Fine-Needle Aspiration of Neurilemoma (Schwannoma). A Clinicocytopathologic Study of 116 Patients.

Henryk A. Domanski, M.D.[1]

Måns Åkerman, M.D., PhD.[1]

Jacob Engellau, M.D., PhD.[2]

Pelle Gustafson, M.D., PhD.[3]

Fredrik Mertens, M.D., PhD.[4]

Anders Rydholm, M.D., PhD.[3]

From the Departments of Pathology and Cytology[1], Oncology[2], Orthopaedics[3] and Clinical Genetics[4], Lund University Hospital, S-221 85 Lund, Sweden.

Address for correspondence and reprints:

Henryk A. Domanski, M.D.

Department of Pathology & Cytology

Lund University Hospital

S-221 85 Lund, Sweden

Telephone +46 46 173402

Fax +46 46 143307

E-mail: henryk.domanski@med.lu.se

Abstract

The preoperative fine-needle aspiration cytology (FNAC) diagnoses in 116 surgically excised neurilemomas were reviewed and compared with the corresponding histopathologic diagnoses made on surgical specimens and with clinical data. In addition, the utility of adjunctive techniques was analyzed and other spindle-cell lesions in the differential diagnoses were discussed. An unequivocal, benign diagnosis was rendered by FNAC in 80 cases, 67 of which were correctly labelled as neurilemoma in a review of the original cytology reports. There were six false positive malignant diagnoses while 23 smears were considered insufficient and seven inconclusive as to whether benign or malignant. On reevaluation, the diagnostic smears in most cases contained spindle cells with wavy nuclei embedded in a fibrillar, occasionally collagenous and/or myxoid matrix and Antoni A /Antoni B tissue fragments. A moderate to abundant admixture of round to oval cells was also frequent. Nuclear palisading was seen in 41 smears with distinctive Verocay bodies in 10. Markedly pleomorphic nuclei were seen in smears from eight ancient and six conventional neurilemomas, and slight to moderate nuclear pleomorphism was observed in 38 additional cases. Thus most neurilemomas have distinct cytomorphologic features that allow correct diagnosis. The major problem in FNAC of neurilemoma is to obtain sufficient material. Furthermore aspirates showing predominantly Antoni A features, nuclear pleomorphism and/or myxoid changes can easily be confused with other types of benign or malignant soft tissue tumors.

Key words: Neurilemoma, schwannoma, ancient neurilemoma, fine-needle aspiration, nerve sheath neoplasm, FNA.

Introduction

Neurilemoma, a spindle cell neoplasm of nerve sheath origin is the most common benign lesion arising from the peripheral nerves. In the files of our institution, neurilemoma is after lipoma, the second most common benign soft tissue neoplasm examined cytologically. Although fine needle aspiration cytology (FNAC) is gaining increasing popularity in the diagnosis of soft tissue lesions, limited data dealing with the FNAC of neurilemomas are available. The diagnosis may be difficult to render from FNA smears, as neurilemomas share some features with other spindle cell lesions [1-8].

Neurilemomas occur in all age groups, but most frequently between 20 and 50 years. Most are deeply seated, arising in the limbs, head and neck region, retroperitoneum and posterior mediastinum [9].

Many patients have minor symptoms from a neurilemoma and pain after surgery can be more pronounced than it was before operation. With a reliable diagnosis conservative treatment-watchful waiting can be therefore recommended in many cases. When an excision of the lesion is considered necessary, a correct diagnosis helps the surgeon to plan surgery so as to avoid neurological sequelae.

The aim of the current study was to establish cytological criteria that permit a confident diagnosis of neurilemoma in FNA smears and to compare the cytologic features of neurilemoma to those of other spindle-cell lesions that constitute differential diagnoses. Another objective was to identify pitfalls and elucidate diagnostic difficulties, particularly in cases misdiagnosed as malignant neoplasms.

Material and methods:

In our institutional files there were 116 patients with neurilemoma who had been examined by FNAC between 1979 and 2005, and for whom histopathologic diagnoses on excised lesions

were available. One patient with cellular neurilemoma in the mediastinum and four cases without available cytological slides were excluded.

All palpable lesions were aspirated by cytopathologists, while non-palpable lesions were aspirated by radiologists or a radiologist together with a cytopathologist. Needles having an outer diameter of 0.4-0.7mm (cytopathologists in the FNA clinic) or 0.6-0.8mm (radiologists in the Department of Radiology) attached to a disposable syringe and the Cameco (Täby, Sweden) syringe holder was used in the standard manner. The aspirates were air dried and May-Grünwald-Giemsa (MGG) stained as well as fixed in 95% ethanol and stained with hematoxylin and eosin (H&E). Portions of the aspirates from two patients were prepared as a cell block or in solution (ThinPrep, Cytyc Corp, Boxborough, MA) for direct routine microscopy. In addition, portions of aspirates from 15 patients were prepared for immunostains as cell blocks (6), ThinPrep (6), cytospin (2) and direct smear (1). Antibodies against S-100 protein, epithelial membrane antigen (EMA), CD34, smooth muscle actin (SMA) and desmin were used. For the purpose of this study all cytological and histologic material obtained from the neurilemomas was re-evaluated.

Results:

There were 56 men and 60 women ranging in age from 13 to 83 years. The sizes of the lesions ranged from one cm to 20 cm. The neoplasms were seated in the lower extremities (46), upper extremities (28), head and neck (18), chest (10), pelvis and retroperitoneum (4), soft tissue of the sacral region (3), shoulder (2), gluteal region (2), mediastinum (1), groin (1), and abdominal wall (1). The histologic diagnosis in excised neoplasms was neurilemoma in 105 cases and ancient neurilemoma in 11. The overall accuracy of the FNAC diagnoses is presented in Table 1. The cases erroneously diagnosed as malignant are presented in Table 2 and a subset of benign diagnoses in Table 3.

Ancillary studies

Tumor cells were positive for S-100 in 12 of 15 examined smears (Figure C-1). In two aspirates prepared as ThinPrep and in one as cytospin the results of immunostains were inconclusive due to insufficient or very sparse material. In addition one cell block and one ThinPrep slides were stained only with Hematoxilin & Eosin for microscopic examination.

Cytological features (At re-evaluation)

Of 116 aspirates 46 were richly, 19 moderately, and 24 poorly cellular. In 27 cases, the smears were insufficient for cytlogic evaluation. Most of the diagnostic smears displayed tissue fragments of varying size with irregular borders and of variable cellularity. Tissue fragments consisting predominantly of cellular cohesive clusters of tumor cells (Figure 1), corresponding to histological areas of Antoni A, were observed in 81 smears, while fragments of loose, cell-poor (Figure 2) and occasionally myxoid tissue corresponding to histological areas of Antoni B, were seen in 75 smears. Only 17 smears contained moderate to large number of dispersed cells. A few dispersed cells or bare nuclei, however, were present in the majority (62) of examined cases. The tumor cells in fragments had indistinct cytoplasmic borders; nuclei were embedded in a fibrillar (82) (Figure 2) and occasionally myxoid (27) or collagenous (28) (Figure 3) matrix. Smears from 88 neurilemomas contained spindle cells. While tumor cells with spindle shaped, wavy, occasionally comma- or boomerang shaped nuclei were found in 81 smears (Figure 4), most of the smears (84) also contained epithelioid cells with round to oval nuclei showing bland chromatin structure (Figure 5) with occasional slight to moderate nuclear pleomorphism. In addition an admixture of cells with oval, cigar shaped and blunt-ended nuclei (Figure 6) were found in all 79 aspirates of sufficient quality. A variable degree of nuclear palisading was observed in 39 smears (Figure 1) but distinctive Verocay bodies were noted in only 10 smears (Figures C-2 and C-3). Nuclear inclusions were identified in eight of nine ancient and in five conventional neurilemomas. In 22 tumors with

cystic degeneration, the aspirates gave variable amounts of fluid which occasionally were acellular and non-diagnostic.

Ancient neurilemoma

Of 11 aspirates five were richly cellular, four poorly cellular and two insufficient. Similar to conventional neurilemomas the majority of the diagnostic smears displayed tissue fragments of varying size with irregular borders consisting either predominantly of cellular cohesive clusters of tumor cells or of loose, cell-poor, occasionally myxoid tissue fragments (corresponding to histological areas of Antoni A and Antoni B respectively). At aspiration five ancient neurilemomas contained an admixture of cystic fluid in aspiration. Only three smears contained a moderate amount of dispersed cells, while six revealed none or only few scattered cells or bare nuclei. While parts of the aspirates were similar to conventional neurilemomas in most smears, there was nuclear pleomorphism in all nine ancient neurilemomas of sufficient quality, marked in eight and moderate in one. Pleomorphic tumor cells were identified mainly in the tissue fragments while dissociated cells with large, hyperchromatic nuclei and variable nuclear shape/ irregular nuclear borders were also found in eight smears. One nucleus showed markedly increased chromatin density with marked hyperchromasia, while moderate hyperchromasia was noted in pleomorphic cells in eight additional smears. Intrauclear inclusions- “Kern-loche” (described by Dahl et al. [8]) were identified in eight of nine cases. While a fibrillar matrix was found in all aspirates, fragments of collagenous matrix were seen in five and focal myxoid areas in only four aspirates. Compared to conventional neurilemomas, only three aspirates from ancient neurilemomas revealed nuclear palisading and Verocay bodies were not seen in any cases. The frequency of cytological findings in the aspiration smears of conventional and ancient neurilemomas is presented in Table 4.

False positive malignant FNAC diagnoses:

There were six false positive malignant cytological diagnoses; five aspirates were diagnosed as sarcoma and one as metastasis of adenoid cystic carcinoma (Table 2). Histological sections from one neoplasm were also diagnosed originally as low-grade malignant peripheral nerve sheath tumor (MPNST). All six neurilemomas erroneously diagnosed as malignant were deeply seated in the lower extremity (3), upper extremity (2) or neck (1) and ranged in size from 1.5 to 20cm. In two patients with false positive cytological diagnosis, aspiration biopsy was performed at another hospital and smears were sent to our institution for second opinion.

Discussion

Although neurilemomas are common benign soft tissue neoplasms, experience in the aspiration cytology of these lesions is still limited.

Many neurilemomas are tender and painful when needled, occasionally with a sharp pain radiating along the nerve. Thus the pain may be a valuable diagnostic sign, but can also be misleading as the same sign may be encountered in the aspiration of other soft tissue lesions seated close to a nerve. Nevertheless, in our series there was history of pain or tenderness in 37 patients.

One of the main reasons that neurilemoma may be difficult to diagnose from cytological smears is the high frequency of poor cellularity or lack of cells, particularly from cystic degenerated lesions [5,10-11]. In our study of 116 cases, 27 aspirates were insufficient for diagnosis and an additional 24 were cell poor but considered evaluable. According to the cytology reports, the aspirates in 22 cases contained fluid, indicating cystic degeneration of the examined neoplasms. Eight aspirates from cystic neurilemomas were insufficient for diagnosis, while six contained a scanty and eight moderately to abundant cellular component. Notably, in one of these, cytological smears showed only scattered round to oval cells, some with the appearance of histiocytes (Figure C-4). Cell block prepared from aspirated fluid,

however, disclosed some clusters of spindle and epithelolid cells, which were strongly positive for S-100 protein (Figure C-4, inset) indicating cystic neurilemoma. Thus centrifuging cyst fluid with subsequent preparation of the cell block enabling immunocytochemistry may occasionally be important for making the correct diagnosis. Neurilemomas have distinct histologic and immunohistochemic patterns, which together with a typical clinical presentation with association to peripheral nerves allows a correct diagnosis in the majority of cases examined histologically. The similarities between FNA aspirates from neurilemomas and their malignant counterparts, MPNST or other soft tissue spindle cell neoplasms may, however, occasionally cause considerable diagnostic problems [8].

One of the most common problems is to diagnose correctly smears from ancient neurilemomas as benign. Ancient neurilemoma often exhibit nuclear pleomorphism with marked anisokaryosis and hyperchromasia (Figure C-5). Many of those large nuclei, however, show evenly distributed chromatin and typical large intranuclear vacuoles, “Kern-loche“ (Figure 7) [8, 12-14]. In addition, in smears adequate with regard to cellularity, it is usually possible to find other components of benign neurilemoma in addition to the atypical cells [13-14]. Notably, neither mitotic figures nor prominent macro nucleoli were found in any of the smears from ancient neurilemomas in the current study. Immunocytochemistry is of considerable help in the cytologic examination of ancient neurilemoma. Strong and diffuse positivity for S-100 protein indicates a benign peripheral nerve sheath tumour (Figure C-5, inset) [10-11,15-16].

Major pitfalls in the interpretation of aspirates from neurilemoma are spindle cell sarcomas such as leiomyosarcoma (LMS) or MPNST [17-19]. In the current study two smears were interpreted initially as LMS/suspicted LMS, and another one as spindle cell sarcoma possibly MPNST.

In addition to the patients included in the current study, a review of our records identified five patients having soft tissue tumors diagnosed initially by FNAC as neurilemoma where the histologic diagnosis was sarcoma; three high-grade LMS, one low-grade MPNST and one low-grade fibromyxoid sarcoma (LGFMS).

The cellular variant of neurilemoma is especially difficult to distinguish from low grade malignant MPNST [2]. However, similar to conventional neurilemomas, cellular neurilemomas are always positive for S-100 protein in almost every cell, while MPNSTs often stain focally or not at all. Compared to neurilemomas, aspirates from MPNSTs usually contain greater numbers of dissociated cells mixed with short and long fascicles of tumor cells. The background of the smears may be myxoid and/or fibrillar and spindle cells similar to those in neurilemoma may be present. In MPNST, however, the tumor cells frequently exhibit more or less prominent atypia, prominent nucleoli and occasional mitoses [17,19]. As MPNSTs share many ultrastructural features with benign nerve sheath neoplasms (branching cytoplasmic processes containing microtubuli and filaments, coating of cells with basal lamina and long spacing collagen), electron microscopy is of limited value in differentiating benign from malignant nerve sheath neoplasms.

High grade malignant, pleomorphic LMS usually displays a pleomorphic pattern in aspirates and should not be difficult to differentiate from conventional neurilemomas. LMS with a fascicular pattern, however, is more challanging (Figure C-6). The typical pattern of fascicular LMS, consists of fascicular fragments and cellular aggregates of cohesive spindle cells often aligned in parallel [19]. Nuclei are often elongated, blunt-ended or cigar shaped and truncated showing coarse chromatin and often nucleoli [20]. Immunocytochemistry is of considerable help, as neurilemomas are positive for S-100 protein and negative for muscle markers, while positive staining for desmin (Figure C-6, inset), and/or H-caldesmon and SMA indicates a smooth muscle neoplasm.

In many cytological studies the importance of clinical and radiological information in the evaluation of FNA smears from soft tissue masses has been emphasized. It is interesting to note that in this series clinical information was sometimes misleading. One patient presented with a 20 cm deeply seated mass in the thigh which at radiologic examination was found to be partly cystic, and diagnosed as a large sarcoma with necrosis. The aspirate was cell-rich containing clusters of quite uniform cells with somewhat granular chromatin but without any prominent atypia (Figure C-7). The nuclei were predominantly round to oval, but a moderate number of spindled nuclei, many of them with folds and pointed ends were also recognised in the smears. One smear showed diffuse positivity for S-100 in almost all tumor cells, a finding more typical of a benign nerve sheath neoplasm than of MPNST. In addition on re-examination of the original slides a few Verocay bodies were seen (Figure C-8). Notably, the histology of the excised tumor (Figure C-9) was initially interpreted as MPNST. Another patient had a history of adenoid cystic carcinoma in the parotid gland, removed two years before aspiration of a mass in the arm. Examination of the FNA smears disclosed multiple clusters of predominantly small or moderately sized cells with round to oval nuclei having somewhat granular chromatin and sparse cytoplasm (Figure C-10). Some small sheets of similar cells surrounding globules of a fibrohyaline matrix were interpreted as stroma cylinders typical of adenoid cystic carcinoma (Figure C-10, inset and C-11), which was the primary cytologic diagnosis. Histologic examination of the excised tumor, however, revealed a typical neurilemoma with occasional small areas of fibrohyaline stroma surrounded by spindle cells (Figure C-12).

Reexamination of smears from 2 additional patients with false positive sarcoma diagnoses disclosed sparse aspirates. Both patients were primarily diagnosed at another hospital and cytological slides were sent to our institution for second opinion. Unfortunately, we concurred with the original cytologic interpretation in both cases and the lesions were operated as

sarcomas. One of these smears contained only scattered moderately pleomorphic cells containing nuclei with small nucleoli and increased chromatin granulation. A few nuclei were oval and indented, resembling nuclei from LMS [20]. Aspiration smears from the second patient contained clusters of adipose tissue with a partly myxoid background and a scanty admixture of spindle cells. The smear was interpreted as myxoid sarcoma, probably myxoid liposarcoma. In retrospect, we can postulate that the aspirator had missed the lesion and sampled only fat with degenerative changes adjacent to the neoplasm. The diagnostic errors in these two patients were thus due to misinterpretation of inadequate material, emphasizing the need for adequate and representative specimens and adjunctive methods in the cytological evaluation of spindle cell tumors of soft tissue. Another patient in this study was given a cytologic diagnosis of myxoid liposarcoma at another hospital and referred to us for additional examination, to confirm the malignant diagnosis before surgery. Repeated aspiration gave smears interpreted as neurilemoma and immunostains on cytospin preparations showed strong positivity for S-100 protein.

Yet another sarcoma which may be misinterpreted as neurilemoma is monophasic fibrous synovial sarcoma. Aspirates from synovial sarcoma typically reveal an abundance of dispersed cells in addition to cell-tight tissue fragments [22-25]. Immunocytochemistry is helpful in differentiating synovial sarcoma from neurilemoma, as the spindle cell component in synovial sarcoma usually shows focal positivity for epithelial membrane antigen and keratin. Occasionally spindle cells in synovial sarcoma can display focal positivity for S-100 protein, but not the diffuse, strong positivity usually observed in neurilemmoma. In addition cytogenetic or molecular genetic analysis of synovial sarcoma in most cases reveals a balanced translocation t(X;18)(p11;11) or its SS18/SSX fusion product. The successful detection of the (X;18) and SS18/SSX fusion gene in aspirates from synovial sarcoma thus

helps in distinguishing synovial sarcoma from neurilemoma and other spindle cell lesions with similar morphology [26].

Benign soft tissue tumors which are important differential diagnoses include spindle cell lipoma (SCL), solitary fibrous tumour (SFT), desmoid fibromatosis and myxoid tumours (cases with abundant myxoid background matrix) such as intramuscular myxoma and perineurioma.

Smears from SCL with a predominance of spindle cells may closely resemble neurilemmoma. One previous study described two cases of SCL misclassified by FNAC as benign neurogenic tumors [26]. The presence of fatty and collagenous components in SCL and immunostains positive for CD34 and negative for S-100 protein in spindle cell components helps to differentiate this lesion from Neurilemoma [27]. SFTs with their relatively uniform spindle cells should also be included as a differential diagnosis. The cytological features of SFT of soft tissue are poorly defined. In our experience, FNAC of SFTs show cellular smears with mostly compact sheets and clusters of or dissociated spindle cells with slight, occasionally moderate nuclear atypia and a distinctive immunopositivity for CD 34 [20,28]. The cell clusters in SFT often show a collagenous background matrix, while neurilemomas often show cohesive sheets and fascicles of wavy spindle cells embedded in a metachromatic and fibrillar background matrix. Compared to neurilemomas, aspirates from desmoid fibromatosis display variable but most often moderate or poor cellularity with a mixture of single cells and small cell clusters and fragments of paucicellular collegenous stroma. Cells with preserved morphology in smears from desmoids frequently show fusiform nuclei and moderate cytoplasm with cytoplasmic processes [20,29-30]. With regard to immunocytochemistry, cells from desmoids are positive for SMA and in about 50% of cases focally also for desmin, while S-100 protein is always negative.

Among myxoid spindle cell neoplasms, aspirates from intramuscular myxoma may occasionally be difficult to distinguish from neurilemoma with a myxoid background matrix. Aspiration smears from myxoma display dispersed cells and small loose aggregates of monomorphic spindle cells having long and slender cytoplasmic processes and a prominent myxoid background. Scattered rounded macrophage-like cells and multinucleated atrophic muscle fibers can also be occasionally seen [31]. Uniform cells with long cytoplasmic processes are not typical of neurilemoma. Perineurioma, another benign spindle cell tumor with abundant myxoid background matrix has poorly defined cytological features. The few cases of perineurioma that we have seen showed variable cellularity and elongated cells with ovoid, fusiform or rounded nuclei, many stripped nuclei and intact cells with long, thin bipolar cytoplasmic processes [20,32]. Compared to neurilemoma, perineurioma cells are negative for S-100 protein and positive for EMA. A specific diagnosis of perineurioma is difficult without the help of immunocytochemistry and/or EM.

Based on this re-evaluation and literature references the main benign differential diagnoses of neurilemoma are SCL, desmoid fibromatosis, perineurioma, intramuscular myxoma and SFT of soft tissues. Malignant tumors which constitute differential diagnoses include sarcoma MPNST, LMS, LGFMS, monophasic fibrous synovial sarcoma and adult fibrosarcoma (Table 5).

Conclusion

Considering the implications for the patient when having to choose between surgery and watchful waiting, the cytologic diagnosis of a neurilemoma as simply “benign soft tissue tumor” is not adequate. The precise diagnosis is necessary for correct treatment. When aspirates are scanty, however, neurilemoma should not be suggested and when the microscopic features are not typical, immunocytochemistry is important. A strong and

uniform S-100 protein positivity is characteristically seen in aspirates from both conventional and ancient neurilemomas.

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Legends to figures

Figure 1. Low-power features of tissue fragment obtained from neurilemoma consisting of cellular cohesive clusters of tumor cells, corresponding to histological areas of Antoni A. (H&E stain X 10).

Figure 2. Loosely cohesive and poorly cellular sheets of spindle cells embedded in the fibrillar matrix corresponding to histological areas of Antoni B. (MGG stain X 25).

Figure 3. FNA of neurilemoma showing small tumor fragments with collagenous matrix. (MGG stain X 10).

Figure 4. Spindle cells with wavy nuclei embedded in a fibrillar matrix is a common feature of FNA smears of neurilemoma. (MGG stain X 25).

Figure 5. Another common feature of neurilemmoma: cells with round to oval nuclei with indistinct cytoplasmic borders. (MGG stain X 50).

Figure 6. Occasional cigar-shaped nuclei similar to those observed in smears from leiomyosarcoma. (MGG stain X 50).

Figure 7. Smear from ancient neurilemmoma showing dispersed cells and naked nuclei with prominent anisokaryosis and intranuclear ”Kern-loche” inclusions. (MGG stain X 50).

Colour Figures

Figure C-1. Strong diffuse positivity for S-100 protein in immunostaining of direct smears (left) and cell block section (right) from neurilemomas. (S-100 X 25)

Figure C-2. FNAc of neurilemoma showing distinctive nuclear palisading and Verocay bodies. (H&E stain X 25).

Figure C-3. Cell block section: note indistinct Verocay bodies. (H&E stain X 10). Inset: MGG stained smears showing Verocay body. (MGG stain X 25).

Figure C-4. Smears from cystic neurilemoma showing scattered round to oval cells with the appearance of histiocytes. (MGG stain X 50). Inset: Immunostaining of cell block prepared from aspirated fluid with clusters of spindle and epithelolid cells strongly positive for S-100 protein. (S-100 X 10).

Figure C-5. Smear from ancient neurilemoma showing loosely cohesive cluster of pleomorphic cells in fibrillary and myxoid matrix. (MGG stain X 50). Inset: Positive immunostain for S-100 proteine on ThinPrep. (S-100 X 25).

Figure C-6.). FNA of leiomyosarcoma with fascicular pattern showing cohesive spindle cells arranged in parallels. Nuclei are often elongated, blunt-ended or cigar shaped and truncated showing coarse chromatin and often nucleoli. (H&E stain X 25). Inset: Immunocytochemistry on cell block section with positive staining for desmin. (Desmin X 10).

Figure C-7. FNA smears from neurilemoma diagnosed erroneously as MPNST showing a tight cluster of quite uniform cells with predominantly round to oval nucleoli with somewhat granular chromatin. (H&E stain X 10).

Figure C-8. On re-examination of original slides the authors found rare Verocay bodies. (H&E stain X 50).

Figure C-9. Corresponding histological section of the excised neoplasm from figures C-8, C-9. (H&E stain X 10).

Figure C-10. FNA smears from neurilemoma diagnosed erroneously as metastasis of adenoid cystic carcinoma showing a tight cluster of predominantly small or moderately sized cells with round to oval nuclei having granular chromatin and sparse cytoplasm (H&E stain X 25). Inset: Cells surrounding a hyaline cylinder-like structure (H&E stain X 25).

Figure C-11. A sheath of small cells surrounding fibrohyaline matrix mimics hyaline stroma spheres typical for adenoid cystic carcinoma. (H&E stain X 100).

Figure C-12. Corresponding histologic section of the excised neoplasm revealed a neurilemoma with rosette-like structures. (H&E stain X 25).

Tables

Table 1.

Overall FNAC Diagnostic Accuracy of FNAC in 116 Cases of Neurilemoma.

	Histology	
FNAC	Neurilemmoma	Ancient Neurilemmoma
Benign (69%)	73	7
Malignant (5%)	5	1
Inconclusive* (6%)	6	1
Insufficient specimen (20%)	21	2
Total (100%)	105	11

* Whether benign or malignant.

Table 2.

False Positive Malignant FNAC Diagnosis in 6 of 116 Cases.

FNAC Diagnosis	No
Leiomyosarcoma/Suspicion of leiomyosarcoma	2
Sarcoma/Spindle cell sarcoma	2
Myxoid sarcoma (Myxoid liposarcoma?)	1
Metastasis of Adenoid cystic carcinoma from parotid	1
Total	6

Table 3.

Benign FNAC Diagnoses in 80 of 116 Cases

FNAC Diagnosis	No
Neurilemoma	63
Ancient neurilemoma	4
Benign mesenchymal neoplasm/proliferation	3
Atypical lipoma	2
Myxoma	1
Vascular neoplasm	1
Perineurioma	1
Benign epithelial neoplasm	1
Desmoid fibromatosis	1
Cyst	3
Total	80

Table 4. Cytological findings, on re-evaluation, of 89* sufficient aspirates of neurilemmoma

Features	Number of cases	
Cellularity	Neurilemoma (N=80)	Ancient Neurilemoma (N=9)
Rich	42	4
Moderate	18	1
Poor	20	4
Architectural pattern		
Palisading		
Absent	42	6
Present	38	3
Verocay bodies	10	-
Antoni A		
Absent	6	2
Present	74	7
Antoni B		
Absent	13	1
Present	67	8
Tissue fragments/ clusters		
Absent	2	-
Present	78	9
Dispersed cells		
Absent	25	2
Present	55	7
Background matrix		
Fibrillary	73	9
Collagenous	25	3
Myxoid	23	4
Hemosiderin	19	3
Nuclei		
Spindled		
Absent	1	-
Rare to Moderate	20	2
Abundant	59	7

Table 4. cont…

Round to Oval		
Absent	5	-
Rare to Moderate	47	7
Abundant	28	2
Nucleolar contures		
Curves and folds		
Absent	7	1
Rare to Moderate	55	7
Abundant	18	1
Pointed ends		
Absent	3	1
Rare to Moderate	47	6
Abundant	30	2
Intranuclear inclusions		
Absent	75	1
Present	5	8
Nuclear pleomorphism		
Absent	37	-
Slight to Moderate	37	1
Marked	6	8

*93 FNAC specimens were considered as sufficient on primary original evaluation. On reevaluation only 89 were considered sufficient.

Table 5. FNA features of neurilemoma and most common differential diagnoses

Tumor	Typical features	Comments
Neurilemoma	Predominance of tumor tissue fragments. Few dispersed cells Fibrillar background in fragments Indistinct cytoplasmic borders. Elongated, wavy (comma-shaped) tapered nuclei.	Sharp, radiating pain at needling. Neurilemomas often fusiform by palpation and usually more mobile laterally than longitudinally
Desmoid/ Fibromatosis	Clusters or small groups of fibroblast-like cells mixed with fragments of cell-poor collagenous matrix. Moderate pleomorphism in tumor cells. Occasional regenerating muscle fibers (muscle giant cells)	Desmoid with prominent collagenous stroma very firm for the needle, difficult to aspirate sufficient material for evaluation
Solitary fibrous tumour	Cellular three dimensional irregular tissue fragments surrounded by dispersed spindle cells with bland nuclei	
Leiomyosarcoma Fascicular, spindle cell	Fascicles of more or less atypical spindle cells. Cigar-shaped or blunt-ended nuclei. Truncated nuclei. Nuclei in tandem. Occasional scattered large atypical cells (stripped nuclei) outside fascicles.	

MPNST	Fascicles and dispersed cells in varying proportions. Atypical spindle cells with elongated, wavy nuclei with pointed ends. Fibrillar background more or less evident. Often comma-shaped nuclei	
Monophasic fibrous synovial sarcoma	Mixture of cell tight irregular, tissue fragments and dispersed cells. Many stripped nuclei. Often vascular network in fragments. Bland spindle-shaped nuclei. Mitoses in fragments. Mast cells.	Calcifications may be observed on radiographic investigation
Adult fibrosarcoma	Sheets, fascicles of atypical often hyperchromatic spindle cells	Diagnosis of exclusion
Intramuscular myxoma	Abundant myxoid back ground matrix. Cell poor aspirates. Small cell clusters and dispersed cells. Cells with long, thin, bipolar cytoplasmic processes and ovoid or elongated bland nuclei. Occasional single vessel fragments and ‘muscle giant cells’.	
Perineurioma	Elongated cells with thin cytoplasmic processes. Rounded, ovoid or fusiform nuclei. Moderate anisokaryosis. Stripped nuclei.	Extremely rare. Cytological criteria not sufficiently defined

Low grade fibromyxoid sarcoma	Slight to moderate atypia in spindle cells. Occasional vessel fragments in a myxoid background.
Spindle cell lipoma	Mixture of mature adipocytes, uniform spindle cells and collagen bundles/fibers in varying proportions. Occasionally myxoid matrix.

Figure 1

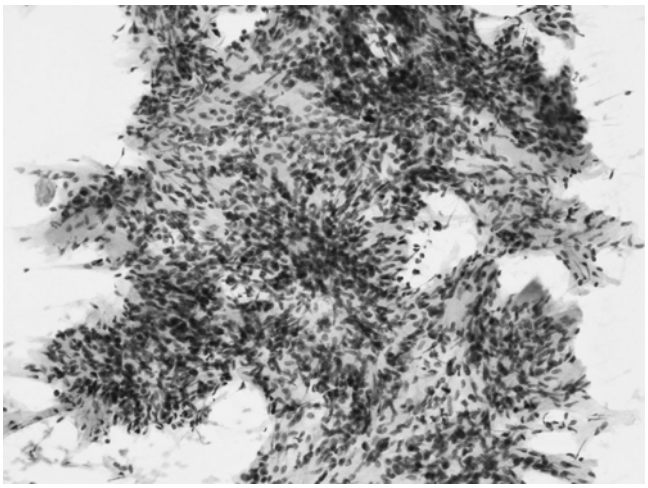
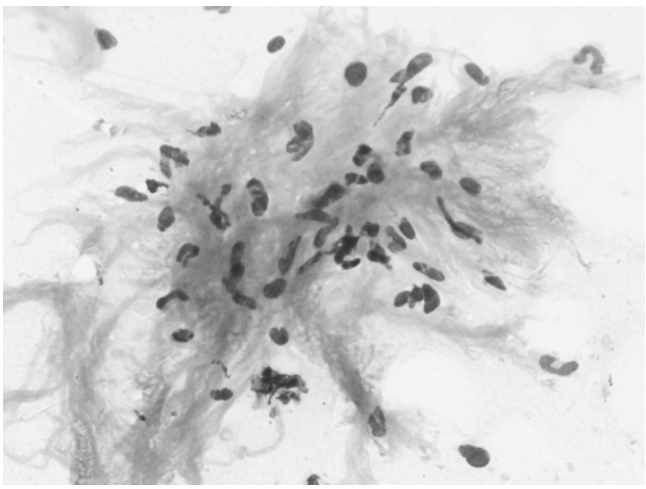


Figure 2



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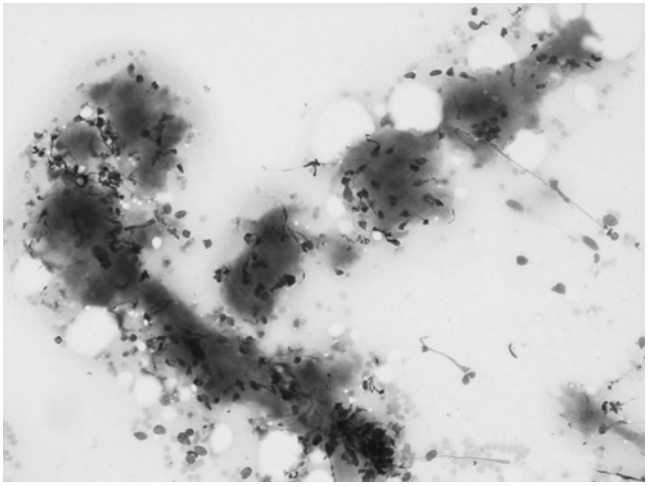

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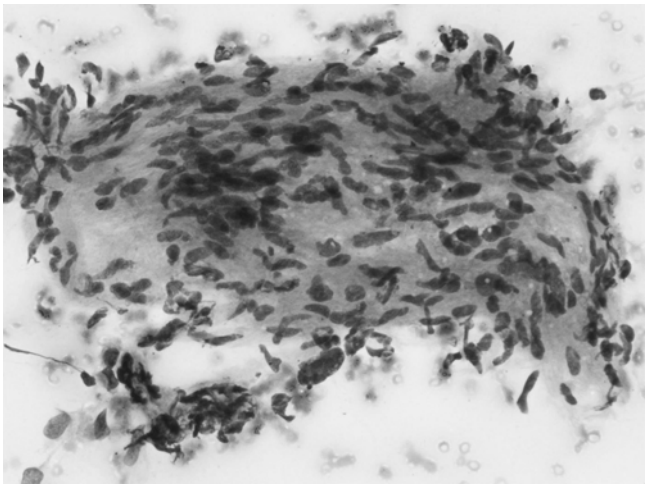

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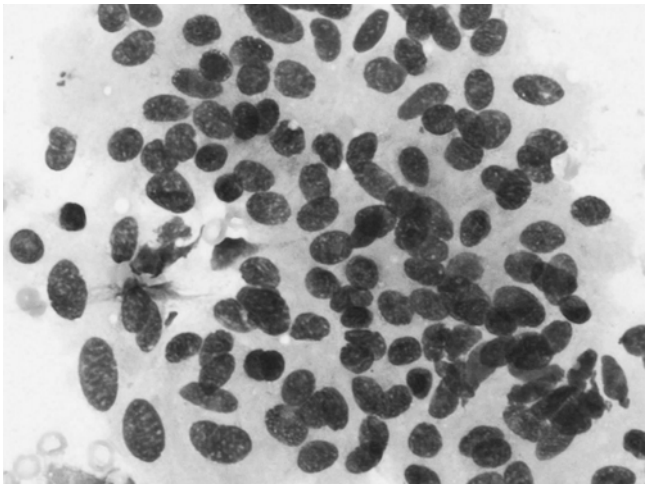

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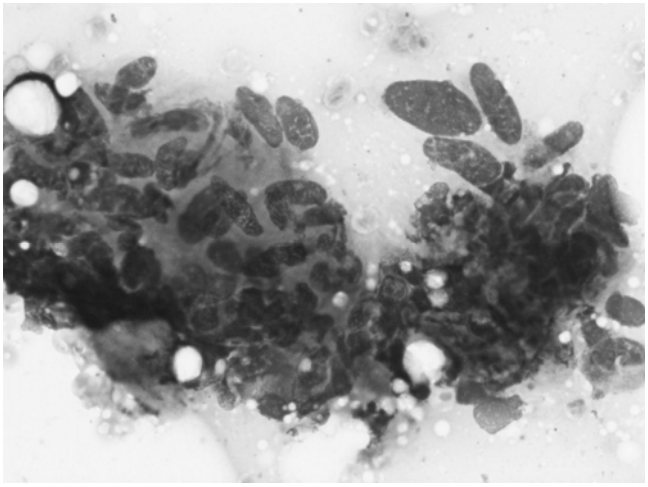

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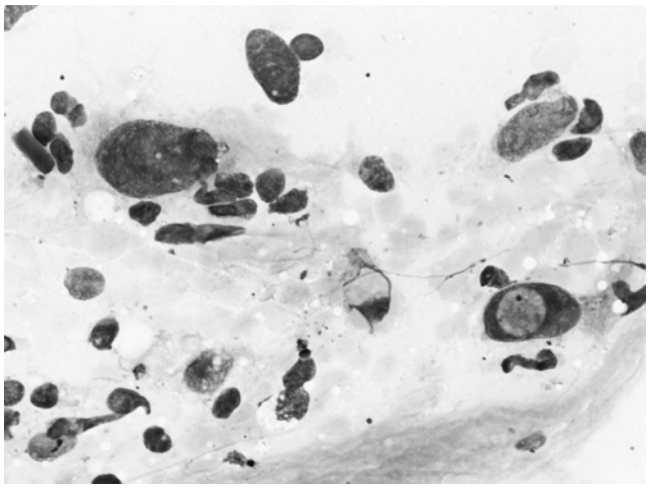
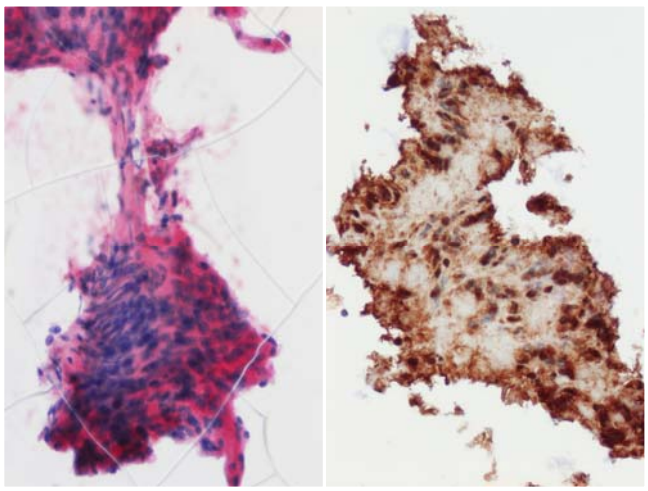


Figure C-1



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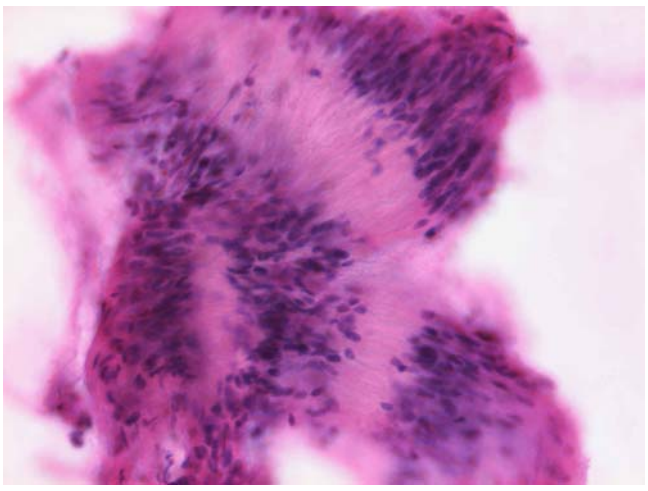

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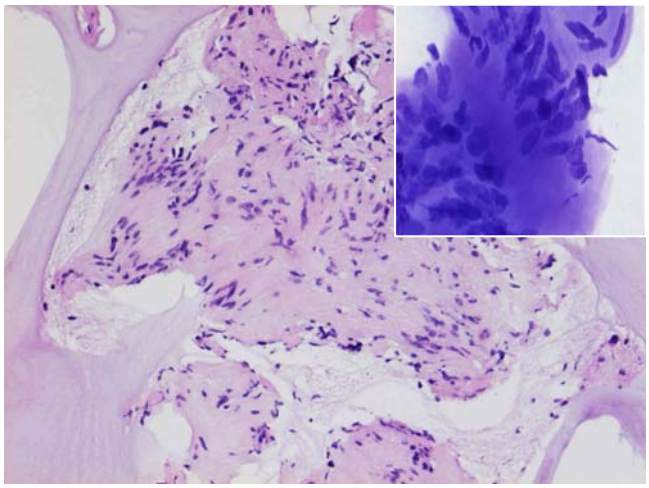

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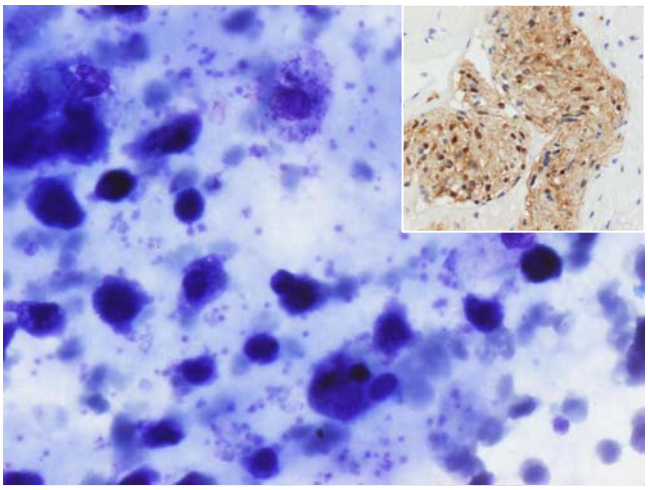

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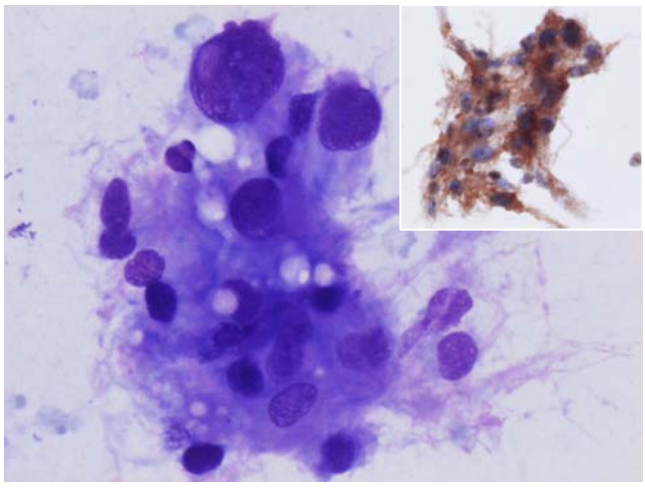

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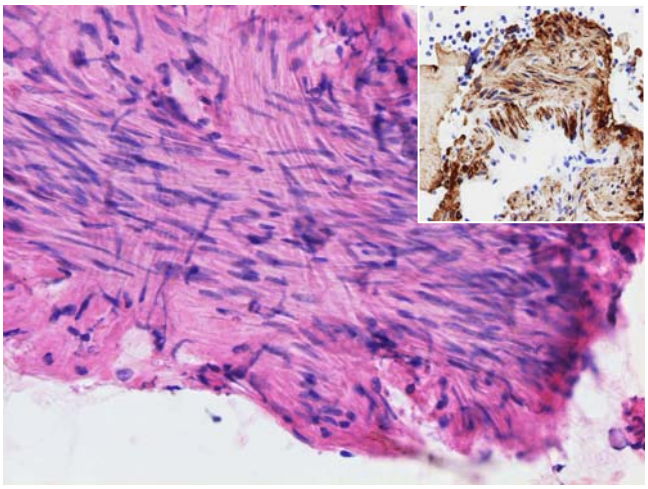

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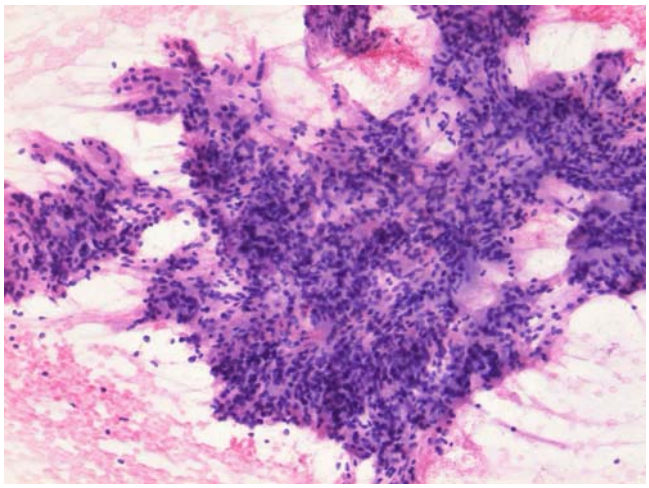

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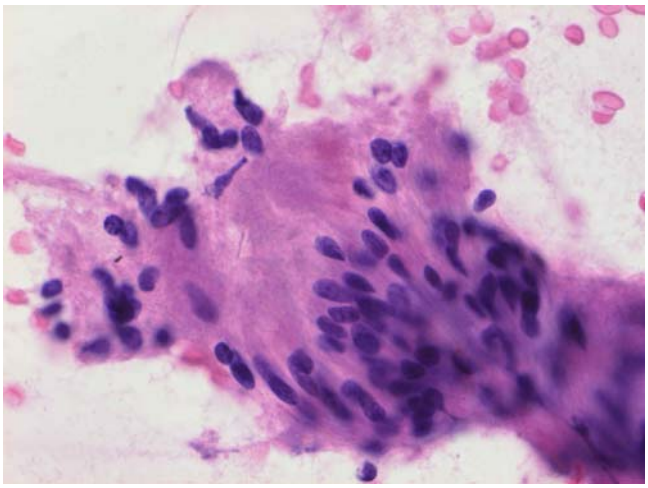

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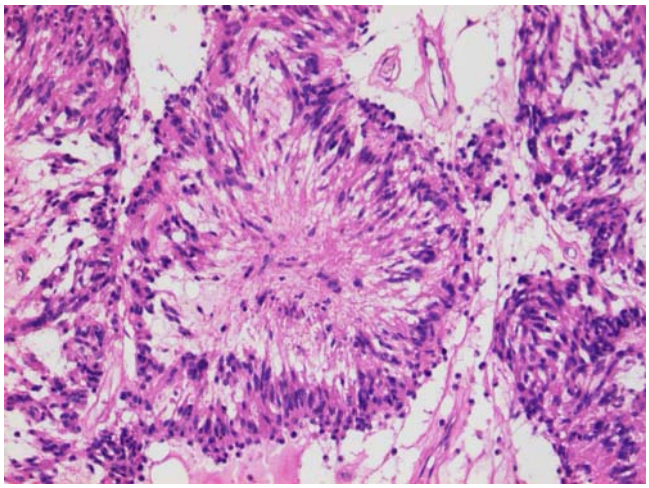

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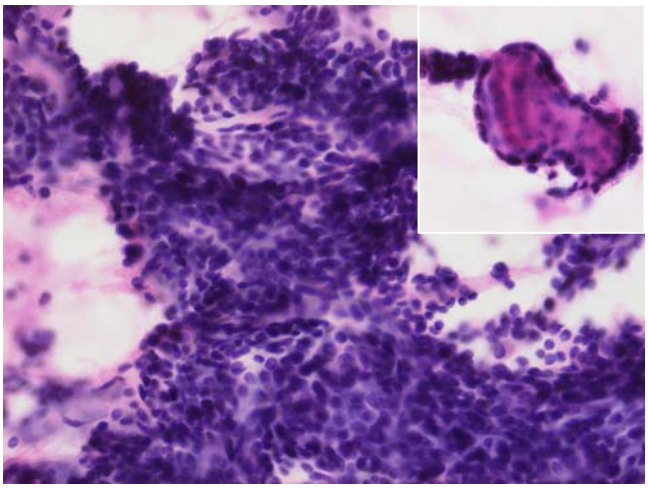

Figure C-11

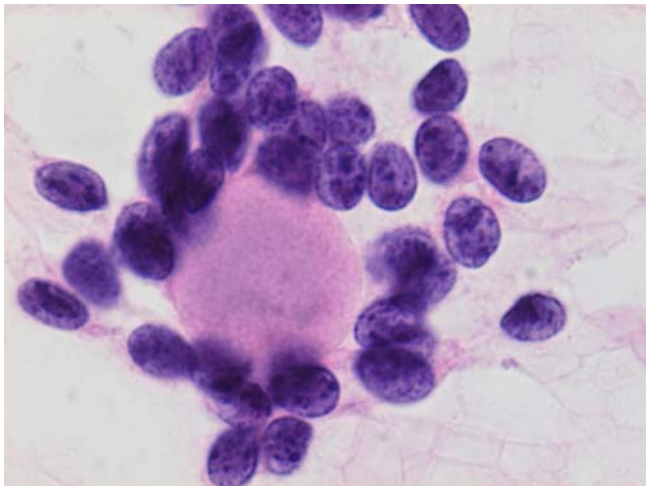

Figure C-12