytology and frozen section in epithelial tumours was 91.6%, which is higher than that for non-epithelial tumours (66.6%), (Table-7). Negative predictive value for assessment of surgical margin clearance using the combination of the two procedures was 93.1% in epithelial tumours (Table-7), which is higher than that in non-epithelial tumours (57.1%).

DISCUSSION

The aim of this study was to evaluate the accuracy of imprint cytology as intraoperative diagnostic procedure in comparison with frozen section. There are several studies to establish the utility and efficacy of imprint cytology and frozen section as intraoperative consultation diagnostic modalities. These have been found that cytology has the advantage of being much less time consuming, easy to adopt, reliable and does not require special instruments [5, 6]. Hence, imprint cytology can be employed routinely in the intraoperative diagnosis in conjunction with frozen section [13, 15]. The use of either frozen section or cytological examination alone has an acceptable rate (93-97%) of correct diagnosis, with regard to interpretation of benign versus malignant [16-18]. The use of cytology smears during intraoperative consultation has often been neglected in favour of traditional examination of frozen sections and this appears to be due to the surgical pathologists are relatively more enthusiastic for frozen sections, though many studies have demonstrated that the diagnostic efficacy of intraoperative cytology is comparable to that of frozen section [17]. In our study, a total of 72 surgically resected specimens were studied on both imprint cytology and frozen section. The diagnostic accuracy of imprint cytology and frozen section were evaluated individually by comparing with the gold standard histopathological examination. Among the 72 cases, 51 cases were diagnosed malignant by histologic examination (Table-1), diagnostic accuracy of touch imprint cytology was 95.8% and accuracy of frozen section was 97.2%, which is comparable to other studies. The pitfall of the present study is that the both procedures yielded equivocal and nondiagnostic results and these were possibly in borderline cases or in haemorrhagic, surface irregularity, presence of fibrous tissue or calcification of the specimen. The diagnostic accuracy rates of imprint cytology were observed 80-97% in different studies [15, 19, 20]. The diagnostic accuracy rates of imprint cytology and frozen section of present study were comparable with that of other studies and we obtained very good results. Among the 72 cases in this study, the ovarian neoplasms constituted the major group comprising of 29(40.3%) cases followed by soft tissue tumour (16.7%), breast (9.7%), and brain (8.3%) neoplasms. The diagnostic accuracy rates of imprint cytology and frozen section in ovarian neoplasms were 93.1%

(27/29) and 96.6% respectively. The false-negative and false-positive rates of imprint cytology in ovarian neoplasms were 6.9% and 0% respectively. Another study on 60 ovarian masses, it was found that the overall accuracy of frozen section was 95.5% [21]. Out of 3(4.2%) thyroid cases in our study, one case of follicular thyroid carcinoma was not diagnosed by imprint cytology because of gross sampling error but frozen section revealed capsular invasion and reported positively. The diagnostic accuracy of imprint cytology and frozen section in thyroid lesions, were 66.6% (2/3) and 100% (3/3) respectively. Sukumar Shaha *et al*., [22] studied a total of 57 thyroid lesions, the diagnostic accuracy of frozen section and imprint cytology were 88.46% and 81.25% respectively. This was almost similar to our findings. In the present study, the diagnostic accuracy of both imprint cytology and frozen section in breast tumours was 100%. Chandrakar J *et al*. [19] studied 36 breast lesions and imprint cytology correctly diagnosed 30(83.3%) cases and in 6 (16.66%) cases, smears were unsatisfactory. In another study by Patil P *et al*., [23] the diagnostic accuracy of frozen section in breast lesions was 93.75% (15/16 cases). In comparison with aforementioned studies, the diagnostic accuracy of both the techniques in breast lesions was 100% in the present study. Lee *et al*., [24] retrospectively studied 522 histologically proven tumours, the total diagnostic accuracy of imprint cytology was 92.9% for both benign and malignant tumours, and individually for benign tumours, accuracy rate was 97.2% and for malignant tumours it was 89.9%. In our study, all the six CNS cases were accurately diagnosed by frozen section and imprint cytology. SAM Ahmed *et al*., [25] studied 33 clinically diagnosed patients of CNS tumours, and the sensitivity of frozen section was 100% and that of imprint cytology was 75%. The accuracy of both the techniques in our study were comparable to this study. The experience of the pathologist in interpretation of imprints is the mainstay in improving the diagnostic accuracy when both the techniques are combined [26]. Not only the experience, but the major pitfall of the present study is that there are some equivocal results in intraoperative procedures, which were considered as negative cases, also there were some non-diagnostic cases in assessment of surgical margin clearance, which might be due to sampling error and technical faults as well as artefacts and this type of report is usually made by the pathologists to evade the false-positive report which might have a misleading effect on treatment. Surgical margin clearance is important in malignant cases in intraoperative procedures for guidance of patient management to prevent recurrence of tumours. Our study emphasizes on the diagnostic accuracy of imprint cytology and frozen section for margin clearance in malignant cases. Yadav *et al*., [27] studied the sensitivity, specificity, positive and negative predictive value for margin clearance status in cases of OSCC and found that imprint cytology has overall accuracy of 83%, sensitivity of 91.1%, specificity of 74.4%, PPV of 79.2%, and NPV of 88.6%, which are comparable to the findings of present study. In the present series, we have tried to explore the variation of yields of epithelial tumours and non-epithelial tumours in intraoperative diagnosis and assessment of margin clearance, the observations of the study are that the accuracy rate of imprint cytology and frozen section in epithelial tumour diagnosis are similar to that in non-epithelial tumours (Table-5), and combined performance of cytology and frozen section is 100%. In the assessment of surgical margin clearance, the combined accuracy in epithelial tumours is 91.66%, which is higher than that in non-epithelial tumours (66.66%), also the negative predictive value in epithelial tumours is 93.1% which is higher than that in non-epithelial tumours(75%), (Table-7). Many studies on frozen section for surgical margin clearance are available but studies on imprint cytology were not done frequently because of touch imprint does not give satisfactory cell yield and not providing an adequate intraoperative technique for surgical margin clearance. Francois D'Halluin *et al*., [28] found in a study on 400 breast lump surgeries that imprint cytology has an accuracy of 91.5%, sensitivity 88.6%, specificity of 92.2%, positive predictive value of 73.6%, and negative predictive value of 97%. The present study reveals a satisfactory accuracy of 86.1%, negative predictive value of 87.1%, positive predictive value of 75%, specificity of 96.5%, but low sensitivity of 42.8% for margin clearance of epithelial tumours. Further study is recommended for exploration of variation between the yields of epithelial tumours and non-epithelial tumours. Thus, a combination of these techniques plays a significant role in arriving at an accurate diagnosis rapidly and in guiding the surgeon intraoperatively in the management of patients.

CONCLUSION

Imprint cytology and frozen section are interdependent intraoperative consultation diagnostic procedures. Imprint cytology alone may not provide a correct diagnosis but a combination of these two techniques helps in achieving high diagnostic accuracy in distinguishing benign and malignant lesions and forms an important aspect of surgical pathology to guide the surgeon in rapid intraoperative pathological evaluation. Malignancies

of epithelial origin yield better results by imprint cytology in comparison with non-epithelial lesions in assessment of surgical margin clearance.

What does this study add to existing knowledge?

Many of the studies done in the past have either used imprint cytology or frozen section as an intraoperative diagnostic tool for a diagnosis. Only few of the studies have showed the combined role of imprint cytology and frozen section in intraoperative diagnosis. In our study, we have assessed the diagnostic accuracy rates of both the methods in various organs and explored the variation of yields of epithelial and non-epithelial tumours for evaluation of surgical margin clearance.

REFERENCES

1. Manafis, K. (1997). An intraoperative consultation. *Usefulness, reason and accuracy of the method. Arch Hell Pathol*, *11*, 472-7.
2. Dudgeon, L. S., & Patrick, C. V. (1927). A new method for the rapid microscopical diagnosis of tumours: with an account of 200 cases so examined. *Journal of British Surgery*, *15*(58), 250-261.
3. Shahid, M., Zaheer, S., Mubeen, A., Rahman, K., & Sherwani, R. K. (2012). The role of intraoperative cytology in the diagnostic evaluation of ovarian neoplasms. *Acta Cytologica*, *56*(5), 467-473.
4. Suen, K. C., Wood, W. S., Syed, A. A., Quenville, N. F., & Clement, P. B. (1978). Role of imprint cytology in intraoperative diagnosis: value and limitations. *Journal of clinical pathology*, *31*(4), 328-337.
5. Shidham, V. B., Dravid, N. V., Grover, S., & Kher, A. V. (1984). Role of scrape cytology in rapid intraoperative diagnosis. Value and limitations. *Acta cytologica*, *28*(4), 477-482.
6. Gal, R. (1988). Scrape cytology assessment of margins of lumpectomy specimens in breast cancer. *Acta cytologica*, *32*(6), 838-839.
7. Kolte, S. S., & Satarkar, R. N. (2010). Role of scrape cytology in the intraoperative diagnosis of tumor. *Journal of Cytology/Indian Academy of Cytologists*, *27*(3), 86.
8. Bianchi, S., Palli, D., Ciatto, S., Galli, M., Giorgi, D., Vezzosi, V., ... & Zampi, G. (1995). Accuracy and reliability of frozen section diagnosis in a series of 672 nonpalpable breast lesions. *American journal of clinical pathology*, *103*(2), 199-205.
9. Bancroft, J.D., Gamble, M. (2002). Theory and practice of histological techniques. 5th edn. Edinburgh, Churchill Livingstone.
10. Ranjan, A., Chandoke, R.K., Chauhan, N., Rajkumari. (2013). Study of tumours by imprint cytology. IJCP, *24*(5); 472-7.
11. Stewart, C. J., Brennan, B. A., Koay, E., Naran, A., & Ruba, S. (2010). Value of cytology in the intraoperative assessment of ovarian tumors: a review of 402 cases and comparison with frozen section diagnosis. *Cancer Cytopathology*, *118*(3), 127-136.
12. Wazer, D. E., DiPetrillo, T., Schmidt-Ullrich, R., Weld, L., Smith, T. J., Marchant, D. J., & Robert, N. J. (1992). Factors influencing cosmetic outcome and complication risk after conservative surgery and radiotherapy for early-stage breast carcinoma. *Journal of Clinical Oncology*, *10*(3), 356-363.
13. Mair, S., Lash, R. H., Suskin, D., & Mendelsohn, G. (1991). Intraoperative Surgical Specimen Evaluation: Frozen Section Analysis, Cytologic Examination, or Both?: A Comparative Study of 206 Cases. *American journal of clinical pathology*, *96*(1), 8-14.
14. Harris, H. F. (1900). On the rapid conversion of haematoxylin into haematein in staining reactions. *Journal of Applied Microscopic Laboratory Methods*, *3*(3), 777.
15. Esteban, J. M., Zaloudek, C., & Silverberg, S. G. (1987). Intraoperative diagnosis of breast lesions: comparison of cytologic with frozen section technics. *American journal of clinical pathology*, *88*(6), 681-688.
16. Scucchi, L. F., Di Stefano, D., Cosentino, L., & Vecchione, A. (1997). Value of cytology as an adjunctive intraoperative diagnostic method. An audit of 2,250 consecutive cases. *Acta cytologica*, *41*(5), 1489-1496.
17. Shidham, V., Gupta, D., Galindo, L. M., Haber, M., Grotkowski, C., Edmonds, P., ... & England, J. (2000). Intraoperative scrape cytology: comparison with frozen sections, using receiver operating characteristic (ROC) curve. *Diagnostic cytopathology*, *23*(2), 134-139.
18. Tribe, C. R. (1973). A comparison of rapid methods including imprint cytodiagnosis for the diagnosis of breast tumours. *Journal of clinical pathology*, *26*(4), 273.
19. Chandrakar, J., & Srivastava, S. (2015). Evaluation of the relevance of touch imprint cytology in the diagnosis of various neoplastic lesions.
20. Ahmad, Z., Barakzai, M. A., Idrees, R., & Bhurgri, Y. (2008). Correlation of intra-operative frozen section consultation with the final diagnosis at a referral center in Karachi, Pakistan. *Indian Journal of Pathology and Microbiology*, *51*(4), 469.
21. Mohammed, A. B. F., Ahuja, V. K., & Farghaly, H. (2015). Role of frozen section in the intraoperative management of ovarian

masses. *Middle East Fertility Society Journal*, *20*(2), 97-101.
22. Shaha, S., & Rahman, A. N. (2009). Comparative Study of imprint cytology and frozen section in the intraoperative diagnosis of thyroid lesions. *Bangladesh Journal of Pathology*, *24*(1), 12-15.
23. Patil, P., Shukla, S., Bhake, A., & Hiwale, K. (2015). Accuracy of frozen section analysis in correlation with surgical pathology diagnosis. *Int J Res Med Sci*, *3*(2), 399-404.
24. Lee, T. K. (1982). The value of imprint cytology in tumor diagnosis: a retrospective study of 522 cases in northern China. *Acta cytologica*, *26*(2), 169-171.
25. Ahmed, S. A. M., Badruddoza, S. M., Meherunnesa, M., Ekramullah, S. M., Hossain, M. Z., Habib, A., & Zahan, R. A. (2014). Diagnostic accuracy of imprint cytology and frozen section for CNS tumor. *Faridpur Medical College Journal*, *9*(1), 24-27.
26. Khalid, A., & Haque, A. U. (2004). Touch impression cytology versus frozen section as intraoperative consultation diagnosis. *Int J Pathol*, *2*(2), 63-70.
27. Yadav, G. S., Donoghue, M., Tauro, D. P., Bharani, S., Kumar, M., & Yadav, A. (2014). Confounding factors and diagnostic accuracy of imprint cytology. *Acta cytologica*, *58*(1), 53-59.
28. D'Halluin, F., Tas, P., Rouquette, S., Bendavid, C., Foucher, F., Meshba, H., & Levêque, J. (2009). Intra-operative touch preparation cytology following lumpectomy for breast cancer: a series of 400 procedures. *The Breast*, *18*(4), 248-253.