PROSPECTIVE STUDY ON COMPARISON OF INTRAOPERATIVE FROZEN SECTION AND CYTOLOGICAL TECHNIQUES AS DIAGNOSTIC MODALITIES OF OVARIAN MASS LESIONS

Sonal Dwivedi¹, Riddhi Jaiswal², Nisha Singh³, Ajay Kr Singh⁴, Madhumati Goel⁵

¹Junior Resident, Department of Pathology, KGMU, Lucknow.

²Associate Professor, Department of Pathology, KGMU, Lucknow.

³Professor, Department of Obstetrics and Gynaecology, KGMU, Lucknow.

⁴Associate Professor, Department of Pathology, KGMU, Lucknow.

⁵Professor, Department of Pathology, KGMU, Lucknow.

ABSTRACT

BACKGROUND

Frozen section and cytology in gynaecological pathology have received less attention till date. This research focusses on indications and limitations of per-operative diagnostic techniques in pathology. Ovarian neoplasms are heterogeneous group of benign and malignant tumours classified on different cells of origin. Histopathology, however, remains the gold standard in tissue diagnosis.

MATERIALS AND METHODS

A descriptive study was conducted including 31 cases. Frozen section was performed on tissue specimens received in normal saline on thermo scientific HM525 cryostat. Simultaneous scrape and imprint smears were prepared and all slides stained with H and E, Giemsa and read by two independent pathologists. Results were then compared with histopathology of each case.

RESULTS

Frozen section in ovarian lesions showed sensitivity, specificity, positive predictive value, negative predictive value and accuracy values of 85.7%, 100%, 100%, 87.5% and 92.9% respectively. Aspirate cytology showed sensitivity, specificity, positive predictive value, negative predictive value and accuracy values of 40%, 100%, 100%, 62.5% and 70% respectively. Imprint cytology showed sensitivity, specificity, positive predictive value, negative predictive value and accuracy values of 33.3%, 100%, 100%, 60% and 66.7%.

CONCLUSION

Comparison of intraoperative histology and cytology show that though cytology provides supporting information preoperatively, frozen section examination is more reliable in deciding extent of surgery in ovarian mass lesions.

KEYWORDS

Frozen Section, Cytology, Ovarian Mass.

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BACKGROUND

Frozen section is of great use in surgical oncology; however, in ovarian pathology large as well as small masses can be of dubious nature. Hence, the part played by per-operative diagnosis gains importance. The following study focuses on adding to the literature, use of frozen section and intra-operative cytology in diagnosis of ovarian diseases. An intraoperative consultation in gynaecological pathology is indicated- (a) To ensure that the tissue sampled is adequate for diagnosis; (b) To determine the nature of a disease process; (c) To plan for appropriate ancillary studies; (d) To determine tumour spread; and (e) To assess the margins.^[1,2,3]

Ovarian neoplasms are a heterogeneous group of benign and malignant tumours of epithelial, stromal and germ cell origin. Histopathology remains the ultimate gold standard in tissue diagnosis.^[4,5]

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Corresponding Author:

Dr. Riddhi Jaiswal,

Associate Professor,

Department of Pathology,

KGMU, Lucknow, UP.

E-mail: riddhiadvay@gmail.com

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Rapid diagnosis of surgically removed specimens has created many controversies and a single completely reliable method has not yet been developed. Frozen section is the most frequently used technique along with some centres utilising cytological techniques including imprint and scrape cytology and intra-operative Fine-Needle Aspiration Cytology (FNAC).^[3,6,7] Few studies in experienced hands have shown its diagnostic efficacy to be almost 92%. It is simple and cheap, not requiring special training.^[8-10] The disadvantages are few and experience yields perfection. It however neither distinguishes in situ from invading carcinoma nor evaluates depth of invasion. Thus, apart from its diagnostic role, intraoperative cytology can become a learning tool as well.^[8,11,12] Scrape smear cytology is a modified imprint cytology, in which cells are scraped from inner surface of specimen.^[11-12] Along with frozen section, it helps expand knowledge of cytology of ovarian lesions.^[13,14,15] Intraoperative opinion resorts staging and modification of surgical procedure.

MATERIALS AND METHODS

Study Setting

Conducted at the Department of Pathology, in co-ordination with Department of Obstetrics and Gynaecology, King George's Medical University.

Duration of Study

1 Year (August 2015 - July 2016).

Study Type

Descriptive study.

Study Group

All patients with ovarian diseases that need surgical treatment.

Sample Collection

Cystectomy, Ovarian biopsy, Oophorectomy and Salpingo-oophorectomy, Omental and Peritoneal nodules in patients ranging from 12 - 70 years were included in study.

In this study, the accuracy of intraoperative cytology was assessed and the results are compared with frozen section and final histopathological diagnosis.

Each technique was evaluated independently, although the diagnosis transmitted to the surgeon was based upon the combination of the clinical, macroscopic, histological and cytological information. The results were compared with the final pathological diagnosis in each case and cases with discordant diagnosis were reviewed.

Inclusion Criteria

Ovarian diseases that need surgical treatment, both neoplastic and non-neoplastic.

Exclusion Criteria

1. Inadequate/Non-representative samples.
2. Patients refusing consent.

1) Frozen Section Technique

The gross specimen is received in normal saline in the laboratory.

1. **Embedding Tissue-** The selected piece of tissue is then placed on a metallic holder and must be oriented a certain way so that the future section will reveal proper spatial relationships. This orientation depends on the question being asked.

The tissue is embedded in soluble M1 cryomatrix medium and is then placed in the cryostat machine, where it is properly frozen.

2. **Cryostat-** Thermo Scientific Micro HM550 installed in department was used for frozen sectioning. Turnaround time for each frozen section was 10 - 15 minutes.

Temperature

The temperature should be at -20° C for most tissues. For tissues with a large fat component, -40° C is optimal. This temperature is critical for optimal sectioning. (If the temperature is too high, i.e. -10°C, the tissue will not stay frozen and firm and will not cut crisp.

If the temperature is too cold, i.e. -50° C, the tissue will crumble and become powder. The ideal tissue should cut like butter, smooth and in one piece).

3. **Staining-** Once the section is cut, the slides are stained using progressive haematoxylin and eosin staining.

4. **Interpreting the Frozen Section-** By two pathologists independently.

2) Aspirate Cytology Smear Technique

1. Aspirate from the ovarian mass is collected by applying negative pressure using a 10 mL syringe.
2. The aspirate is then centrifuged and the

supernatant discarded.

3. A drop is poured on the slide and smeared.
4. Slide is fixed by putting into the alcohol.
5. Slide is then stained by Harris haematoxylin and eosin staining.

3) Imprint Cytology Smear Technique

1. Slide is taken and tissue is imprinted on it by pressing upon.
2. It is then fixed by putting into the alcohol.
3. Stained by Harris haematoxylin and eosin.

4) Haematoxylin and Eosin Staining Procedure

1. Dissolve all wax with xylene or by keeping it on hot plate.
2. After thorough dewaxing, slide is passed through several changes of progressively decreasing concentration alcohol to remove xylene and then thoroughly rinsed in water.
3. Slide is now stained with nuclear stain such as haematoxylin, which consists of a dye and a mordant.
4. Slide is dipped for 8 - 15 minutes in the stain and then rinsed in tap water.
5. Background staining is removed and also contrast is improved by dipping the slide in weak acid alcohol for 1 - 5 seconds.
6. After this thorough rinsing in tap water is required.
7. Slide is then dipped in counter stain, eosin.
8. Slide is then passed through increasing concentration of alcohol and then dried and dipped in xylene.
9. Xylene clears the tissue and renders slide completely transparent and then slide is mounted.

5) Giemsa Staining Procedure

1. Air dried smear prepared.
2. Giemsa stain is then poured over the smear and kept for 10 minutes.
3. After this a similar quantity of buffer is added over the smear covered with the Giemsa stain.
4. Washed in running water.
5. Air dried and the slides then mounted with the help of xylene and Canada balsam.

Our study was approved by the Ethical Committee, King George's Medical University, Lucknow, UP.

Statistical Analysis Plan

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 Statistical Analysis Software. The values were represented in number, percentage and mean $\pm$ SD. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy values were calculated for each of three modalities.

RESULTS

Age of patients ranged from 12 to 70 years. Majority of cases were aged between 31 and 50 years (n= 18; 58.1%). There were only 2 (6.5%) cases in age group 21 - 30 and 61 - 70 years. Mean age of patients was 38.29 $\pm$ 14.65 years.

Specimen	No. of Cases	Percentage
Ovarian mass	18	58.1
Uterus with adnexa	8	25.8
Others	5	16.1
Ovarian biopsy	1	3.2
Ovary with gall bladder	1	3.2
Right ovary with fallopian tube	1	3.2
Sigmoid colon, rectum, left ovary	1	3.2
Tubo-ovarian mass	1	3.2

Table 1. Distribution of Cases according to Specimen Type

Graph 1

Majority of specimen were obtained from ovarian mass (n= 18; 58.1%). A total of 8 specimens (25.8%) were obtained from uterus with adnexa. Among remaining 5 (16.1%) cases, one each (3.2%) was obtained from ovarian biopsy, ovary with gall bladder, right fallopian tube, sigmoid colon-rectum with left ovary and tubo-ovarian mass respectively.

Sl. No.	Aspirate	Frozen	Imprint	Histology
1.	Positive for malignant cells	Mixed germ cell tumour	Paucicellular	Malignant mixed germ cell tumour
2.	Hemosiderin-laden macrophages	Cyst	Hemosiderin-laden macrophages	Follicular cyst
3.	Paucicellular comprising of mesothelial cells, RBC's and inflammatory cells	Cyst	Paucicellular	Simple cyst
4.	Acellular	Cyst	Paucicellular	Autolysed tissue only
5.	Mucoid material	Necrotic material	Suspicious atypical cell clusters	Mixed germ cell tumour
6.	Negative	Suspicious for malignancy	Degenerated cells	Left ovary- Granulosa cell tumour
7.	Benign columnar epithelial cells	Suspicious for malignancy	Negative	Mucinous cyst adenocarcinoma
8.	Proteinaceous material only	Cyst	Haemorrhage only	Mature teratoma
9.	Positive for malignant cells	Papillary serous cyst adenocarcinoma	Degenerated suspicious cells	High-grade serous carcinoma
10.	Few squamous epithelial cells	Cyst	Pultaceous material, necrotic material	Mature teratoma
11.	Negative	Suspicious for malignancy	Positive for suspicious cells	High-grade serous carcinoma
12.	Negative	Papillary serous cystadenocarcinoma	Small cluster of epithelial cells, mesothelial cells	Papillary serous cyst adenocarcinoma
13.	Negative	Benign-to-borderline serous cyst adenoma	Mesothelial cells and bland epithelial cells	Borderline serous cyst adenoma
14.	Negative	Fibrocollagenous tissue	Negative	Simple cyst
15.	Spindled and inflammatory cells	Endometriosis	Stromal and inflammatory cells	Endometriosis
16.	Anucleated squames	Teratoma	Anucleated squames	Mature teratoma
17.	Positive for tumour cells	Yolk sac tumour	Positive for tumour cells	Malignant mixed germ cell tumour
18.	Negative	Granulosa cell tumour/Non-Hodgkin's lymphoma	Positive	Granulosa cell tumour
19.	Negative	Benign serous cyst	Sheets of monolayered cells	Benign serous cyst
20.	Negative	Yolk sac tumour	Negative	Granulosa cell tumour
21.	Negative	Simple Cyst	Negative	Simple mucinous cyst
22.	Negative	Haemorrhagic cyst	Negative	Endometriosis
23.	Negative	No evidence of malignancy	Negative	No e/o malignancy
24.	Hemosiderin-laden macrophages	Endometriosis	Hemosiderin-laden macrophages	Endometriosis
25.	Positive for malignant cells	Serous cyst adenocarcinoma	Negative for malignant cells	Papillary serous cyst adenocarcinoma
26.	Paucicellular	Suspicious for malignancy	Negative for malignant cells	Malignant ovarian tumour
27.	Paucicellular	Benign cyst	Negative for malignant cells	Malignant ovarian tumour
28.	Not done	Germ cell tumour	Not done	Germ cell tumour
29.	Positive for tumour cells	Not done	Positive for malignant cells	Granulosa cell tumour
30.	Negative for tumour cells	Not done	Negative for malignant cells	Mature teratoma
31.	Positive for tumour cells	Not done	Positive for malignant cells	Mucinous cyst adenocarcinoma

Table 2. Comparison of Finding of each Enrolled Case in Our Study in Regard to each of the Techniques Used

Specimen	No. of Cases	Percentage
Benign	16	57.1
Benign ovarian cyst	10	35.71
Endometriosis	2	7.1
Fibrocollagenous tissue	1	3.6
Necrotic material	1	3.6
No evidence of malignancy	1	3.6
Teratoma	1	3.6
Malignant	12	42.9
Serous cyst adenocarcinoma	3	10.7
Suspicious for malignancy	4	14.3
Yolk sac tumour	2	7.1
Germ cell tumour	2	7.1
Granulosa cell tumour/NHL	1	3.6

Table 3. Diagnoses Based on Frozen Section Evaluation

Frozen section could be evaluated in 28/31 (90.3%) cases, out of which 16 (57.1%) were diagnosed as benign and 12 (42.9%) as malignant.

Among cases diagnosed as benign, maximum (n= 10; 35.7%) were diagnosed as benign ovarian cyst, 2 cases (7.1%) were diagnosed as endometriosis and one each (3.6%) reported as fibrocollagenous tissue, necrotic material, teratoma and absence of malignancy.

Among cases diagnosed as malignant, maximum were diagnosed as suspicious for malignancy (n= 4; 14.3%) followed by serous cyst adenocarcinoma (10.7%), yolk sac tumour (n= 2; 7.1% each) and germ cell tumour (n= 2; 7.1%) and granulosa cell tumour/NHL (n= 1; 3.6%).

Specimen	No. of Cases	Percentage
Benign	24	80.0
Acellular	1	3.3
Anucleated squames	1	3.3
Benign columnar cells	1	3.3
Few squamous epithelial cells	1	3.3
Hemosiderin-laden macrophages	2	6.7
Mucoid material	1	3.3
Negative for Malignant Cells	12	40.0
Paucicellular	2	6.7
Paucicellular comprising of mesothelial cells, red blood cells and inflammatory cells	1	3.3
Proteinaceous material only	1	3.3
Spindle and inflammatory cells	1	3.3
Positive for Malignant Cells	6	20.0

Table 4. Aspirate Cytology Diagnosis (n = 30)

Aspiration cytology could be performed in 30 cases. Out of these, 24 (80%) were diagnosed as benign and remaining 6 (20%) were diagnosed as positive for malignant cells.

Among cases diagnosed as benign, a total of 12 cases (40%) were negative for malignant cells. In 2 (6.7%) cases hemosiderin-laden macrophages were seen, while another 2 (6.7%) were paucicellular. There was one (3.3%) case each, which were reported as acellular, anucleated squames, presence of few squamous epithelial cells, mucoid material, paucicellular comprising of mesothelial cells, RBCs and inflammatory cells, proteinaceous material and spindle and inflammatory cells respectively.

Specimen	No. of Cases	Percentage
Benign	25	83.3
Negative	10	33.3
Anucleated squames	1	3.3

Degenerated cells	1	3.3
Degenerated suspicious cells	1	3.3
Hemorrhage only	1	3.3
Hemosiderin-laden macrophages	2	6.7
Mesothelial cells and bland epithelial cells	1	3.3
Paucicellular	3	10.0
Negative for tumour cells	1	3.3
Pultaceous material, necrotic material	1	3.3
Sheets of monolayered sheets	1	3.3
Small cluster of epithelial cells, mesothelial cells	1	3.3
Stromal and inflammatory cells	1	3.3
Positive for Malignant Cells	5	16.7

Table 5. Imprint Cytology Diagnosis

Imprint cytology could be performed in 30 cases. Of these, 25 (83.3%) were diagnosed as benign and remaining 5 (16.7%) were diagnosed as malignant.

A total of 25 cases were diagnosed as benign, 10 (33.3%) were negative, 3 cases were reported as (10%) paucicellular, 2 cases (6.7%) were reported as hemosiderin-laden macrophages, 1 case (3.3%) each had anucleated squames, degenerated cells, degenerated suspicious cells, haemorrhage only, mesothelial cells with bland epithelial cells, negative for tumour cells, pultaceous/necrotic material, sheets of monolayered cells, small cluster of epithelial cells/mesothelial cells and stromal with inflammatory cells respectively.

Specimen	No. of Cases	Percentage
Benign	15	48.4
Autolysed tissue only	1	3.2
Benign serous cyst	2	6.5
Endometriosis	3	9.7
Follicular cyst	1	3.2
Mature teratoma	4	12.9
No evidence of malignancy	1	3.2
Simple cyst	2	6.5
Simple mucinous cyst	1	3.2
Malignant	16	51.6
Germ cell tumour	4	12.9
Granulosa cell tumour	4	12.9
Serous cyst adenocarcinoma	4	12.9
Mucinous cyst adenocarcinoma	2	6.5
Malignant ovarian tumour	2	6.5

Table 6. Final Diagnosis (n = 31)

Graph 2

Graph 3

Graph 4

Final diagnosis based on histopathology was benign in 15 (48.4%) and malignant in 16 (51.6%) cases.

Among benign cases, the most common diagnosis was mature teratoma (n= 4; 12.9%) followed by endometriosis (n= 3; 9.7%), simple cyst and benign serous cyst in 2 (6.5%) cases each. There was 01 case each reported as autolysed tissue, follicular cyst, simple mucinous cyst and was without evidence of malignancy.

Among malignant cases, most common diagnosis was germ cell tumour, granulosa cell tumour and serous cyst adenocarcinoma (n= 4; 12.9% each). There were 2 (6.5%) cases reported as mucinous cyst adenocarcinoma and malignant ovarian tumour respectively.

Frozen Section Diagnosis	Final Diagnosis (HPE)		Total
	Malignant	Benign	
Malignant (Fig. 1, 3, 4)	12	0	12
Benign (Fig. 2)	2	14	16
Total	14	14	28

Table 7. Diagnostic Efficacy of Frozen Section Diagnosis against Final Diagnosis for Malignancy (n = 28)

Sensitivity= 85.7%; Specificity= 100%; PPV= 100%; NPV= 87.5%; Accuracy=92.9%.

Frozen sections could be analysed in 28 cases only. On comparing the diagnosis of 28 cases of frozen section diagnosis, all the 12 cases diagnosed as malignant by frozen section were found to be malignant on final diagnosis too, whereas of the 16 cases diagnosed as benign 14 were diagnosed as benign and 2 diagnosed as malignant on final diagnosis. Thus, the technique had 12 true positive, no false positive, two false negative and 14 true negative cases, thereby showing a sensitivity, specificity, positive predictive value, negative predictive value and accuracy values of 85.7%, 100%, 100%, 87.5% and 92.9% respectively.

Aspirate Diagnosis	Final Diagnosis		Total
	Malignant	Benign	
Malignant (Fig. 1, 3, 4)	6	0	6
Benign (Fig. 2)	9	15	24
Total	15	15	30

Table 8. Diagnostic Efficacy of Aspirate Diagnosis against Final Diagnosis for Malignancy (n = 30)

Sensitivity= 40%; Specificity= 100%; PPV= 100%; NPV= 62.5%; Accuracy= 70%.

A total of 30 cases could be analysed using aspirate diagnosis. On comparing the diagnosis of these 30 cases against final diagnosis, it was seen that all the 6 malignant cases diagnosed by aspiration were malignant on final diagnosis too. However, of the remaining 24 cases diagnosed as benign by aspiration, 15 were benign and 9 were malignant. Thus, a total of 6 cases were true positive, none was false positive, 9 were false negative and 15 were true negative. Correspondingly, aspiration had a sensitivity of 40%, specificity of 100%, positive predictive value of 100%, negative predictive value of 62.5% and accuracy of 70%.

Imprint Diagnosis	Final Diagnosis		Total
	Malignant	Benign	
Malignant (Fig. 1, 3, 4)	5	0	5
Benign (Fig. 2)	10	15	25
Total	15	15	30

Table 9. Diagnostic Efficacy of Imprint Diagnosis against Final Diagnosis for Malignancy (n = 30)

Sensitivity= 33.3%; Specificity= 100%; PPV= 100%; NPV= 60%; Accuracy= 66.7%.

A total of 30 cases could be analysed using imprint diagnosis. All the 5 malignant cases diagnosed by imprint cytology were malignant on final diagnosis too. However, of the remaining 25 cases diagnosed as benign by imprint, 15 were benign and 10 were malignant. Thus, a total of 5 cases were true positive, none was false positive, 10 were false negative and 15 were true negative. Correspondingly, imprint had a sensitivity of 33.3%, specificity of 100%, positive predictive value of 100%, negative predictive value of 60% and accuracy of 66.7%.

Variable	Frozen Section	Aspirate Cytology	Imprint Cytology	Final Diagnosis
Total cases tested	28	30	30	31
Malignant	12	6	5	16
% Malignancy rate	42.9	20	16.7	51.6

Table 10. Comparison of Malignancy Rate among Different Diagnostic Methods

Graph 5

Malignancy rate was maximum in final diagnosis (51.6%) followed by frozen section (42.9%), aspirate cytology (20%) and imprint cytology (16.7%). Statistically, no significant difference in malignancy rate by frozen section and final diagnosis was observed ($p = 0.739$). Final HPE diagnosis had significantly higher malignancy rates as compared to both aspirate cytology and imprint cytology ($p < 0.05$).

Frozen section had higher malignancy rates as compared to both aspirate and imprint techniques, but difference was significant only for comparison between frozen section and imprint techniques ($p = 0.029$).

DISCUSSION

Frozen Section Techniques' Statistical Parameters

85.7% sensitivity, 100% specificity, 100% Positive Predictive Value (PPV), 87.5% Negative Predictive Value (NPV) and 92.9% accuracy in regard to frozen section technique. Other studies done in the past regarding the use of frozen section in intraoperative diagnoses of ovarian tumours are listed below.

Author	Year	Sample Size	Sensitivity	Specificity	PPV	NPV	Accuracy
Stewart CJ et al ^[3]	2010	402 cases	-	-	-	-	97.8%
U. D. Bafna et al ^[9]	2013	135 cases	Benign- 90.4% Borderline- 31.2% Malignant- 91.5%	Benign- 82.6% Borderline- 94% Malignant- 98.2%	-	-	89.5%- Serous 48.2%- Mucinous 100%- Germ cell tumour 85%- Sex cord
Virach Wootipoom et al ^[16]	2006	229 cases	Benign- 98.2% Borderline- 57.1% malignant- 86.1%	Benign- 87.0% Borderline- 96.4% malignant- 98.5%	Benign- 89.5% Borderline- 63.2% Malignant- 97.1%	Benign- 97.8% Borderline- 95.4% Malignant- 92.3%	89.7%
Amita Maheshwari et al ^[17]	2006	241 cases	Benign- 100% Borderline- 45.5% Malignant- 93.5%	Benign- 93.2% Borderline- 98.5% malignant- 98.3%			91.2%
Arikan Ilker et al ^[18]	2011	266 cases	Benign- 100% Borderline- 77.8% Malignant- 71.4%	Benign- 83.8% Borderline- 98.4% Malignant- 100%	-	-	-
Sennur Ilvan et al ^[19]	2005	617 cases	Benign- 100% Borderline- 87% Malignant- 87%	Benign- 97% Borderline- 98% Malignant- 100%	-	-	97%
Atif Ali Hashmi et al ^[7]	2016	141 cases	Benign- 100% Borderline- 83% Malignant- 96%	Benign- 97% Borderline- 99% Malignant- 100%	-	-	99.00%
Our Study	2016	28 cases	85.7%	100%	100%	87.5%	92.9%

Table 11. Comparative Data of Different Studies Performed regarding Frozen Section Technique

Thus, our study results show higher sensitivity, specificity, positive predictive value and negative predictive value in regard to frozen section technique.

Some of the researchers have suggested that one frozen section should be performed for every 10 cm diameter of tumour for very large mucinous ovarian tumours to improve accuracy.^[20] They suggested the value of frozen section of ovarian tumours also lies in establishing whether an ovarian tumour is primary or metastatic.^[7]

Intraoperative Cytology Techniques’ Statistical Parameters

Author	Year	Cases	Sensitivity	Specificity	PPV	NPV	Overall Accuracy
Stewart CJ et al ^[3]	2010	402 cases	-	-	-	-	-
Khunamornpong S et al ^[6]	2012	50 cases	95.8%	96%	-	-	95.8%
Nishat Afroz et al ^[14]	2009	120 cases	-	-	-	-	-
Chandrashekhar T et al ^[15]	2014	30 cases	-	-	-	-	-
Renu Jain et al ^[21]	2015	68 cases	97.7%	91.37%	95.56%	95.65%	95.6%

Table 12. Comparative Data of Various Studies Performed in Regards to Intraoperative Cytology

1. Cystadenocarcinoma- Cytology, 40x H and E Histology, Frozen, Fresh Gross (Clockwise)

2. Endometriotic and Simple Cysts- Cytology did not reveal adequate Smear. Gross and Frozen (Right corresponding 40x H and E).

3. Malignant Mixed Germ Cell Tumour- Frozen could not be done. 40X Giemsa Cytology, Gross, H and E 40x Histology (Clockwise).

4. Granulosa Cell Tumour- Cytology did not reveal adequate Smear. 40x H and E Histology, Gross, Frozen (Clockwise).

Limitations of Study

1. Power failure resulted in reduction of number of samples initially planned to be taken up for comparison of the three arms.
2. All cases of ovarian diseases (enrolled in KGMU Obstetrics Department) could not be included because of referral to surgical/medical oncology departments of same or other institutes for further management.
3. Interpretation of error in benign or borderline cases in frozen samples.
4. Morphology interpretation error.
5. In some cases, cytology could not be done in our study due to very small amount of ovarian tissue provided.

CONCLUSION

1. Frozen section is a technique that determines intraoperatively whether an ovarian mass is benign or malignant and helps determine the extent of surgery.
2. Frozen section has a higher sensitivity, specificity, positive predictive value, negative predictive value and accuracy than aspirate and imprint cytology.
3. Aspirate cytology has a higher sensitivity, specificity, positive predictive value, negative predictive value and accuracy than imprint cytology.
4. Gold standard that detects whether the ovarian lesion is malignant or benign is histopathological examination and immunohistochemistry wherever needed.

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