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Research Article

Cytohistopathological and immunohistochemical correlation of soft tissue tumors

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ABSTRACT

Background: Fine needle aspiration cytology has become an established tool in the diagnostic armamentarium of many clinical practices. The initial diagnosis of many mass lesions, both superficial and deep-seated, can often be readily and safely assessed by fine needle aspiration cytology. In our study, we assessed 361 cases of soft tissue tumors by fine needle aspiration cytology during a period of three years. We tried to follow up as many cases as possible to obtain corresponding excision biopsies for histopathological examination. Immunohistochemical studies were also performed on biopsy sections in some cases for confirmation of diagnoses. Aims and objectives: 1) To study the age, sex and site-wise distribution of soft tissue tumors. 2) To assess the utility of fine needle aspiration cytology in diagnosing various types of soft tissue tumors. 3) To assess the sensitivity, specificity, positive and negative predictive values, and overall histological correlation percentage of fine needle aspiration cytology in diagnosing soft tissue tumors.

Methods: Aspirations were carried out using a 22 gauge disposable needle and a 10c.c disposable syringe for suction. Wet-fixed smears were stained with hematoxylin and eosin and pap stain. Dry-fixed smears were stained with May-Grunwald Giemsa stain. Periodic Acid Schiff stain was used in some cases of extraskeletal Ewing's sarcoma. Corresponding biopsy sections were stained with hematoxylin and eosin. Immunohistochemical stains were also used in some of the cases for confirmation of diagnosis.

Results: Of the 361 cases recorded in our study, 320 patients could be successfully followed up and excision biopsies were obtained. The remaining 41 patients were excluded from the study due to inability to obtain biopsy. Of the 320 cases, 200 were diagnosed as benign soft tissue tumors, while 120 were diagnosed as malignant on cytological examination. The median age of occurrence of benign soft tissue tumors was 34.23years, while that of malignant soft tissue tumors was 48.33years. Prevalence was highest in the age group of 20-49years, during which majority were benign lesions. Soft tissue tumors were more common in the lower extremities with predominant benign tumors, while malignant tumors were more common in the trunk. Sexwise distribution showed a male:female ratio of 1.76:1.

Various patterns were observed in cytology. The commonest tumors were lipomas (55%), followed by benign peripheral nerve sheath tumors (37%). Malignant soft tissue tumors constituted 37.5% cases, among which malignant fibrous histiocytoma was the most frequent tumor. Soft tissue sarcomas were classified into 5 general categories on the basis of predominant appearance in aspiration smears: I. Myxoid II. Spindle cell III. Pleomorphic IV. Polygonal V. Round cell. Immunohistochemical studies were done for some tumors with vimentin, desmin, S-100 protein and Neuron Specific Enolase (NSE), Leucocyte Common Antigen (LCA), cytokeratin (CK) and Epithelial Membrane Antigen (EMA). A comparative analysis was done between the cytology report and histopathology.

Conclusion: Final evaluation of the results showed that the diagnostic accuracy of fine needle aspiration cytology in soft tissue tumors was 96.88%, sensitivity was 95.08% and specificity was 97.98%.Thus our study proves the efficacy of fine needle aspiration cytology in the diagnosis of soft tissue tumors as a useful cost-effective procedure.

Keywords: Aspiration, Soft tissue tumors, Cytology

INTRODUCTION

Fine Needle Aspiration Cytology (FNAC) has become an established tool for diagnosis of several pathological lesions. The initial diagnosis of many mass lesions in both superficial and deep body sites can often be readily and safely assessed by FNAC. One of the important frontiers for FNAC is evaluation of primary soft tissue tumors.[5]

Several important challenges are encountered in assessment of soft tissue neoplasms by FNAC. Firstly, many of these lesions, especially sarcomas are relatively rare and we do not usually see them on a routine basis. Secondly, they have overlapping histopathologic and cytomorphologic features that are further compounded by the morphologic heterogeneity present in some of these mass lesions. Thirdly, the increasing recognition of borderline tumors of intermediate malignancy make interpretation by FNAC problematic.

FNAC has a number of advantages compared to other techniques.[8] It is a rapid outpatient procedure that can provide an immediate diagnosis. It permits the surgeon to discuss potential additional diagnostic procedures and therapy with the pathologist and patient. Patients suffer relatively little pain or discomfort during aspiration and in most cases local anaesthesia is not required. Another advantage of FNAC over core needle biopsy is greater sampling of the lesion. By altering the direction of the needle during a single puncture, multiple portions of the mass can be aspirated. If necessary, multiple punctures may be performed during a single patient visit. FNAC has a low rate of complications and if not diagnostic, can easily be followed by a repeat aspiration. Finally, FNAC is a relatively inexpensive and cost-effective technique in our current medical economic milieu. However FNAC has some disadvantages, specific for soft tissue lesions. It sometimes results in inadequate sampling of the tumor due to blood contamination. The individual cells are dispersed leading to partial loss of recognisable diagnostic pattern. This shall inevitably result in less specific diagnoses. It may also be difficult to distinguish between benign cellular lesions, borderline tumors and low grade sarcomas. In densely collagenised or sclerotic or vascular lesions, FNAC may yield sparse cellularity making diagnosis difficult.

It is important to emphasize that diagnosis of soft tissue tumors by FNAC requires cooperation and interaction between the pathologist, surgeon and radiologist. So, ultimately our prime aim has been to prove the efficacy of FNAC in the diagnosis of soft tissue tumors by means of histological correlation with the help of immunohistochemistry.[13]

Aims & objectives

1. To study the age, sex and sitewise distribution of soft tissue tumors.
2. To assess the utility of FNAC in diagnosing various types of soft tissue tumors.
3. To assess the sensitivity, specificity, positive and negative predictive values, and overall histological correlation percentage of FNAC in diagnosing soft tissue tumors using immunohistochemical markers.

METHODS

The study included 361cases and was carried out in the Department of Pathology, Andhra medical college, Visakhapatnam for a period of 3 years from October 2011 to September 2014. Patients with soft tissue tumors attending the surgical outpatient department and cytology/histopathology sections of pathology department were selected for the study. Aspiration was carried out using a 22 gauge disposable needle and a 10 cc disposable syringe for suction. The wet-fixed smears were stained with hematoxylin-eosin (H&E) and pap stain, while dry smears were stained with MGG (May-Grunwald Giemsa) stain, and a detailed cytological examination done. The FNAC report was then correlated with the histopathology report and the diagnostic accuracy of FNAC was expressed as a percentage in relation to histopathological diagnosis. Immunohistochemical stains like vimentin, cytokeratin, desmin, S-100 protein, Epithelial Membrane Antigen (EMA), Leucocyte Common Antigen (LCA) and Neuron Specific Enolase (NSE) were also used in some of the cases for confirmation of diagnosis. PAS (Periodic Acid Schiff) stain was used in cases of extra skeletal Ewing's sarcoma.

RESULTS

Of the 361 cases recorded in our study, 320 patients could be successfully followed up and excision biopsies obtained. The remaining 41 patients were excluded from the study due to inability to obtain biopsy as the patients could not be traced after aspiration. Of the 320 cases, 200 were diagnosed as benign soft tissue tumors, while 120 were diagnosed as malignant on cytological examination.

The median age of occurrence of benign soft tissue tumors was 34.23years, while that of malignant soft tissue tumors was 48.33years. Prevalence was highest in the age group of 20-49years, during which majority were benign lesions (Table1).

Table 1: Agewise distribution of soft tissue tumors.

Age (years)	Benign (200 cases)	Malignant (120 cases)	Total (320 cases)
0-20	40	40	80
21-40	90	10	100
41-60	52	34	86
61-80	18	36	54

Soft tissue tumors were more common in the lower extremities with predominant benign tumors, while malignant tumors were more common in the trunk (Table 2).

Table 2: Sitewise distribution of soft tissue tumors.

Site	Benign (200 cases)	Malignant (120 cases)	Total (320 cases)
Lower extremity	92	56	148
Upper extremity	72	20	92
Trunk	22	32	54
Head & neck	14	12	26
Total	200	120	320

Sexwise distribution of soft tissue tumors showed a male:female ratio of 1.76:1, indicating that they were more common in males (Table 3).

Table 3: Sex-wise distribution of soft tissue tumors.

Sex-wise distribution	
Male	204 cases
Female	116 cases
Total	320 cases

Out of the 320 soft tissue lesions, 200 (62.5%) were benign. They included 110 cases of lipoma (Figure 1) and fibrolipoma, 74 benign nerve sheath tumors - 60 neurofibromas (Figure 2) and 14 schwannomas (Figure 3), 8 cases of fibromatoses, nodular fasciitis, desmoid tumors and 8 cases of benign fibrous histiocytoma (Figure 5). Lipoma was the commonest soft tissue tumor (55%) followed by benign nerve sheath tumors (37%) (Table 4).

Soft tissue sarcomas were classified into 5 general categories on the basis of the predominant appearance of the aspiration smears:[5] (Table 5).

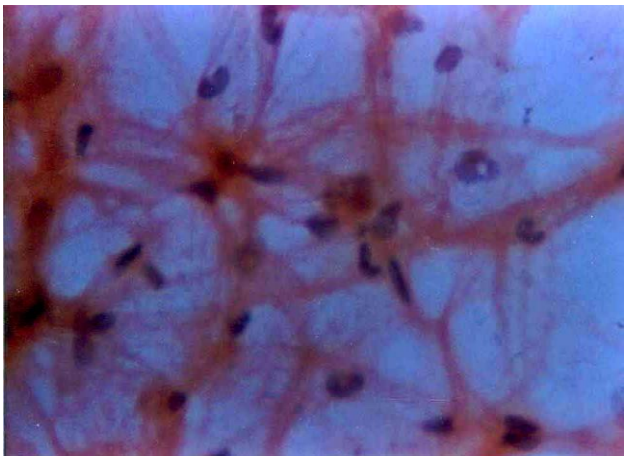

Figure 1: Cytological smear of lipoma showing adipocytes having eccentric nucleus and vacuolated cytoplasm (Pap x400).

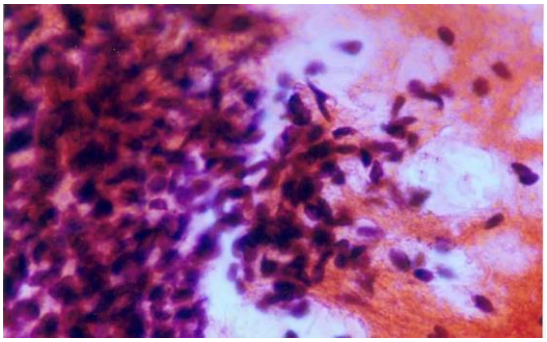

Figure 2: Cytological smear of neurofibroma stained with Pap (x400).

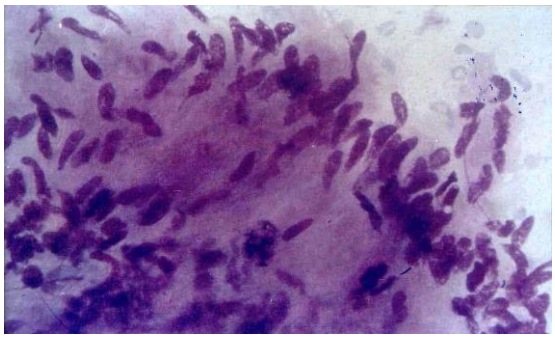

Figure 3: Cytological smear of schwannoma showing typical verocay body (MGG x400).

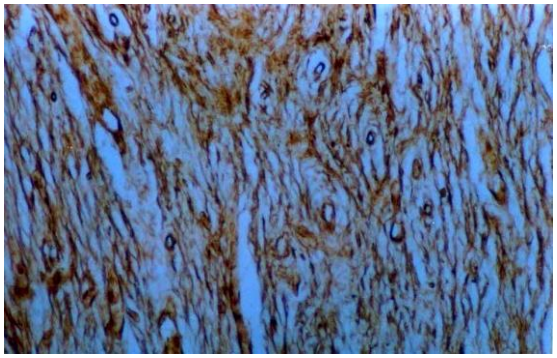

Figure 4: Intense immunoreactivity for S-100 protein in a case of schwannoma (x100).

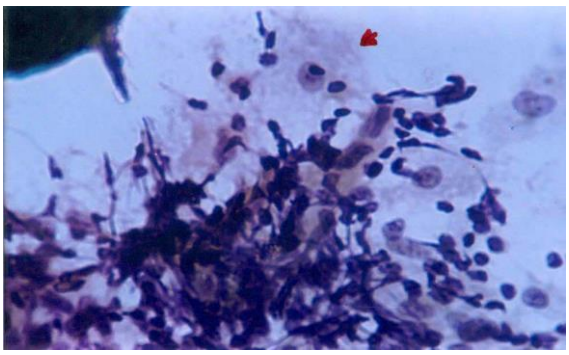

Figure 5: Cytological smear of fibrous histiocytoma showing plump spindle shaped fibroblasts and histiocytic cells (arrow) (Pap x400).

Table 4: Benign soft tissue tumors (200/320 cases=62.5%).

Type of tumor	Number of cases (%)
Lipoma & fibrolipoma	110 (55%)
Benign nerve sheath tumors	74 (37%)
Neurofibroma	60 (30%)
Schwannoma/neurilemmoma	14 (7%)
Fibromatoses, desmoid tumor, nodular fasciitis	8 (4%)
Benign fibrous histiocytoma	8 (4%)
Total	200 cases

Table 5: Malignant soft tissue tumors (120/320 cases=37.5%).

Type of tumor	Number of cases
I. Myxoid sarcomas (22 cases)	
Myxoid liposarcoma	13
Myxoid malignant fibrous histiocytoma	8
Extraskeletal chondrosarcoma	1
II. Spindle cell sarcomas (44 cases)	
Fibrosarcoma	16
Dermatofibrosarcoma protruberans	12
Synovial sarcoma	8
Malignant peripheral nerve sheath tumor	4
Leiomyosarcoma	2
Hemangioendothelioma	2
III. Pleomorphic sarcomas (30 cases)	
Pleomorphic malignant fibrous histiocytoma	28
Pleomorphic rhabdomyosarcoma	1
Pleomorphic liposarcoma	1
IV. Round cell sarcomas (22 cases)	
Extraskeletal Ewing's sarcoma	13
Rhabdomyosarcoma	6
Neuroblastoma	2
Round cell liposarcoma	1
V. Polygonal cell sarcomas (2 cases)	
Epitheloid sarcoma	2

I. Myxoid sarcomas (22 cases) - Usually considered as low grade sarcomas. Included 13 cases of myxoid liposarcoma, 8 cases of myxoid malignant fibrous histiocytoma and 1 case of extraskeletal myxoid chondrosarcoma. The most apparent feature ot aspirate smears is voluminous extracellular matrix material. In myxoid liposarcomas, lipoblasts (Figure 6) were sparse and required a careful search. Another highly distinctive feature in smears of myxoid liposarcomas was the presence of branched delicate capillaries in the matrix material (Figure 7). Aspirates from myxoid malignant fibrous histiocytomas consisted of spindle cells, histiocytic cells and giant cells. There was one case of extraskeletal myxoid chondrosarcoma that yielded cellular smears showing binucleate cells with abundant cytoplasm and enlarged nuclei against a background of chondroid matrix. The diagnosis was later confirmed by histopathology.

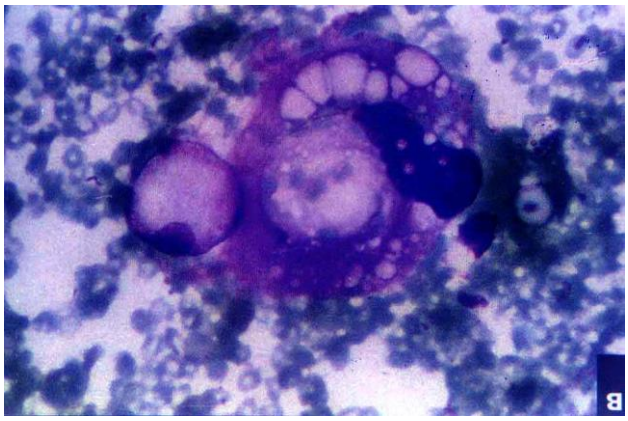

Figure 6: Cytological smear of well differentiated liposarcoma showing multivacuolated lipoblast (MGG x600).

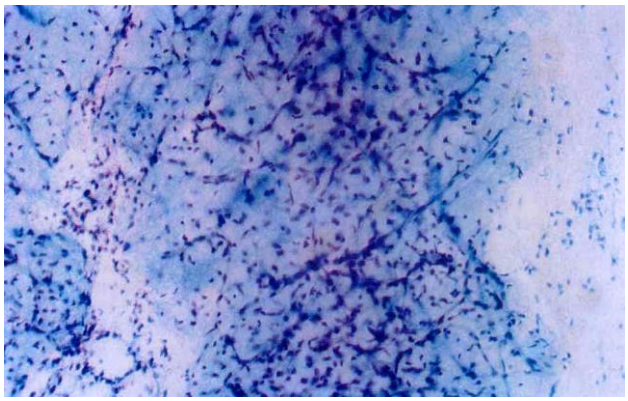

Figure 7: Cytological smear of a case of myxoid liposarcoma showing arborizing capillary channels in a myxoid matrix (Pap x100).

II. Spindle cell sarcomas (44 cases) - Included 16 cases of fibrosarcoma (Figure 8 & 9), 12 cases of dermatofibrosarcoma protruberans, 8 cases of synovial sarcoma, 4 cases of malignant peripheral nerve sheath tumors (MPNST), 2 cases of leiomyosarcoma and 2 cases of hemangioendothelioma. All the tumors were positive for Vimentin, confirming the sarcomatous nature of the lesions. However, this group posed the greatest diagnostic difficulty in FNAC due to risk of both false positive and false negative diagnoses because of the problem of distinguishing between benign and low grade tumors. The two major attributes that allowed an aspirate to be designated as sarcoma were moderate to high smear cellularity and hyperchromatic nuclei in almost all sampled cells. There were 4 cases of spindle cell tumors that gave a false impression of well-differentiated fibrosarcoma cytologically, later proved to be fibromatoses histologically. Based purely on cytomorphologic features, aspirates of well differentiated fibrosarcomas were difficult to distinguish from fibromatoses. The presence at low magnification of a

whorled or storiform arrangement of cells and infiltration of fatty tissue by proliferating spindle cells was useful for rendering a diagnosis of dermatofibrosarcoma protruberans. Aspirates from synovial sarcomas (Figure 10) were dominated by spindle cells. However the neoplastic elements exhibited focal distinct epithelial differentiation, evidenced by polygonal contours and round hyperchromatic nuclei. The specific diagnosis of synovial sarcoma was markedly enhanced by immunohistochemistry - the epithelial component showed positive reactivity with cytokeratin and epithelial membrane antigen. There were 2 cases of leiomyosarcoma, both females aged 55 and 61 years, who revealed large uterine masses on ultrasound. Ultrasound guided FNAC was done in both the cases and smears prepared for cytological analysis, following which a diagnosis of leiomyosarcoma was given in both cases. Immunoreactivity for desmin (Figure 11) further confirmed the diagnosis. There were 2 cases of MPNST (Figure 12). In contrast to schwannomas, they showed only focal and weak positivity for S-100 protein. There were 2 cases of hemangioendothelioma. Smears had a prominent background of blood. Oval to spindle shaped cells were present in clusters as well as individually dispersed with moderate amount of cytoplasm and vesicular oval nuclei showing indentations of nuclear membrane.

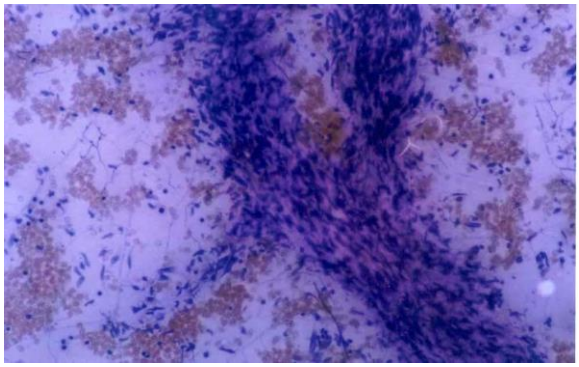

Figure 8: MGG stained cytological smear of fibrosarcoma showing fascicular arrangement of tumor cells (x100).

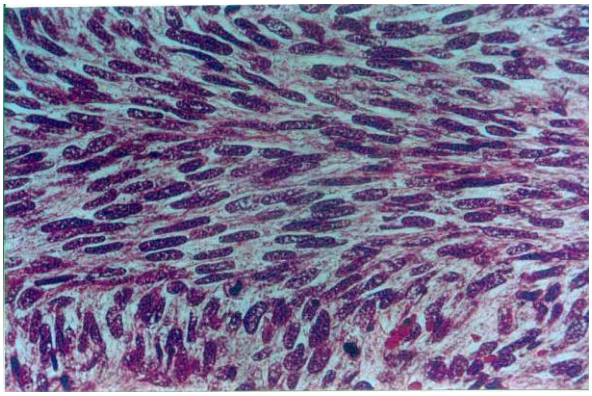

Figure 9: Histopathologial section of fibrosarcoma (H&E x400).

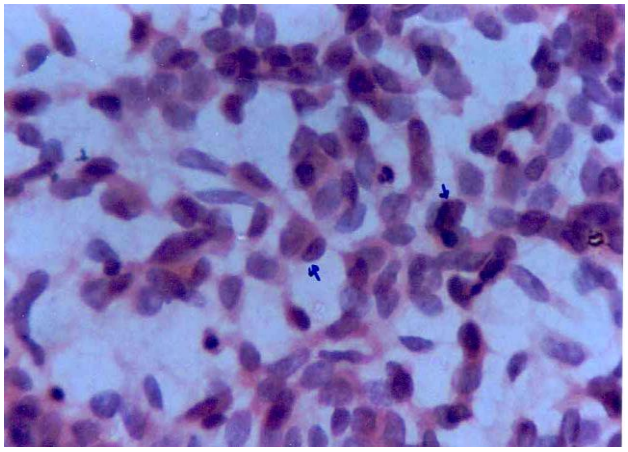

Figure 10: Richly cellular cytological smear of synovial sarcoma showing oval to spindle tumor cells having homogenous uniform nuclear chromatin in the spindle cells and darkly stained nuclear chromatin within the oval cells (epithelial component-arrows) (Pap x400).

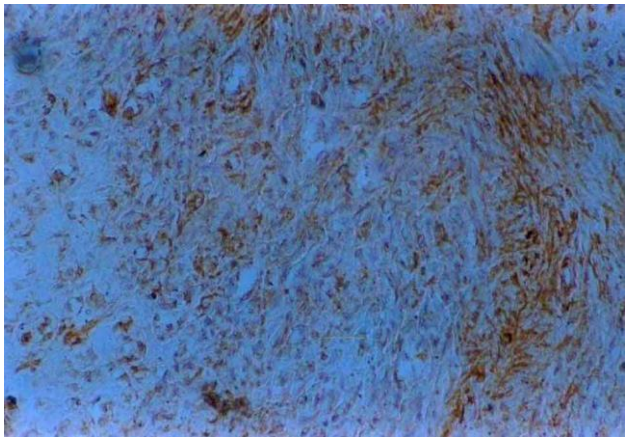

Figure 11: Immunoreactivity for desmin in leiomyosarcoma (x100).

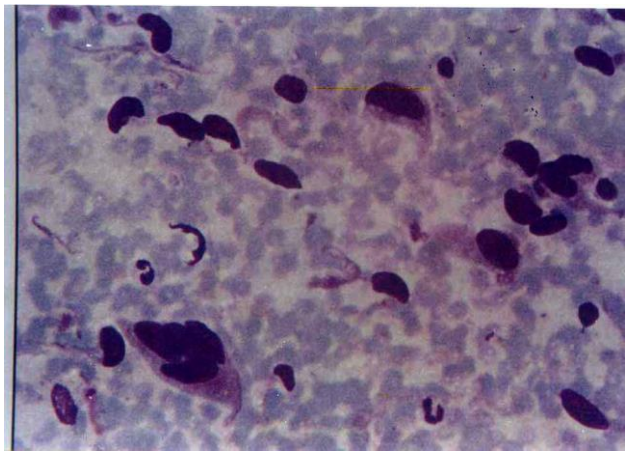

Figure 12: Cytological smear of malignant peripheral nerve sheath tumor (MPNST) showing pleomorphic tumor cells and occasional multinucleated giant cells. Some of the nuclei are buckled. (Pap x400).

III. Pleomorphic sarcomas (30 cases) - Included 28 cases of pleomorphic Malignant Fibrous Histiocytoma (MFH), 1 case of pleomorphic liposarcoma (LPS) and 1 case of pleomorphic rhabdomyosarcoma (RMS). Smears of pleomorphic MFH (Figure 13 & 14) were characterised by high cellularity, mostly single malignant cells, marked pleomorphism and tumor giant cells. Immunoreactivity for vimentin (Figure 15) confirmed the sarcomatous nature of the neoplasm. There was one case of pleomorphic LPS whose smears showed an admixture of adipocytes, tumor giant cells and lipoblasts. We also received one case of pleomorphic RMS in a 67 year old patient who presented with mass in the thigh region. Smears showed a pleomorphic MFH like picture including scattered atypical rhabdomyoblast-like cells with abundant dense eosinophilic cytoplasm and eccentric nucleus, on the basis of which the diagnosis was made. Immunoreactivity for desmin confirmed the diagnosis. Pleomorphic RMS is usually seen in elderly individuals in the lower extremities, in contrast to embryonal and alveolar RMS which usually are seen in children in the head & neck region and are grouped under round cell sarcomas.

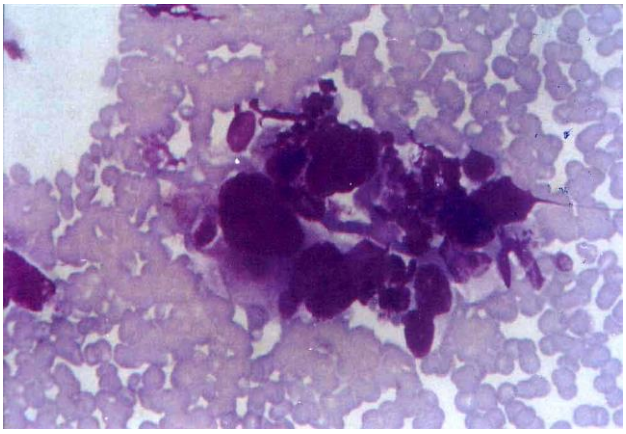

Figure 13: MGG stained cytological smear of pleomorphic MFH showing a clump of highly pleomorphic tumor cells (MGG x400).

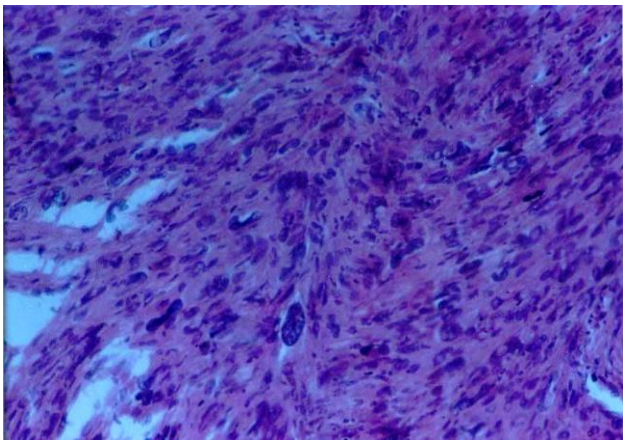

Figure 14: Histopathological section of pleomorphic MFH (H&E x100).

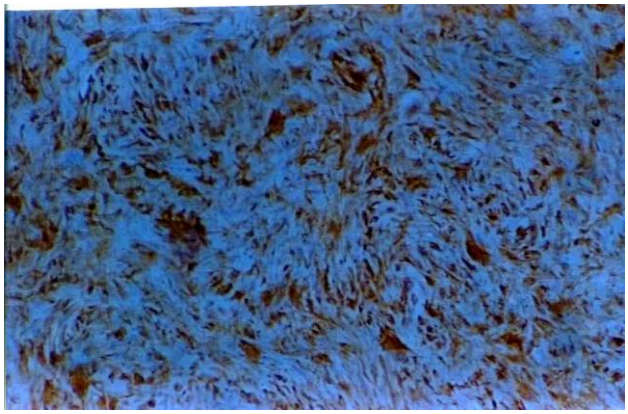

Figure 15: Immunoreactivity for vimentin in MFH (x100).

IV. Round cell sarcomas (22 cases) - Included 13 cases of extraskeletal Ewing's sarcoma/ primitive neuroectodermal tumor (PNET), 6 cases of rhabdomyosarcoma (4 embryonal + 2 alveolar variants), 2 cases of neuroblastoma and 1 case of round cell liposarcoma . Round cell sarcomas were mostly found in paediatric and adolescent population. Aspiration cytology yielded cellular smears composed of typical small round cells. The presence of strap or 'tadpole' cells (Figure 16) correlated well with the interpretation of rhabdomyosarcomas. Positive reactivity for desmin (Figure 17) confirmed the diagnosis. Aspirates of PNET consistently yielded high cellularity with numerous solitary mononucleated neoplastic cells showing high nuclear/cytoplasmic ratio and pseudorosette formation (Figure 18). The nuclei appeared perfectly round with uniformly dispersed fine chromatin and inconspicuous nucleoli. Occasionally, cytoplasmic blebs or sharply punched out glycogen vacuoles were seen which stained positive with PAS (Periodic Acid Schiff) stain (Figure 19). Absence of lymphoglandular bodies helped in differentiation from lymphoma. Negative immunoreactivity for LCA (Leucocyte Common Antigen) ruled out the possibility of lymphoma. We received 2 cases of neuroblastoma. Both were children aged one year and two years respectively who presented with abdominal masses. Ultrasound revealed retroperitoneal tumors in both cases. Guided FNAC was performed, which yielded cellular aspirates showing small primitive malignant cells with solitary nuclei and high nuclear/cytoplasmic ratio (Figure 20). One important diagnostic clue was the presence of pseudorosettes which consisted of one or more layers of nuclei surrounding central fibrillar material. Similar filamentous material corresponding to the neuropil was also present in the background in some fields. Another potentially helpful clue was the presence of neoplastic ganglion cells. There was one case of round cell liposarcoma. Smears were considerably more cellular than those of myxoid liposarcoma, myxoid ground substance was less conspicuous and capillary network less prominent. Atypical lipoblasts were also found.

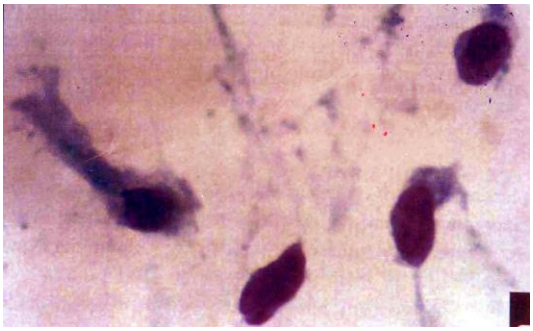

Figure 16: Tumor cells in rhabdomyoblastoma showing rhabdomyoblastic differentiation (Pap x400).

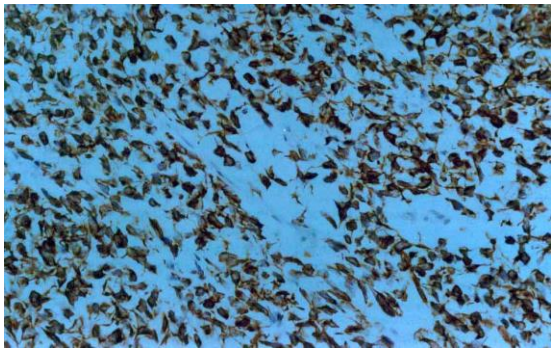

Figure 17: Immunoreactivity for desmin in embryonal rhabdomyosarcoma (x100).

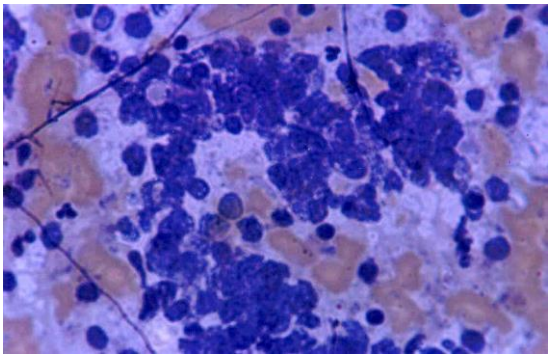

Figure 18: Cytological smear of Ewing's sarcoma showing monomorphic round tumor cells with barely perceptible cytoplasm (Pap x400).

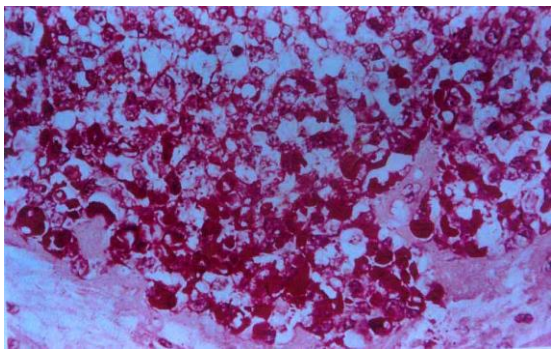

Figure 19: Case of Ewing's sarcoma showing PAS positivity (x400).

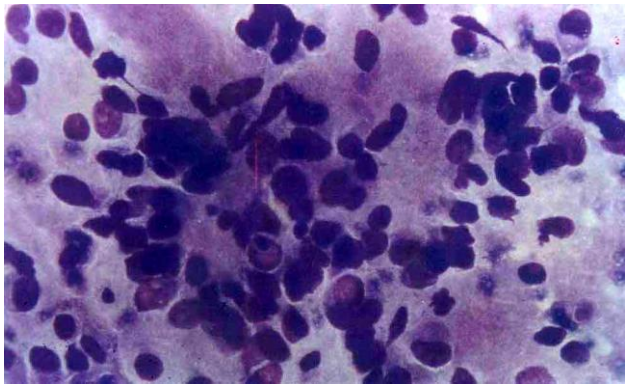

Figure 20: Cytological smear of neuroblastoma showing round to oval tumor cells with rosette formation. Background is fibrillary (MGG x400).

V. Polygonal cell sarcomas: Included 2 cases of epitheloid sarcoma. Cytological smears showed polygonal cells with pleomorphic hyperchromatic nuclei and eosinophilic cytoplasm against a necrotic background. The diagnosis was later confirmed on histopathology in both the cases. Both the cases showed positive immunoreactivity for vimentin, which proved the sarcomatous nature of the tumors.

The most common malignant soft tissue tumor in our study was malignant fibrous histiocytoma which constituted 36 cases (28 pleomorphic + 8 myxoid variants).

After initial cytological diagnosis, every case was followed up and after surgery the excised specimens were subjected to histopathological examination. A comparative analysis was done with the original cytology report. It was found that there were 6 false negative cases-3 cases of lipoma that were later diagnosed as well-differentiated liposarcoma on histopathology, 2 cases of fibromatoses that were later diagnosed as well-differentiated fibrosarcoma on histopathology and 1 case of benign spindle cell tumor on cytology that turned out to be low grade fibromyxoid sarcoma on histopathology. There were also 4 false positive cases-3 cases of well-differentiated fibrosarcoma that were later diagnosed as fibromatoses on histopathology and 1 case of malignant peripheral nerve sheath tumor which was diagnosed as ancient schwannoma on histopathology.

Evaluation of results: (Table 6) & (Table 7)

Diagnostic accuracy of FNAC = 310/320 x 100 = 96.88%

Sensitivity = (true positive/true positive + false negative) x 100 = (116/116+6) x 100 = (116/122) x 100 = 95.08%

Specificity = (true negative/true negative + false positive) x 100 = (194/194+4) x 100 = (194/198) x 100 = 97.98%

Positive predictive value = (true positive/true positive + false positive) x 100 = (116/116+4) x 100 = (116/120) x 100 = 96.67%

Negative predictive value = (true negative/true negative + false negative) x 100 = (194/194+6) x 100 = (194/200) x 100 = 97%

The accuracy rate, sensitivity, specificity, positive predictive value and negative predictive value, thus, indicate that FNAC is a very useful tool and a reliable technique in diagnosing soft tissue tumors.

Table 6: Evaluation of results-I.

Cytological impression	Cytology consistent with histopathology	Cytology inconsistent with histopathology
Benign (200 cases)	194	6
Malignant (120 cases)	116	4
Total (320 cases)	310	10

Table 7: Evaluation of results-II.

Cytological diagnosis	Final histopathological diagnosis		Total
	Benign	**Malignant**	
Benign	194 (true negative)	6 (false negative)	200
Malignant	4 (false positive)	116 (true positive)	120
Total	198	122	320

DISCUSSION

In the present study age-wise distribution of soft tissue tumors showed that the median age of occurrence of soft tissue tumors was 36.43 years. According to Enzinger,[5] malignant soft tissue tumors are most commonly seen in middle aged to elderly people. This correlated well with other studies conducted by Campora et al.,[3] Talati et al.[14] and Hajdu et al.[7] according to whom the median ages were 46.32, 39.5 and 36.83 years respectively.

Sex-wise distribution of soft tissue tumors showed a male:female ratio of 1.76:1. Thus the prevalence of soft tissue tumors was higher in males than females.

Distribution of the anatomical sites of benign and malignant soft tissue tumors showed that the lower extremities (46.25% cases) were the most common site for presentation of soft tissue tumors, that correlated well with other studies conducted by Campora et al.[3] and Enzinger[5] who showed 40% and 45% cases respectively in the lower limbs.

Out of the 320 cases, 200 (62.5%) were benign and 120 (37.5%) were malignant tumors. This correlated well with the study conducted by Nagira et al[10] according to whom the incidence of benign and malignant soft tissue tumors was 61.43% and 38.57% respectively. The most common benign soft tissue tumor was lipoma. The most common malignant soft tissue tumor was malignant fibrous histiocytoma, which correlated well with studies by other workers like Campora et al.,[3] Enzinger et al.[5] and Akerman et al.[1]

Tumors with spindle cell pattern posed diagnostic difficulties. It was difficult to distinguish between benign tumors with high cellularity like nodular fasciitis and fibromatoses, intermediate grade tumors like dermatofibrosarcoma protruberans and low grade sarcomas. The criteria for malignancy as described by Kilpatrik SE et al.[8] was that an aspirate is designated as a sarcoma when the smear shows moderate to high cellularity, hyperchromatic nuclei in almost all the sampled cells and ill-defined edges of the neoplastic fragments.

Costa MJ et al.[15] stated that in any aspirate from a spindle cell lesion,the main criteria to be assessed are cellularity, nuclear pleomorphism, mitosis and necrosis. In the present study, diagnostic pitfalls were observed in 7 spindle cell tumors-2 cases of fibromatoses, 3 cases of well-differentiated fibrosarcoma, 1 case of low grade fibromyxoid sarcoma and 1 case of malignant peripheral nerve sheath tumor.

Among lipomas, there were 3 false-negative cases that later proved to be well-differentiated liposarcoma. According to Enzinger,[5] well-differentiated liposarcoma may be mistaken for lipoma because smears are only moderately cellular and consist mostly (or exclusively) of mature-appearing fat cells, often in fragments. The diagnosis of liposarcoma requires finding unequivocal lipoblasts with cytoplasmic lipid vacuoles that compress and distort the hyperchromatic nucleus. Kilpatrick et al.[8] reported difficulties in evaluation of lipomatous tumors by FNAC.

There was one false positive case of malignant peripheral nerve sheath tumor in cytology which later proved to be ancient schwannoma on histopathology. The aspirated cells were large with one or more large, hyperchromatic, irregularly contoured nuclei, and thus mistaken for malignancy.

However, the presence of diffuse and intense immunoreactivity for S-100 protein in schwannoma (Figure 4) was useful to differentiate the tumor from MPNST which shows weak positivity with S-100 protein.

Final evaluation of results showed that the diagnostic accuracy of FNAC of soft tissue tumors as per the present study was 96.88%, which correlated well with other studies (Table 8).

The present study showed a sensitivity of 95.08%, specificity of 97.98%, positive predictive value of 96.67% and negative predictive value of 97% that correlated well with other studies (Table 9).

Table 8: Final evaluation of results which correlated well with other studies.

Author	Accuracy rate
Akerman et al.[1]	85%
Nagira K et al.[10]	88%
Palmer et al.[11]	90%
Kulkarni et al.[9]	93.33%
Sapi et al.[12]	95%
Wakely PE[15]	98.3%
Present study	96.88%

Table 9: Sensitivity and specificity that correlated well with other studies.

Author	Sensitivity	Specificity
Akerman et al.[1]	86.66%	93.49%
Benzabih[2]	88.5%	81.5%
Nagira et al.[10]	92%	97%
DeMay et al.[4]	95%	95%
Kilpatrick et al.[8]	95%	95%
Wakely PE[15]	100%	88%
Sapi et al.[12]	100%	94.4%
Palmer et al.[11]	100%	95.12%
Present study	95.08%	97.98%

CONCLUSION

The bulk of reported data and our own practices strongly support the ability of fine needle aspiration cytology to accurately diagnose soft tissue tumors. From the above observations, we can conclude that FNAC is a useful, safe and cost-effective procedure for the evaluation of soft tissue tumors with accuracy rate almost at par with that of biopsy. Therefore our study proves the efficacy of fine needle aspiration cytology in the diagnosis of soft tissue tumors.

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