The Role of USP6 Gene Rearrangement by FISH Analysis in Nodular Fasciitis and Histological Mimics

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Research

Keywords: USP6, Nodular fasciitis, fluorescence in situ hybridization

Posted Date: July 21st, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-728808/v1>

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Abstract

Background: Nodular fasciitis (NF) is a common benign fibroblast and myofibroblast tumor. Although there have been constant concerns about its histological features and differential diagnosis, NF is still the most easily misdiagnosed mesenchymal lesions, especially over diagnosed as a sarcoma. USP6 gene rearrangement was reported recently to be a reproducible and specific gene change in NF, which strongly assists the diagnosis of NF. We aim to study USP6 Gene Rearrangement in NF and other spindle cell lesions mimicking NF, and to investigate the use of USP6 Gene Rearrangement in differentiating NF and its mimics.

Methods: USP6 translocation by fluorescence in situ hybridization (FISH) was studied on 40 cases of NF and 54 cases of other spindle cell lesions (including 10 cases of spindle cell sarcoma) that mimic NF.

Results: Thirty-four cases (85.5%) of NF showed USP6 gene translocation, including 10 cases which previously diagnosed or considered as malignant diseases by the referring pathologists. All of other 54 cases of spindle cell lesions were negative for USP6 translocation.

Conclusions: USP6 gene rearrangement by FISH analysis is a reliable test for diagnosis of NF, and also a helpful adjunct to prevent over diagnosis of NF. Positive USP6 gene rearrangement by FISH could be a useful marker to exclude malignant lesions that mimics NF.

Introduction

NF is a commonly encountered, benign fibroblast and myofibroblast neoplasm, which usually presents as a small but rapidly growing mass¹⁻³. It predominant occurs in young to middle-aged adults between 20 and 40 years, without sexual predisposition. Upper extremities are the most common affected site, followed by the trunk and head and neck. Cases occur in extremities and hands and feet are infrequent²⁻³. Most cases are located in the superficial subcutaneous fascia, but some can involve deep muscle tissues regardless of its location. Histologically, NF displays spindle cells with myofibroblasts features arranged into loose fascicles, showing storiform or S-like appearance. The spindle cells are usually bland looking, with variable myxoid vascularized to densely sclerotic stroma, and erythrocyte extravasations foci, with frequent foci of erythrocyte extravasations. These histological features of NF make it easily misdiagnosed as other spindle cell malignant tumors, such as low-grade myofibroblastic sarcoma, myxofibrosarcoma, synovial sarcoma, and so on, which is harmful for the patients with risk of overtreatment. On the other hand, it should also be differentiated from benign or intermediate lesions such as desmoid fibromatosis, inflammatory myofibroblastic tumor, dermatofibroma, etc. Despite being recognized for over six decades and heightened awareness of this entity constantly, NF is still among the most common benign mesenchymal lesions misdiagnosed as a sarcoma. A recent report showed that the misdiagnosis rate of NF was more than 50% and the over diagnosis rate was more than 30%. Making the diagnosis accurately and avoid over diagnosis of NF is still a great challenge for surgical pathologists, due to its confusing morphology and non-specific immunophenotype.

USP6 gene, also known as TRE17, encodes an ubiquitin-specific protease (ubiquitin-specific peptidase 6). USP6 protein is involved in regulation of ubiquitination and transport. It may also act as a driving oncogene due to gene rearrangement. A clear association between nodular fasciitis and USP6 gene rearrangement had been established. Molecular findings showed that MYH9-USP6 translocation is the most common rearrangement in NF. This finding resulted in its redefinition as a benign true neoplasm. In 2013, Amary et al conducted a series of studies identified

USP6 rearrangements by FISH in 31 of 34 NF cases, with a sensitivity of about 91%. Patel and colleagues reported similar findings, identified USP6 gene rearrangements in 20 of 26 NF cases. These results suggest that USP6 gene rearrangement test may serve as an important adjunct in the diagnosis and differential diagnosis of NF.

Up till now, only few literatures studied the USP6 gene rearrangement in NF and its mimics. Herein, we collected a cohort of NF and a group of its mimics, reviewed the clinical pathological features and morphology, and studied the USP6 rearrangement by FISH, aiming to analyze the use of USP6 rearrangement by FISH in diagnosis and differential diagnosis of NF.

Materials And Methods

Cases selection

Spindle lesions which diagnosed as NF, or have been mentioned as differentiated with NF, or have been tested USP6 gene translocation by FISH in the department of pathology, Sun Yat-sen University Cancer center from August 2017 to January 2020 were collected. To ensure the accuracy of the diagnosis, two senior pathologists specified in soft tissue (Yingchun Zhang and Huilan Rao) reviewed all the collected cases with initial routine hematoxylin and eosin (HE) and immunohistochemistry (IHC) slides. Some cases were also submitted to molecular test to confirm or exclude the corresponding lesions, for example, SS18-SSX fusion gene FISH analysis for synovial sarcoma, COL1A1-PDGFB fusion gene for protuberant dermatofibrosarcoma, etc. Following criteria of the World Health Organization (WHO, 2013), we divided those cases into three groups: NF, benign or intermediate lesions similar to NF, and malignant tumors similar to NF. Patients' age and sex, tumor location, related clinical information and follow-up data were collected. Patients diagnosed as nodular fasciitis and malignant tumors were followed up in detail. Sun Yat-sen University cancer center (SYSUCC) institutional ethics committee approved this study.

FISH analysis

FISH analysis for USP6 rearrangement was performed formalin-fixed, paraffin-embedded (FFPE) sections by using specific Dual Color Break Apart Probes following the manufacturer's instructions (LBP Medicine Science and Technology Co., Ltd, Guangzhou, China). The FISH signals were assessed under an Olympus BX 51 microscope (Olympus, Japan) equipped with a triple-pass filter (DAPI/Green/Orange, Vysis) Images were acquired using the Cell Sens Standard Imaging System (version 1.7, Olympus Microsystems Inc., Japan). USP6 signals were independently scored by two experienced pathologists (and). Cells with an orange and green signal were scored as normal. The distance of break-apart signals between one of the signals, and one orange and green signal were more than twice, indicating a rearrangement for the USP6 gene. A total of 100 tumor cells were counted and the percentage of the cells with split signal was recorded. Positive cases with a rearrangement for the USP6 gene were defined as those with > 10% of cells showing the break-apart signal.

Results

General clinical and demographic features of the total cohort

After eliminating the cases of duplication and failure in detection, 94 cases of spindle cell lesions were retrieved, including 40 cases of NF, 44 cases of benign or intermediate lesions and 10 cases of malignant tumors

histologically similar to NF. The cohort consisted of 52 males (55.3%) and 42 females (44.7%), ranging in age from 1 to 70 years (median, 30 years). The patient's clinico-pathological information is shown in Table 1 and Table 2.

Table 1
Clinico-pathological features of nodular fasciitis cases

Case no.	Age	Sex	Site	Duration time before diagnosis	Size(cm)	previous diagnosis	USP6 gene rearrangement by FISH
1	33	M	Right neck	10 days	2.5	In-house case	Positive
2	42	M	Subcutis of right forearm	1 week	2	In-house case	Positive
3	42	F	Right thigh	1 month	2.3	In-house case	Positive
4	26	F	Right lower abdominal wall	NA	1.3	In-house case	Positive
5	44	F	Left hip	NA	1.7	In-house case	Positive
6	57	M	Right sternoclavicular joint	NA	4.0	In-house case	Positive
7	27	F	Right thigh	NA	2.2	In-house case	Positive
8	46	F	Lower left clavicle	6 months	3.2	In-house case	Positive
9	13	F	Right thigh root intramuscular	1 year	6.2	In-house case	Positive
10	60	M	Left chest wall	half a month	2.0	Spindle cell tumor	Positive
11	26	M	Left upper arm	NA	NA	Dermatofibroma	Positive
12	4	M	Waist back	1 day	4.8	Desmoid-type fibromatosis	Positive
13	50	M	Right cheek	4 months	NA	Inflammatory myofibroblastic tumor	Positive
14	30	M	Left cheek	2 weeks	NA	Nodular fasciitis	Positive
15	5	M	Eyelid	NA	1.0	Spindle cell tumor, borderline tumor is considered	Positive
16	7	M	Left waist	half a year	1	Nodular fasciitis	Positive
17	45	F	Right thumb	NA	1.5	Soft tissue tumor	Positive
18	34	M	Nose Root	half a month	NA	Desmoid-type fibromatosis	Positive
19	57	M	Right eye orbit	1 month	1.0	Haemangioendothelioma	Positive
20	32	F	Left cheek	2 months	NA	NA	Positive

NA: not available

Case no.	Age	Sex	Site	Duration time before diagnosis	Size(cm)	previous diagnosis	USP6 gene rearrangement by FISH
21	3	M	Left forehead	half a year	1.2	Soft tissue tumor	Positive
22	29	M	Side of Cervical spine	4 months	3.0	Myofibroblastic tumor	Positive
23	30	F	Left back	1 week	2.5	Nodular fasciitis	Positive
24	7	M	Right temporal	5 months	1	Inflammatory myofibroblastic tumor	Positive
25	53	F	Left biceps	1 month	2.4	leiomyosarcoma	Positive
26	54	M	Left hand	1 year	NA	Synovial sarcoma	Positive
27	4	M	Right parotid region	1 month	1.7	Infantile fibrosarcoma	Positive
28	48	M	Waist	NA	NA	Dermatofibrosarcoma protuberans	Positive
29	11	M	Posterior neck	3 months	3.0	Dermatofibrosarcoma protuberans	Positive
30	36	F	Left forearm	3 weeks	3.5	Low-grade fibromyxoid sarcoma	Positive
31	15	M	Right neck	3 months	3.0	Low-grade fibromyxoid sarcoma	Positive
32	22	M	Buccal	NA	1.0	Low-grade fibromyxoid sarcoma	Positive
33	44	F	Right hip	3 months	2.8	Low-grade fibromyxoid sarcoma	Positive
34	34	M	Right thigh	10 days	4.0	Myxofibrosarcoma / Low-grade fibromyxoid sarcoma	Positive
35	35	M	Extrathyroid soft tissue nodule	NA	NA	Postoperative thyroid cancer	Negative
36	36	F	Right thigh	> 2 years	1.4	NA	Negative
37	31	F	Subcutis of right upper arm	NA	1.2	In the course of breast cancer treatment	Negative
38	25	M	Right chest wall	NA	NA	NA	Negative
39	48	M	Right thigh	1 week	2.0	Nodular fasciitis	Negative
40	5	F	Subcutaneous back	> 5 months	NA	NA	Negative
NA: not available							

Table 2
clinico-pathological features of lesions mimicking NF

Case no.	Tumor	Age	Sex	Site	USP6 gene rearrangement by FISH
1	Desmoid-type fibromatosis	31	M	Cervical vertebra	Negative
2	Desmoid-type fibromatosis	34	F	the left lower abdominal wall	Negative
3	Desmoid-type fibromatosis	23	F	Left neck	Negative
4	Desmoid-type fibromatosis	65	M	Right abdominal paraaortic	Negative
5	Desmoid-type fibromatosis	48	M	Left neck	Negative
6	Desmoid-type fibromatosis	42	F	Deep fasciatus	Negative
7	Desmoid-type fibromatosis	61	M	Right shoulder	Negative
8	Desmoid-type fibromatosis	30	F	Left rectus abdominis	Negative
9	Desmoid-type fibromatosis	22	F	Left breast	Negative
10	Desmoid-type fibromatosis	20	M	Right upper arm	Negative
11	Desmoid-type fibromatosis	15	F	Left abdominal wall	Negative
12	Desmoid-type fibromatosis	29	F	Groin	Negative
13	Desmoid-type fibromatosis	18	F	Left upper arm	Negative
14	Desmoid-type fibromatosis	33	F	Right upper jaw	Negative
15	Desmoid-type fibromatosis	53	F	Left abdominal wall	Negative
16	Desmoid-type fibromatosis	67	F	Right chest wall	Negative
17	Desmoid-type fibromatosis	28	F	abdominal cavity	Negative
18	Desmoid-type fibromatosis	25	F	NA	Negative
19	Reactive/myofibroblast proliferative lesions	24	M	Neck shoulder	Negative
20	Reactive/myofibroblast proliferative lesions	46	M	Right thigh	Negative
21	Reactive/myofibroblast proliferative lesions	16	M	Right tibia	Negative
22	Reactive/myofibroblast proliferative lesions	47	M	Left upper arm intermuscular	Negative
23	Reactive/myofibroblast proliferative lesions	28	M	Face	Negative
24	Reactive/myofibroblast proliferative lesions	54	F	Thyroid	Negative

Case no.	Tumor	Age	Sex	Site	USP6 gene rearrangement by FISH
25	Reactive/myofibroblast proliferative lesions	29	F	Right neck	Negative
26	Cellular fibrous histiocytoma	14	M	Left arm	Negative
27	Cellular fibrous histiocytoma	15	M	Left abdominal wall	Negative
28	Solitary fibrous tumor	32	F	Abdominal wall	Negative
29	Solitary fibrous tumor	46	M	Right nasal cavity	Negative
30	Myositis ossificans	70	F	Right calf	Negative
31	Myositis ossificans	20	M	Left axillary fossa	Negative
32	Inflammatory myofibroblast tumor	55	F	Left mandibular gingiva	Negative
33	Deep benign fibrous histiocytoma	50	M	NA	Negative
34	Fibrohistiocytoma	19	F	Right upper arm	Negative
35	Proliferative myositis	50	F	Right thigh	Negative
36	Schwannoma	37	M	Left thigh	Negative
37	perineurioma	42	M	Skin of left ankle	Negative
38	Dermatofibroma	41	M	left waistwaist	Negative
39	Benign myofibroblastic tumor	26	F	Left forearm	Negative
40	Benign myofibroblastic tumor	20	F	Subcutaneous of right waist	Negative
41	Benign or intermediate tumor	1	M	Left hip	Negative
42	Fibrous dysplasia of bone	25	M	Left femoral neck	Negative
43	Chondroblastoma	20	M	Upper right femur	Negative
44	Chondroblastoma	11	F	Upper left tibia	Negative
45	Low-grade myofibroblast sarcoma	28	M	Right neck	negative
46	Low-grade myofibroblast sarcoma	16	M	Left thigh	negative
47	Low-grade myofibroblast sarcoma	26	M	Right neck	negative
48	Low grade myxoid fibrosarcoma	57	F	Left knee	negative
49	Pleomorphic undifferentiated sarcoma	43	M	Right supraclavicle	negative
50	Synovial sarcoma	24	F	Right sole	negative
51	osteosarcoma	24	F	Right upper jaw	negative

Case no.	Tumor	Age	Sex	Site	USP6 gene rearrangement by FISH
52	osteosarcoma	36	M	Left distal femur	negative
53	Low-grade malignant mesenchymal tumors	29	M	Subcutaneous back	negative
54	Spindle cell rhabdomyosarcoma	21	M	Anterior maxillary region	negative

Of the NF group, 9 were in-house cases and 31 were consult cases, with the latter being the majority. The most common site affected is head and neck (n = 15, 37.5%), followed by the trunk (n = 10, 25.0%), upper extremities (n = 7, 17.5%), and lower extremities (n = 8, 20.0%). Tumor size ranged from 1.0 to 6.2 cm (median, 2.0 cm). Tumor size of 30 cases was recorded, with 21 (73.3%) cases smaller than 3 cm. Median age was 32.5 years (ranging, 1–60 years). Twenty-five (25/40, 62.5%) patients were in their second to fifth decades, and 10 (10/40, 25.0%) patients were children and adolescents (age ≤ 15 years). The preoperative duration of 28 cases of patients were obtained, ranged from 1 day to > 2 years, 53.6% (15/28) of which were less than 3 months, while 28.6% (22/28) were less than 6 months. Thirty-one cases of NF were consult cases, and the initial submitted diagnoses and the reason for external consultation for 27 cases were recorded. Some of them were given definite diagnosis by the referring pathologists, while others with indefinite diagnosis were given assessment of potential biological behavior (e.g., favoring a sarcoma or sarcomatoid neoplasm). Of these 27 cases with diagnostic opinions, only 4 cases were correctly diagnosed as NF, while 9(9/27, 33.3%) cases were initially diagnosed as malignant tumors, including low-grade malignant fibromyxoid sarcoma, myxoid fibrosarcoma, myxoid liposarcoma, synovial sarcoma, etc. Others were named as desmoid fibromatosis, inflammatory myofibroblast tumor and other benign or intermediate lesions.

Microscopically, our cases had a wide variety of morphologic features: many cases had abundant myxoid matrix, and a few cases had a higher cellularity, while some lesions was characterized by increased collagen production, sometimes with deposition of keloid-like collagen fibers. All the cases were composed of plump, immature-appearing fibroblasts and myofibroblasts that arranged in short intersecting fascicles. In the area with obvious mucoid degeneration, those cells were arranged in a haphazard fashion, often called “tissue culture appearance” or “feathery pattern”, usually accompanied extravasated erythrocytes and scattered lymphocytes. Mitotic figures are fairly common, but cytological pleomorphism and nuclear atypia were absent. Most lesions were well circumscribed but unencapsulated, whereas a minority of cases had poorly defined borders with infiltration into the surrounding skeletal muscle, adipose tissue, and entrapped nerve fascicles. The stroma was at least focally myxoid in all cases and there were frequent cystic spaces in these myxoid areas. In some cases, the cells were abundant and dense, with more mitotic images and similar morphology to malignant tumors (Fig. 1). Mitotic figures are fairly common, but atypical mitoses are virtually never seen. Possibly related to the duration of the lesion, there are three major subtypes of NF: mucinous, cellular and fibrous.

Due to its variable morphologic features, nodular fasciitis were easily misdiagnosed as other benign or even malignant lesions with mucinous appearance, or with proliferation of fibroblasts and myofibroblasts, such as low-grade myofibroblast sarcoma, desmoid-type fibromatosis, cellular fibrous histiocytoma, solitary fibrous tumor, myositis ossificans, inflammatory myofibroblast tumor, et al.

Clinic-pathological features of 54 cases of spindle cell lesions mimicking NF were summarized in Table 2. Some of the cases displayed proliferation of fibroblast or myofibroblast features, some showed mucinous stroma, some showed proliferation of collagen fiber, and some showed dense spindle cellularity. All these features were mimicking different periods of NF, which have been described as mucinous, cellular and fibrous subtypes (Fig. 2).

Frequency of USP6 translocation in NF and in NF-like lesions

The results of FISH analysis of USP6 translocation was shown in Table 3. Of these 98 cases, 35 (35/98, 37.6%) were positive. Within the 40 cases of NF, 35 (35/40, 85.0%) of them were positive. All of other 58 cases that mimic NF were negativet. It is worth noting that all 9 cases that initially diagnosed as malignant tumors by the submitting pathologist were all positive for USP6 gene rearrangement. The microscopic images and FISH results of representative cases showed in Fig. 3.

Table 3
The frequency of USP6 Gene Rearrangement by FISH Analysis in nodular fasciitis and histological mimics

Lesions	cases (n)	USP6 gene rearrangement (n, %)
Nodular fasciitis	40	34 (85.0)
Begnin or intermediate tumor	45	0/45(0)
Fibromatosis	17	0/17
Reactive/reparative myofibroblastic lesion	7	0/7
Myositis ossificans	2	0/2
Chondroblastoma	2	0/2
Others	17	0/17
Malignant tumor	10	0/10
Total	95	34/95(35.8)

Discussion

In this study, we reviewed a cohort of NF and its histological mimics, collected their clinico-pathological characteristics, and studied their USP6 gene rearrangement status by FISH. Clinico-pathological analysis showed that NF occurred over a wide age range, from 1 to 60 years old, and predominant in young to middle-aged adults between 20 and 50 years old. Most of the lesions grow rapidly and the lesion duration was short, with most cases less than 3 months. The greatest dimensions of NF were smaller than 3 cm in 73.3% of cases. The follow-up data showed that most NF patients only underwent complete resection, and no recurrence or metastasis happened. These results demonstrated important clinical features of NF: rapid growth, small nodule, and benign course.

Similar to previously reported series, the pathologic spectrum of NF is wide and the morphology can vary significantly between and within cases. However, in the case of complete resection, more or less mucoid degeneration, or microcapsule structure with lymphocyte infiltration can be seen in the background of spindle tumor cells in most cases, suggesting that this is a very important diagnostic clue. Mitotic figures are fairly

common, but atypical mitoses are virtually never seen. The absence of atypical mitosis is one of the most important morphological features to distinguish nodular fasciitis from malignant tumors.

It is worth noting that NF is very easy to be misdiagnosed, especially over diagnosed as a sarcoma. In 1991, Montgomery EA and Meis JM reviewed 53 cases of NF and found that the misdiagnosis rate was 57%, of which 21% were over diagnosed as sarcomas. In 2018, Erber R and Agaimy A reported that of the 36 consult cases with diagnostic suggestions, only one third of NFs were correctly diagnosed by submitting pathologists, while one third was initially judged as malignant. Our data showed that only 9.6% of NF was correctly diagnosed by submitting pathologists. Over diagnosis as malignancy (ranging from low-grade to high-grade sarcoma) was rendered or favored in 35.4% of cases, which would cause catastrophic clinical consequences. The main reasons for over diagnosis attributed to not considering NF as a differential diagnosis, or mislead by features such as increased mitotic activity, high cellularity, high Ki-67 index, deep infiltrative location, prominent myxoid change, and good circumscription being not compatible with a diagnosis of NF. Since the histological features of NF is confusing, while immunohistochemistry staining is not helpful, sometimes even misleading, more objective and specific auxiliary methods are urgently needed.

In 2011, Erickson Johnson et al. found that USP6 gene rearrangement occurred in approximately 92% (44/48) of NF cases, but not in normal control tissues or other spindle cell lesions that required to be differentiated from NF, suggesting that USP6 gene rearrangement was a reproducible and specific genetic change in NF, and has potential application value in clinical diagnosis. In recent studies conducted by Amary et al., USP6 rearrangement was detected by FISH in 31 of 34 NF cases with a sensitivity of approximately 91%. Patel and colleagues reported similar findings, which identified USP6 gene rearrangements in 20 of 26 NF cases.

In our study, 34 of 40 NF cases are positive for USP6 FISH test, with a sensitivity of 85%, consistent with the results reported in the literature. For those NF cases which were initially diagnosed as malignant tumors by the submitting pathologist, the USP6 gene rearrangement by FISH was 100% positive (9/9), while for those malignant cases that needed to be differentiated from NF, including low-grade myxofibrosarcoma, synovial sarcoma, osteosarcoma and other cases, USP6 gene rearrangement by FISH was 100% negative (10/10). Positive USP6 gene rearrangement by FISH could prompt the possibility of NF.

As showed in table 4, including our series, a total of 53 cases of different malignancies were tested by USP6 FISH and none was positive. Therefore, a positive of USP6 gene rearrangement test could almost rule out malignant tumors, which is of great value in preventing NF from being over diagnosed as sarcoma.

In summary, USP6 gene rearrangement by FISH analysis is a reliable test for the diagnosis of NF, and also a helpful adjunct to prevent over diagnosis of other malignancies. Negative USP6 gene rearrangement by FISH could not exclude NF, but USP6 gene rearrangement by FISH indicates that NF is the most likely, and the possibility of other malignant tumors is basically excluded. As the technology of USP6 gene rearrangement tested by FISH is mature and widely available, we recommend that USP6 FISH analysis should be performed to exclude NF and other USP6-induced neoplasms before a diagnosis of malignant rendered when a case with rapidly growing, small nodule without definite atypical mitoses is encountered.

Abbreviations

NF: Nodular fasciitis; FISH: fluorescence in situ hybridization; HE: hematoxylin and eosin; IHC: immunohistochemistry

Declarations

Ethics approval and consent to participate

This study was ethically approved by Sun Yat-sen University Cancer Center IRB, and has been granted exemption from requiring informed consent to participate from participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated during and/or analyzed for this study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

Authors' contributions

ZYC designed the study. FYF and ZYC drafted the manuscript and contributed to data analysis. ZYC and RHL contributed to the diagnoses. ZY contributed to clinico-pathological data collection. LJP assisted in patient selection and figure preparation. ZZC contributed to FISH analysis. LM contributed to the patients' follow-up. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

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Table

Table 4 is not available with this version.

Figures

Figure 1

Different histological features of NF (H&E, 400x). a. Plump, immature-appearing fibroblasts and myofibroblasts arranged in short intersecting fascicles. b. Area with obvious mucoid degeneration, and cells were arranged in a haphazard fashion (called "tissue culture appearance" or "feathery pattern"). c. Extravasated erythrocytes and scattered lymphocytes infiltrate. d. Collagen production of stroma.

Figure 2

Different histological features of spindle cell lesions mimicking NF (H&E, 400x). a. Inflammatory myofibroblast tumor showed myofibroblasts arranged in Fascicles, with numerous inflammatory cells. b. low-grade myofibroblast sarcoma showed fat spindle cells with abundant plasma arranged in fascicles. c. myositis ossificans showed long spindle cell range in fascicles, with abundant eosinophilic plasma, and bony tissues with osteoblast around were seen. d. desmoid-type fibromatosis showed fibroblasts and myofibroblasts arranged in fascicles, with collagen rich stroma.

Figure 3

Representative image of USP6 gene rearrangement analyzed by FISH (X1000).