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# Characterisation of a Novel Radiological Entity in Neurofibromatosis Type 1 - Diffuse Neurofibromatous Tissue

Venkata Amruth Nadella, K. Joshi George and Calvin Soh

## Abstract

*Objectives:* To describe the prevalence, demographics and characteristics of a novel radiological entity in neurofibromatosis type 1: diffuse neurofibromatous tissue (DNFT) *Design:* Retrospective, descriptive review of MDT and radiology notes. *Methods:* Of the 1049 patients from the NF1 adult radiology MDT minutes (2009–2021), 77 patients with DNFT were identified and clinical data were collected. MRI scans from 20 DNFT cases were interpreted. *Results:* Although overall gender distribution of DNFT was roughly even, it was more prevalent in females (73.9%) at the sacroiliac joint—where this entity was most common (29.9%). DNFT often involves the fibrous part of the sacroiliac joint and is seen as diffuse, streaky infiltrating tissues that cause bone erosion without mass effect. The period prevalence of scoliosis and dural ectasia on corresponding spinal levels with spinal DNFT was 62.8 and 51.2%, respectively (n=43). *Conclusions:* This is the first reported descriptive study of DNFT in NF1 and the first to describe its MRI features in detail. The predilection for the sacroiliac joint and the possible associations with scoliosis and dural ectasia provide important insights that can form the basis for future studies whilst also suggesting the need for active surveillance of this tissue in NF1 patients.

**Keywords:** Neurofibromatosis type 1, diffuse neurofibromatous tissue (DNFT), scoliosis, Dural ectasia, Neurofibroma, sacroiliac joint

## 1. Introduction

Neurofibromatosis type 1 (NF1) is an autosomal dominant inherited genetic condition in which affected patients have a disposition to the development of benign neoplasms in peripheral nerve sheaths around the body – neurofibromas [1–4].

There are three main established types of neurofibroma: solitary, plexiform and diffuse neurofibromas [5]. Solitary neurofibroma is a benign, discrete neurofibroma involving a nerve root [6].

Plexiform neurofibromas are also benign tumours but they are diffuse and incorporate multiple, deeper nerve fascicles and corresponding branches. The involved large nerve trunks and nerve roots may form a thickened tortuous mass

resembling ‘a bag of worms’ [5–7]. They are congenital but can also develop in later stages of life and are present in roughly half of all NF1 patients [5, 8]. Moreover, as they are not encapsulated, they can displace surrounding tissue and/or cause bony deformities (e.g. scoliosis) resulting in pain [5, 7, 8]. This can make surgical resection of the tumour complex as the neoplasm is interspersed with its surrounding tissues [5]. The brachial and lumbosacral plexi are most commonly affected by plexiform neurofibromas as well as paraspinal tissues and the orbit [7]. There is a risk of malignant transformation into malignant peripheral nerve sheath tumour (MPNST) [9].

Meanwhile, diffuse neurofibromas are a rare subtype of neurofibroma that are found as a plaque-like mass in children and young adults [10]. They often have ill-defined borders and diffusely infiltrate the skin and subcutaneous tissues as a contiguous sheet. They infiltrate around other structures (rather than displacing them as in plexiform neurofibroma), thus enclosing subsequent neurovascular tissues [6, 10]. This diffuse infiltrating pattern makes surgical excision of the tumour challenging [6]. Moreover, it has been recently shown that diffuse neurofibromas are most prevalent in the subcutaneous regions of the head, neck, trunk and extremities and can grow deep into the fascia [10, 11]. However, as well as these three varieties, neurofibromas can also develop along the spinal nerve roots (spinal neurofibromas) in as much as 38% of the NF1 population [12].

In addition to neurofibromas, NF1 patients can also have many other clinical manifestations of the disease including short stature, cardiovascular disease, café-au-lait macules (CALMs), iris hamartomas and optic pathway gliomas [8, 13, 14]. Due to this wide variability in clinical features of NF1, a multidisciplinary approach to patient management is often required [13]. However, to provide the best patient care, we must first understand the disease in its entirety. Moreover, with an incidence of roughly 1 in 3000 people globally, NF1 is the most common neurofibromatosis, which conveys the importance of ongoing research in this area [13].

Over the past 10 years, a novel radiological finding – “diffuse neurofibromatous tissue” (DNFT) – has been noticed in many NF1 patients presenting to our NF1 centre. This tissue is a distinct entity from the more commonly reported neurofibromas in NF1, thus may represent an atypical form of the disease. Unlike diffuse neurofibroma which is plaque-like, this DNFT is streaky in appearance, diffusely infiltrating and does not have much mass effect but still erodes adjacent bone. From spinal imaging, this DNFT is often seen to involve the sacroiliac joint and the paraspinal locations.

Overall, there is a lack of significant literature on any such DNFT in NF1 patients. This paper aims to describe the period prevalence, demographics, characteristics and radiological appearance of DNFT. Moreover, this report will also attempt to identify the period prevalence of any lesions that occur with DNFT. Period prevalence refers to the proportion of individuals affected by a particular variable over a specified timeframe [15]. Any prevalence results from this paper will be referring to the period prevalence between October 2009 to April 2021. Finally, using this current research, this paper will endeavour to determine the effects, or lack thereof, that this novel entity will have on the clinical management of NF1.

## **2. Material and methods**

### **2.1 Study design and overview**

This is a retrospective, descriptive study of DNFT. We have identified this novel radiological entity that is similar to the well described diffuse neurofibroma but

with some differences that will be discussed later in Section 4.2 of this paper. A descriptive approach to this study is favoured as this paper aims to characterise DNFT and identify any prevalent features.

This study was based in Manchester which is one of the two nationally commissioned complex NF1 centres in the UK. Hence, this centre is in a unique position wherein this type of large study can be undertaken due to the relative ease of access to NF1 patient records. Retrospective data from patients with DNFT was extracted from various sources at this centre: (1) NF1 adult radiology MDT minutes from October 2009 to April 2021, (2) NF1 adult neurology MDT minutes from February 2020 to March 2021 and (3) a piloted data collection proforma. Specific radiological data from 20 patients with DNFT was also collected by the interpretation of MRI scans of these patients. MRI was chosen as this is the most superior form of imaging for any NF1-related tumours.

## **2.2 Ethics approval**

Formal ethical approval was not needed as this was a descriptive study that used retrospective patient data from the Manchester NF1 adult centre.

## **2.3 Study subjects and inclusion criteria**

Initially, source [1] – containing 1049 patients – was used to identify the 77 NF1 patients with DNFT according to radiological interpretation of MRI, computerised tomography (CT) scans and X-rays. The following search terms were applied: “diffuse neurofibromatous” and “neurofibromatous”.

## **2.4 Demographic data, outcome measures and procedures**

Following the extraction of the 77 patients with DNFT, patient demographics (including gender and age as of 28/05/2021) were collected using all three sources mentioned earlier. Data on these patients was collected regarding the location of DNFT, scoliotic deformity and dural ectasia using a combination of all three sources. Data on any scoliotic deformity of the spine and its location was chosen as it was the most common spinal deformity in NF1 patients in this complex centre, with a prevalence of 38.3% [4]. Meanwhile dural ectasia was chosen as it is a common spinal lesion with a prevalence of 28.4% in this centre [4].

This data was all inputted into a pre-piloted data collection proforma on “Microsoft Excel for Mac Version 16.48”. Analysis was carried out using pivot tables (in the aforementioned version of Microsoft Excel) from which the desired correlations were selected in order to calculate the period prevalence of each feature with DNFT. Patients were grouped based on the location of their DNFT to assess gender distribution and other correlations in each subset of patients. Microsoft Excel was used to create relevant graphs on the data.

# **3. Results**

## **3.1 Patient demographics**

As mentioned in Section 2.3, 77 patients were found to have DNFT from the 1049 NF1 patients in source [1]. Thus, the period prevalence of DNFT in this NF1 centre (between October 2009 and April 2021) was 7.34%. Furthermore, the mean

age of the patients was 39 years old with a roughly even gender distribution of 39 males to 38 females.

### 3.2 Location of DNFT and gender distribution in each group

DNFT was commonly found as a paravertebral lesion of the spine at varying levels and at the sacroiliac joint of the pelvis. The sacroiliac joint was the most common site for this tissue ( $n = 23/77$ , 29.9%), as shown by **Figure 1**.

There was a total of 19 miscellaneous cases in whom the DNFT was not located in any of the aforementioned regions. However, as DNFT was most prevalent at the sacroiliac joint, the presence of the tissue in this location has been studied in more depth in this paper.

### 3.3 DNFT at the sacroiliac joint and its radiological appearance on MRI scans

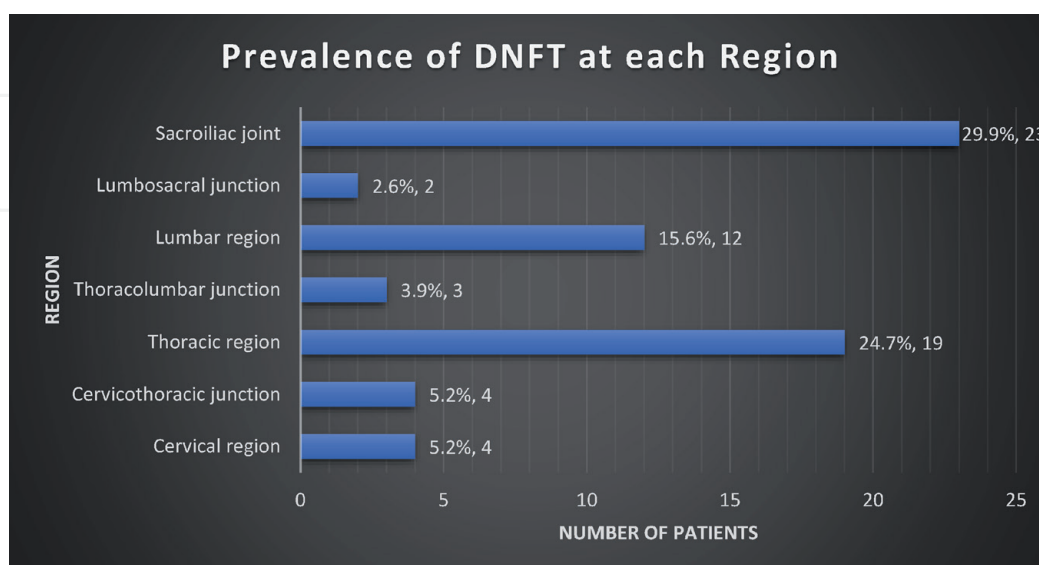
#### 3.3.1 General findings of DNFT at the sacroiliac joint

Of the 23 cases at the sacroiliac joint, 17 were females (73.9%) and 6 were males (26.1%) (**Figure 2**). These figures suggest a strong female correlation of DNFT at the sacroiliac joint.

Moreover, it was more common to have the tissue on the right side ( $n = 14/23$ , 60.9%) of the sacroiliac joint compared to the left side ( $n = 7/23$ , 30.4%). There were 2 out of the 23 cases where the patient displayed the tissue on both the left and right sacroiliac joint (8.70%).

#### 3.3.2 The radiological appearance of DNFT at the sacroiliac joint

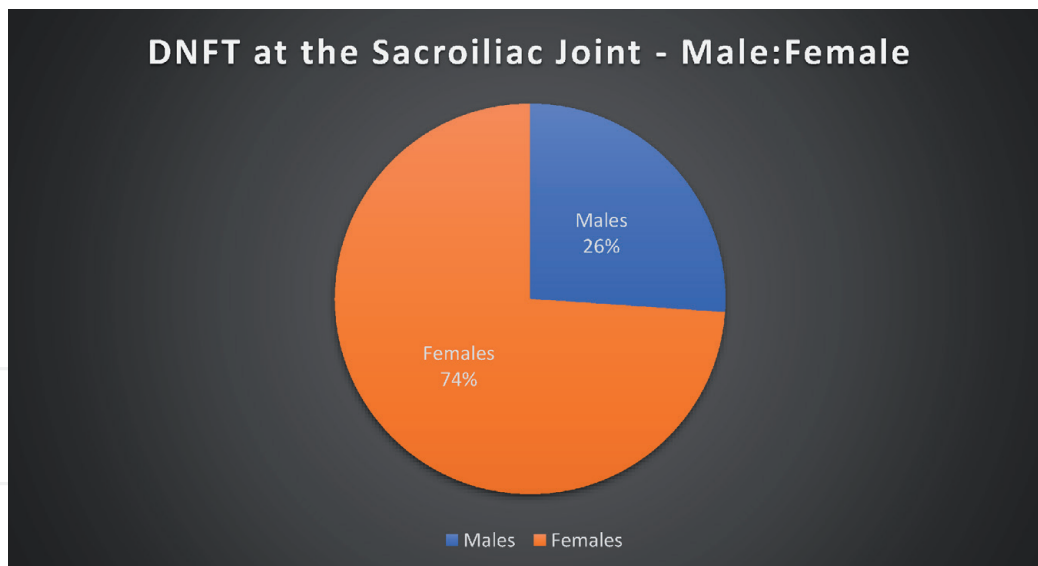
As DNFT is usually an incidental finding, not all sacroiliac joint cases had adequate MRI imaging for review. In our institution, our standard spinal MRI protocol includes sagittal and coronal post-contrast T1W and STIR sequences. As the comprehensive protocol includes brachial and lumbosacral plexal imaging, often



**Figure 1.**

A graph that shows the prevalence of DNFT at each region of the spine and at the sacroiliac joint. For each data label, the first number is the percentage of patients with DNFT at that region out of the total 77 patients. The second number is the raw number of patients with the tissue at that region.





**Figure 2.**  
*A pie chart showing the gender distribution of DNFT at the sacroiliac joint.*

including cranial and orbital imaging, pre-contrast T1W sequences are not routinely included in the spinal protocol.

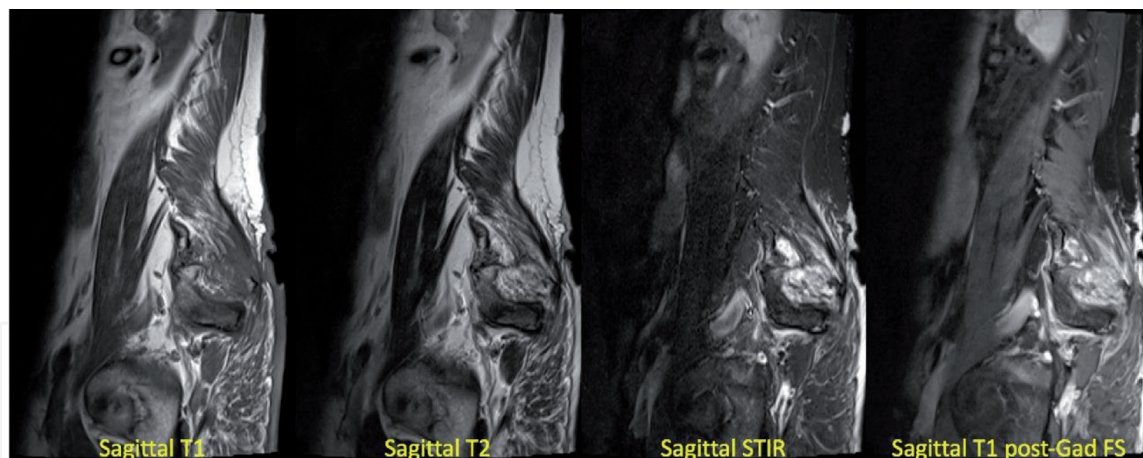
In total, 20 out of the 23 patients had sufficient MRI imaging that could be studied. From the radiological review of these 20 patients, several patterns have been identified.

On imaging, this DNFT tends to appear as streaky, diffuse, infiltrating tissues with no real mass effect but seem to cause bone erosion and scalloping, resulting in a dysplastic joint. These bony changes can also be appreciated on available CT scans (**Figure 3**). This tissue is isointense with muscle on T1 but enhances on post-Gadolinium T1 with fat-saturation and appears hyperintense on STIR (**Figures 4 and 5**). However, on post-contrast STIR sequence, the lesion is inconspicuous – most likely due to the suppression of the Gadolinium contrast enhancement signal, as evident in the kidneys (**Figure 5**). Hence, the lesion is visible on STIR and post-contrast T1 with fat-saturation, but invisible on post-contrast STIR sequence.

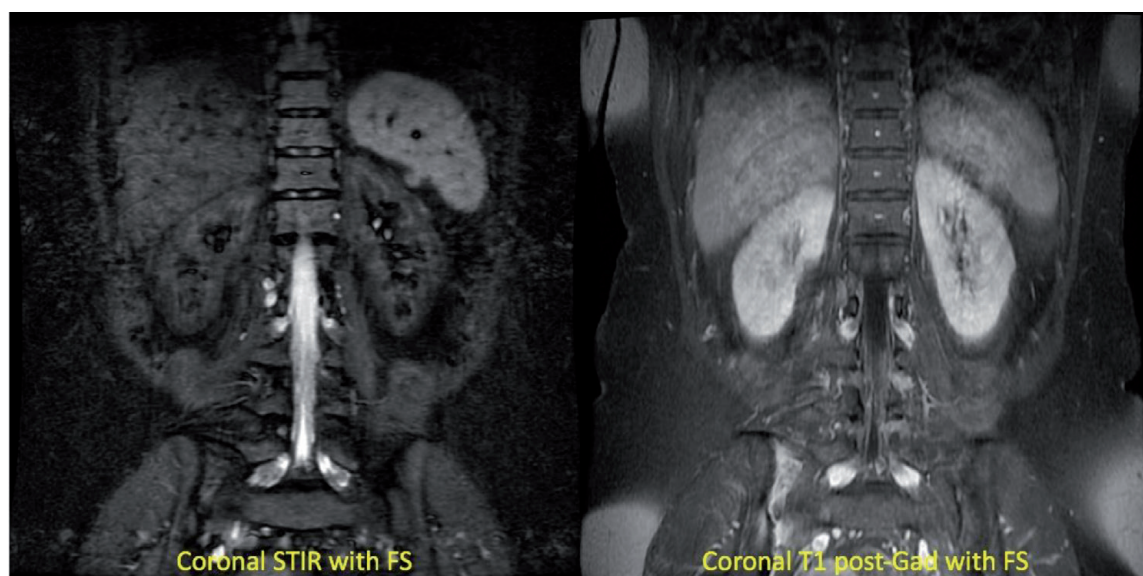
Furthermore, the periosteum is presumed to be involved. Anatomically, the sacroiliac joint is a composite joint, the upper one-third is a syndesmosis, the lower two-thirds are lined by articular cartilage, although only the lower third is lined by synovium, while the middle third resembles a symphysis. This DNFT invariably



**Figure 3.**  
*This CT imaging shows a 74-year-old female with DNFT eroding right sacroiliac joint (SIJ). CT scan shows streaky soft tissues on soft tissue windows, bone scalloping on bone windows, and an eroded fibrous part of the joint on 3D reformats.*



**Figure 4.** Sagittal MRI imaging of streaky tissues shows T1-isointensity, T2-slight hyperintensity, STIR-hyperintensity and enhancing with contrast on post-gad fat-saturated T1. There is some streaky residual fat interposed between the enhancing tissues.



**Figure 5.** A 36-year-old female with DNFT on the right SIJ. Left: Post-contrast coronal STIR: Shows complete signal suppression, as in the kidneys. Right: Post-contrast coronal T1 with fat-saturation shows streaky enhancement.

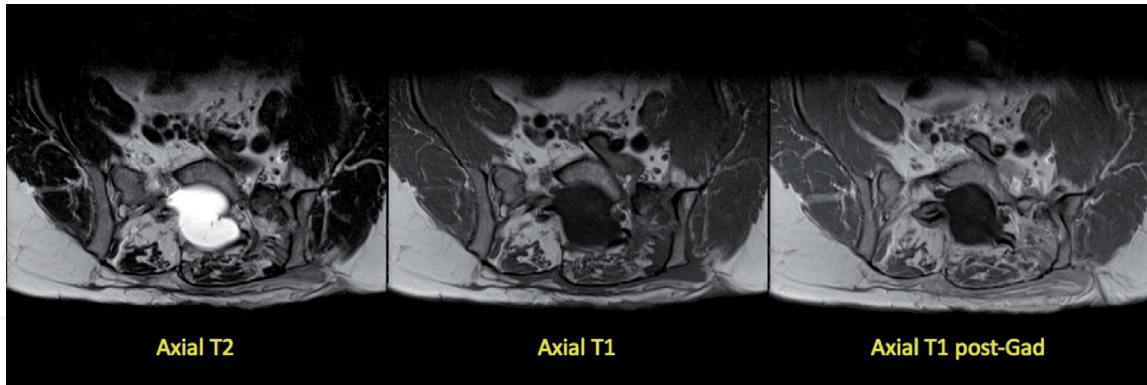
involves the upper third and in some cases extends down towards the lower part of the sacroiliac joint.

Moreover, this streaky DNFT was shown to commonly involve only the fibrous part of the sacroiliac joint (n = 18/20, 90%) (**Figures 3 and 6**). The remaining 2 cases involved both the fibrous and synovial part of the sacroiliac joint. In the few cases that had sufficiently comparable scans over time, the development of the tissue seemed to be relatively static.

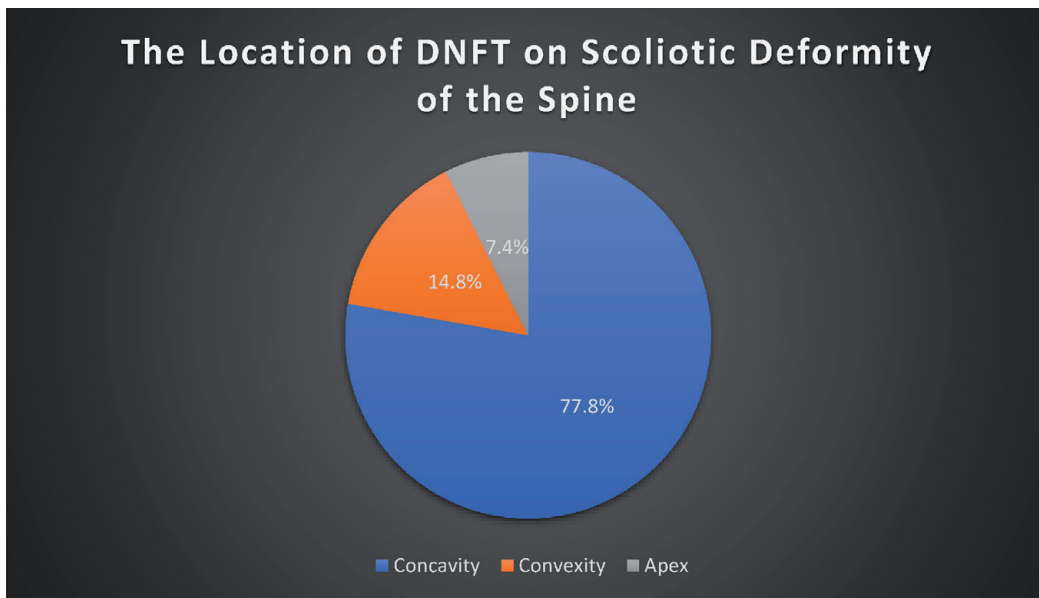
### 3.4 DNFT and its correlated lesions

#### 3.4.1 Scoliosis and Dural ectasia

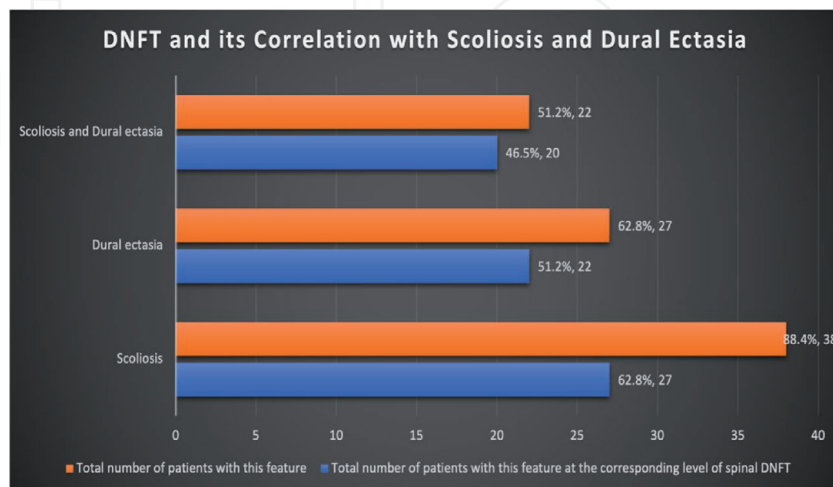
It was calculated that a total of 43 patients had DNFT somewhere along the spine. Out of these 43 patients, 38 (88.4%) had a scoliotic deformity of the spine. A further



**Figure 6.** This MRI shows a 57-year-old male with left SIJ DNFT. Streaky tissues eroding the fibrous part of the left SIJ, minimally hyperintense on T2, isointense on T1 with contrast enhancement.



**Figure 7.** A graph showing the prevalence of DNFT on each location of a scoliotic deformity in the 27 patients with the tissue at the same level as their scoliosis.



**Figure 8.** A graph showing the number of spinal DNFT patients with scoliosis and/or dural ectasia and the number of cases of each feature at the same spinal level. There are 2 values for each bar labelled: 1) the percentage (out of 43 spinal DNFT cases). 2) the raw number of cases.



27 out of the 43 patients (62.8%) had the scoliotic deformity at the same level as the DNFT, suggesting a strong correlation between spinal DNFT and scoliosis.

Moreover, the most common location of DNFT on the scoliotic deformity was the concavity of the scoliosis (n = 21/27 cases, 77.8%) (**Figure 7**).

Out of the 43 patients with spinal DNFT, 27 (62.8%) also had dural ectasia. A further 22 out of 43 (51.2%) of these patients had both the tissue and dural ectasia at the same spinal level.

In the spinal DNFT population of 43 patients, 22 (51.2%) cases had both scoliosis and dural ectasia. A further 20 of the 43 patients (46.5%) had both the scoliosis and dural ectasia at the same level as the spinal DNFT. Thus, it can be concluded that, out of the 22 cases with dural ectasia at the same spinal level as the tissue, 20 (90.1%) also had scoliosis at the same level. Overall, these results show a correlation between spinal DNFT, scoliosis and dural ectasia (**Figure 8**).

## **4. Discussion**

The aims of this descriptive study were to describe the demographics, characteristics and radiological appearance of this novel, streaky tissue. Moreover, the prevalence of certain NF1 lesions such as dural ectasia and scoliosis was also investigated to find any correlated lesions. This section will discuss the principal results in relation to the objectives of this paper.

Although this report has been able to characterise this novel finding, the identification of past research on any similar tissue in NF1 proved challenging due to the lack of a standardised definition, characterisation, and terminology for DNFT. This scarcity of literature and existing knowledge on this entity is reflected in the few result comparisons that this paper can comment on with other similar studies. Moreover, DNFT is infrequently associated with specific clinical symptoms apart from the radiological deformity of the sacroiliac joint. As such, there is no justification for histological tissue diagnosis and DNFT is often accepted as an NF1-related lesion and loosely mislabelled plexiform neurofibroma. However, the results will be compared to the better studied plexiform and diffuse neurofibromas which should provide some insight into this novel tissue finding as a distinct entity from neurofibromas in NF1.

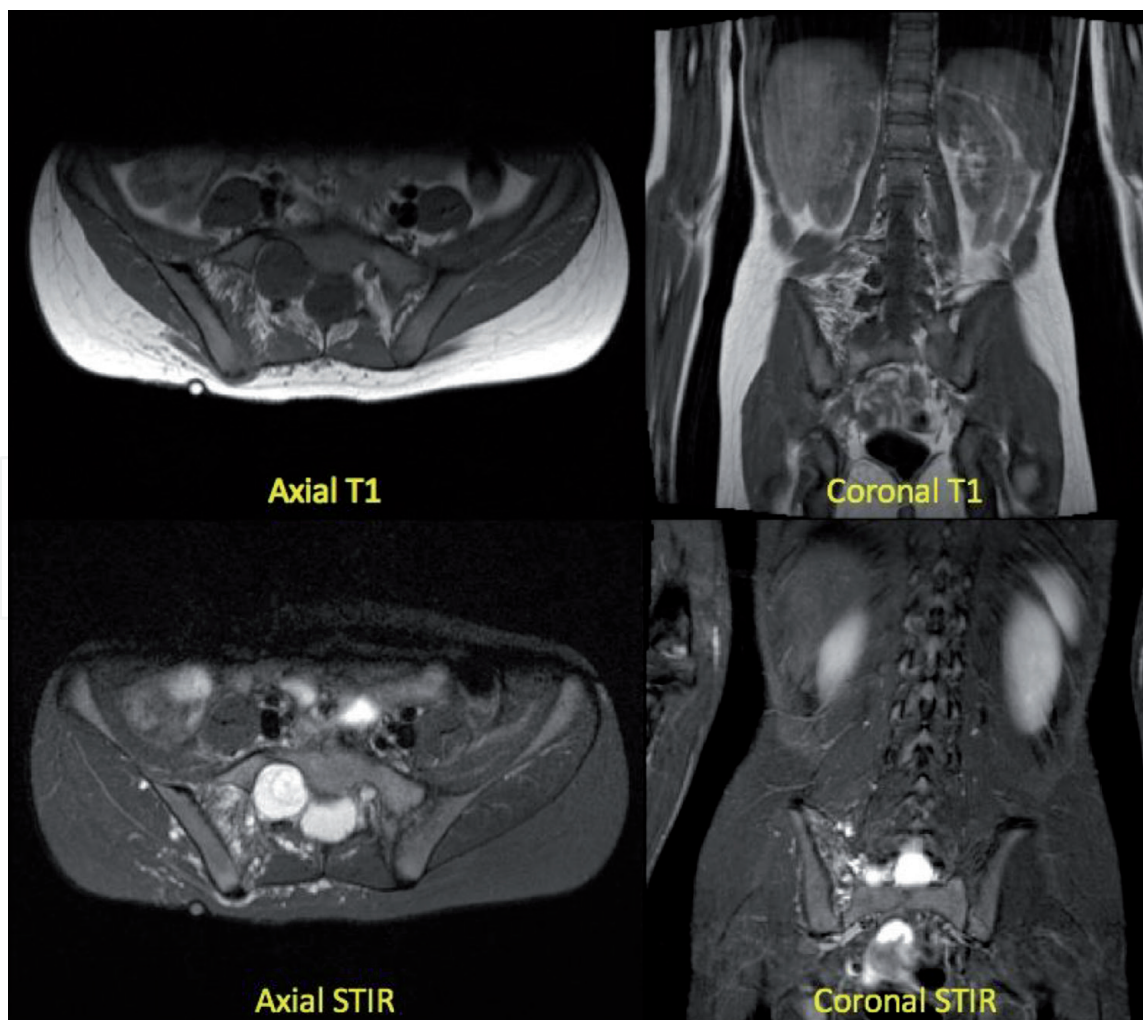
### **4.1 DNFT is most prevalent at the sacroiliac joint and thoracic region of the spine**

Although neurofibromas can be found on skin and other areas of the body, they can also be found along the spinal nerve roots [5]. It has been identified in recent literature that spinal nerve root neurofibromas in NF1 patients are most common in the cervical – specifically C2 – and lumbar regions [4]. Following this finding, it was hypothesised that frequent movement of these mobile regions of the spine could be involved in the ‘second hit’ (of the Knudson’s two-hit hypothesis) in NF1 leading to the development of spinal neurofibromas [4]. Meanwhile, the findings of this study suggest that this distinct entity – DNFT – has a predilection for immobile regions, the sacroiliac joint (29.9%) and thoracic spine (24.7%). The costovertebral and costotransverse joints of the thoracic vertebrae and the sacroiliac joint are all examples of synovial (diarthrodial) planar joints [16, 17]. This joint type contributes to the restricted movement at these areas. This could suggest that rather than repetitive movement, as in spinal neurofibromas, it is the lack of movement of these regions that could be a factor in the pathogenesis of DNFT. Moreover, as both the sacroiliac joint and the joints of the thoracic vertebrae are of the same classification, it could be possible that DNFT originates from the joints themselves.

In comparison, although plexiform neurofibromas can also be found at paraspi-  
nal regions, they have a predilection for the lumbosacral and brachial plexi which is  
not seen in our study of DNFT [7]. Meanwhile, diffuse neurofibromas are com-  
monly found in the head and neck where only 10.4% (n = 8/77) of DNFT was found  
in this study [10].

#### 4.2 Radiological comparison of plexiform and diffuse Neurofibroma with DNFT

To appreciate the differences between DNFT and the other common neuro-  
fibromas, one must first understand the MRI results – regarding the tissue com-  
position. The MRI results of this study convey two principal findings. Firstly, as  
already mentioned, the streaky tissues are hyperintense on STIR imaging (another  
example of this is illustrated in **Figure 9**). As STIR imaging completely suppresses  
the fat signal of a T2-weighted image, this allowed for distinct identification of this  
tissue without it being obscured by the interposed fat that it is known to infiltrate.  
Moreover, the hyperintense nature of the tissue on STIR imaging, conveys that this  
entity has a notable amount of water content as seen in other tumours. Secondly,  
the streaky tissues were shown to enhance following the administration of  
Gadolinium contrast on T1-weighted images which suggests that this entity is solid  
in nature.



**Figure 9.**  
*These MRI scans show a 22-year-old female with right sacroiliac joint DNFT. This figure reinforces the streaky changes which are T1-isointense and STIR-hyperintense, as mentioned earlier in section 3.3.2 of the results. Note that these STIR sequences are not post-contrast, hence the hyperintensity of the tissues and the kidneys.*

Distinguishing between plexiform neurofibromas and DNFT requires less focus on the aforementioned imaging techniques but rather more attention to their relevant growth patterns. Plexiform neurofibromas are seen to have a “bag of worms” appearance on MRI [18]. This is due to their diffuse, lobular growth along multiple nerves and their branches which creates a pattern of mass effect, whilst DNFT appears as streaky tissues without any real mass effect [19]. Although plexiform neurofibroma displays mass effect and DNFT does not, they both seem to be involved in bone erosion and thus, dysplasia of adjacent bony structures [7].

However, on review, we noticed that the radiological appearance of DNFT was more similar to that of diffuse neurofibromas but with some differences. Unlike a diffuse neurofibroma, which is a contiguous sheet of diffusely infiltrating soft tissue, this novel lesion is streaky. This streaky lesion erodes bone without actual mass effect whilst diffuse neurofibroma – like plexiform neurofibroma – also shows mass effect. Moreover, diffuse neurofibromas are more commonly found involving the skin and subcutaneous tissues of the head and neck whereas DNFT is more common in the sacroiliac joint and thoracic spine.

### **4.3 Spinal DNFT and its correlation with other NF1 spinal lesions**

The study of a subset of NF1 patients with DNFT along the spine allowed for the identification of patterns of this tissue with other spinal lesions in NF1.

A notable finding of this study was the correlation between spinal DNFT and scoliosis. Scoliotic deformity had a prevalence of 88.4% in patients with spinal DNFT. Meanwhile, in a recent study of spinal lesions in NF1, conducted by Curtis-Lopez et al., it was found that only 38.3% of NF1 patients had a scoliotic deformity in their study [4]. The research by Curtis-Lopez was also carried out at Manchester’s NF1 centre and as a result, also included some of the patients present in this study [4]. The prevalence of scoliosis in these two studies may suggest that scoliotic deformity is more common among the subset of patients with spinal DNFT. However, a comparison of the studies cannot be made directly as their study had a larger population size and did not include all the patients present in this study [4]. Moreover, the correlation of scoliosis with spinal DNFT at the same level (prevalence of 62.8%) could imply that the two lesions may be associated. However, this correlation will need to be tested in the future to confidently determine if the two factors have a true and significant association.

Another noteworthy finding of this study was the correlation found between spinal DNFT and dural ectasia. In a study conducted by Shah et al., it was identified that the prevalence of dural ectasia in the NF1 population was 10.05% [20]. Meanwhile, the prevalence of dural ectasia in the spinal DNFT subset in this study was 62.8% – with 51.2% at the same level as the spinal DNFT. These results convey a relationship between these two spinal lesions. Moreover, a study previously mentioned, by Curtis-Lopez et al., attempted to find significant associations between a range of spinal lesions as associations of DNFT with other lesions could be crucial in the discovery of possible inherited modifying factors of the disease process in NF1 [4]. Although their study did not find an association between spinal neurofibromas and dural ectasia, there could be an association between DNFT and dural ectasia [4]. Thus, in the future, studies should be carried out to establish whether there is a significant association between these two lesions.

Moreover, the prevalence of both scoliosis and dural ectasia with spinal DNFT was 51.2% (n = 22/43) – of which 46.5% (n = 20/43) of cases had all three lesions at the same spinal level. The significance of these figures relies on several factors based on the causal associations, if any, between these three lesions. Firstly, it has been shown that dural ectasia is significantly associated with spinal deformity such as scoliosis [4].



Thus, the importance of finding scoliosis with this novel entity is subjective. A total of 27 out of the 43 spinal DNFT cases had scoliosis present. However, from **Figure 8** it can be calculated that only 7 patients had just scoliosis without dural ectasia at the same level as the DNFT. Thus, in the remaining 20 cases where scoliosis was found at the same level as the DNFT, dural ectasia was also present. As there is a 1.41 relative risk of spinal deformity (e.g. scoliosis) occurring with dural ectasia, the relevance of scoliotic deformity in the presence of DNFT needs more research [4]. However, as this study has shown that DNFT causes bone erosion leading to dysplasia and scalloping, it could be suggested that the tissue itself directly leads to scoliosis. Nonetheless, as the pathogenesis and pathophysiology of DNFT is not known, it cannot be confirmed that this novel entity has a causal association with either of these lesions. It may be that certain regions of the body in patients with NF1 are affected by a factor which then predisposes to the development of various unrelated lesions from a common progenitor. Thus, as mentioned previously in this section, more future research is needed in this area. Thus far, tissue diagnosis remains a challenge as there is no clinical justification yet which is needed to intervene and retrieve tissue samples. The histological differences of DNFT compared to diffuse neurofibroma remain to be seen.

#### **4.4 The significance of DNFT on the future Management of Forme Fruste NF1 patients**

Clinical management of NF1 aims to promptly recognise symptomatic complications of the disease (and hence treat them) through the use of active surveillance [21]. This allows a prophylactic solution for the deterioration of the quality of life of NF1 patients. Moreover, as already mentioned earlier in this paper, DNFT is an entity that has often been discovered as an incidental finding when imaging for other NF1-related pathology. Together with the lack of past knowledge and literature in this area, this has meant that this novel entity has often been ignored in the management of NF1 patients. However, as can be seen from this paper, DNFT may predispose to or be associated with other spinal lesions in NF1. These spinal lesions include dural ectasia and scoliosis and can lead to clinical outcomes such as pain and deformity [4]. Thus, we propose that dedicated monitoring of this tissue (once detected) should form a routine part of annual active surveillance in NF1 patients. Moreover, a prevalence of 7.34% in this study, further supports the need for active monitoring of this atypical radiological presentation in NF1.

#### **4.5 Future directions**

This study is a descriptive study including only patients with DNFT. Thus, the results of this study only show correlations between this DNFT and other lesions. As such, this study cannot ascertain significant associations between this tissue and the other lesions mentioned in this research. As explained previously in this paper, information on associations with other lesions is important as it could be vital in the discovery of possible inherited modifying factors of the disease process in NF1 [4]. Thus, future studies should aim to identify, if any, causal associations between DNFT and the other spinal NF1 lesions mentioned in this paper.

Moreover, future research focussing on the pathogenesis of DNFT may help in identifying the reasons for some results that this study was not able to comment on. Firstly, the reason for the involvement of the fibrous part of the sacroiliac joint and the periosteum of bone is still not known. Furthermore, the right sacroiliac joint is affected more than the left which this paper has not been able to comment on. It may be the case that, when a larger sample size is used, both the right and left sacroiliac joints are equally affected. This further supports the need for future studies with a larger sample



population. Thirdly, it remains perplexing that this streaky tissue, without significant mass effect, causes bone erosion and deformity, raising the possibility of indeterminate cytokine release. In addition to larger investigations, prospective studies may also prove useful in determining the development of DNFT over time. This will provide insight into the progression of this tissue and the ideal frequency for monitoring. Finally, tissue diagnosis and immunohistochemistry may reveal the true nature of this DNFT.

#### **4.6 Limitations**

Although the interpretation of the MRI scans was conducted by a senior neuro-radiologist with a lot of expertise in this area, the imaging itself was in some cases, inconsistent and varied. This was because some cases were imported from other centres in the UK where they did not necessarily use the same imaging sequences or sometimes even in the same planes. Thus, comparing and identifying patterns between scans proved more challenging than initially thought. Moreover, of the 20 scans that could be studied, very few had comparable imaging over time. Thus, we have not been able to study whether there is progression of DNFT with time. Therefore, as previously mentioned, the progression of DNFT should be a focus in future studies. Finally, the lack of tissue diagnosis means that DNFT, for the time being, remains a radiological finding.

#### **5. Conclusion**

This study at this complex NF1 centre has described the demographics, characteristics, and radiological appearance of DNFT in adult NF1 patients. To our knowledge, this is the largest descriptive study of DNFT and the first to describe its radiological appearance and its correlation with other NF1 lesions.

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