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Neurovascular-derived masses on the digital bundle topographically at the finger

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Abstract

The arteries supplying the fingers and sensory nerve are located on the radial and ulnar aspects of the fingers, which are called the digital bundle. Masses can be found on this bundle topographically. This study aimed to investigate whether this mass originates from the neurovascular structure in patients presenting with a mass on the digital bundle topographically between the A1 pulley-distal interphalangeal (DIP)/interphalangeal (IP) joint in the finger. Additionally, it aimed to determine whether tumors originating from neurovascular structures originate from the main digital bundle and the steps involved in their reconstruction. We reviewed 27 cases with mass lesions at the digital bundle trace topographically between the A1 pulley and DIP/IP, which underwent surgery and were confirmed by histopathological examination between October 2014 and April 2022. Each patient requested at least two plane radiographs, US and MRI. All patients underwent surgery under a loupe-magnification or microscope. First, we determined whether the mass lesion originated from a main digital artery or nerve. Thereafter, the relationship of the mass with pulley and tendon structures was evaluated. All patients underwent histopathological examination. Mean follow-up 21 months. The mean age was 39.3 years. The pain was the most common presenting complaint and was observed in 13 patients. The tumors originating from neurovascular structures were found in 10 patients. In 5 patients, the tumor originated from the main digital artery and nerve. Three of them were reconstructed with a nerve graft. The most common non-neurovascular tumors were giant cell tendon sheath tumors and epidermal inclusion cysts. Some of the tumors on the topographically digital bundle are of neurovascular in origin. Reconstruction can be made in tumors originating from the main digital bundle. Again, the protection of pulley and tendon structures in this region is important in terms of morbidity.

Keywords: Hand, digital bundle, hand masses, neurovascular masses, nerve graft, angioleiomyoma

Introduction

The hand has a unique morphology with complex anatomy and functions. Although it is relatively smaller than the other body parts, the hand comprises numerous structures, such as muscles, tendons, nerves, and vasculature [1]. Various tumors originating from one of the hand tissues have been reported [2-4]. Based on their origin, these tumors can be classified as skin, soft tissue, and bone origin [5]. While 97.5% of these tumors are benign, 2.5% are malignant [6].

The arteries supplying digits and sensory nerves are located on the radial and ulnar sides of the fingers. The structure of this artery and nerve is called the digital bundle. Masses can be found on this bundle topographically.

This study aimed to investigate whether this mass originates from the neurovascular structure in patients presenting with a mass on the digital bundle topographically between the A1 pulley-distal interphalangeal (DIP)/interphalangeal (IP) joint in the finger. Additionally, it aimed to determine whether tumors originating from neurovascular structure originate from the main digital bundle and the steps involved in their reconstruction.

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Material and Methods

We reviewed 27 cases with mass lesions at the digital bundle trace topographically between the A1 pulley and DIP/IP, which undergone surgery and were confirmed by histopathological examination between October 2014 and April 2022. The study included soft tissue mass lesions. The data regarding age, gender, presented complaint, histopathological diagnosis, and origin of the mass lesion (whether neurovascular or not) were analyzed.

Each patient requested at least two plane radiographs. Tumors originating from bone and cartilage tissue were excluded from the study. Subsequently, the patients were assessed by ultrasonography (US), and the cases with no soft tissue mass in the US were also excluded from the study. Patients who were evaluated for soft tissue masses on US were evaluated with magnetic resonance imaging (MRI) (Figure 1).

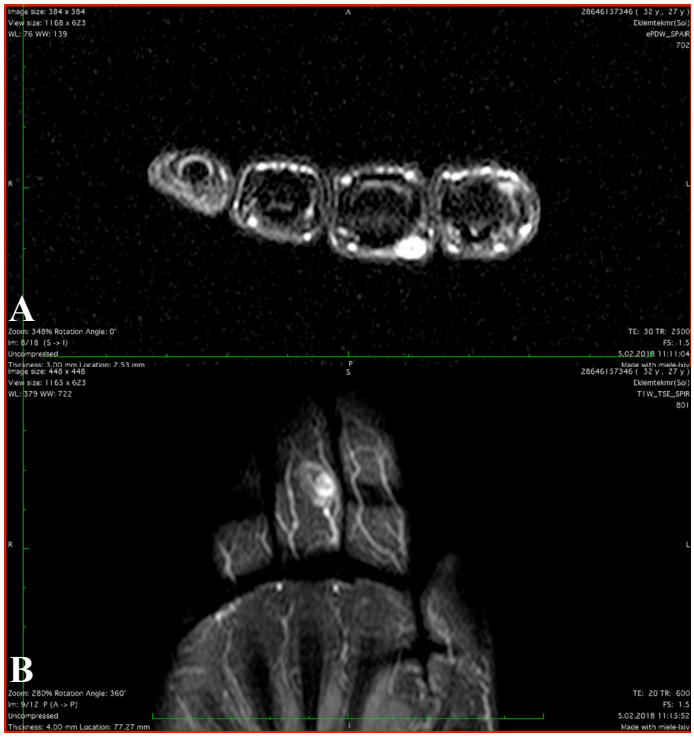

Figure 1. There is a solid mass with the diameters of 13x5 mm at the ulnar part of third digit tendon represented with PDW image at the axial plane **1A**, and postcontrast T1 weighted MR image at the coronal plane **1B**. PDW: Proton density weighted

All patients underwent surgery under a loupe-magnification or microscope, and the intact digital bundle proximal and distal to the mass lesion was identified. First, we determined whether the mass lesion originated from a main digital artery or nerve. Thereafter, the relationship of the mass with pulley and tendon structures was evaluated. The mass lesions without any relationship with the digital bundle or pulley-tendon were excised (Figure 2) while the remaining mass lesions were re-assessed during surgery. The tumors originating from digital nerves were evaluated under the microscope to determine whether or not the tumors involved nerve fibers. The artery was clamped distal to the tumors originating from the digital artery and circulation in the finger was assessed (Figure 3).

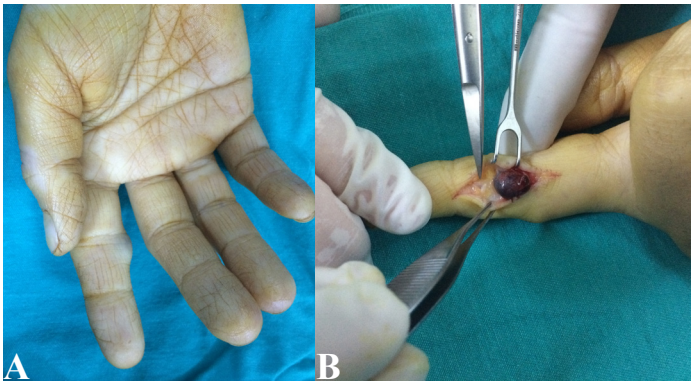

Figure 2. Vascular malformation does not originate from main the digital artery. **2A.** Bluish mass at the second finger on mid-phalanx level. **2B.** The tip of the scissors shows the main digital bundle in the intraoperative view

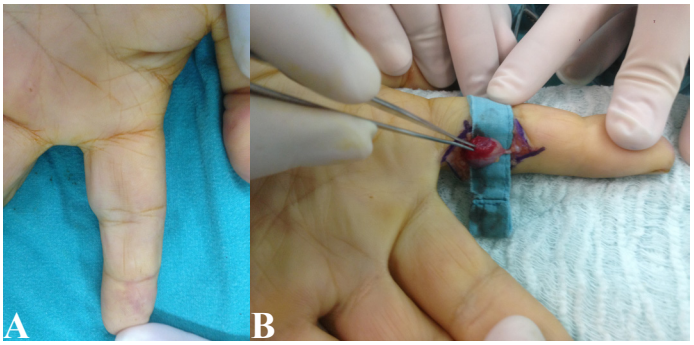

Figure 3. Neurovascular-derive tumor originating from main digital artery. **3A.** Preoperative view of angioleiomyoma at the level of the proximal phalanx of the second finger. **3B.** Intraoperative image of the mass originating from the main digital artery

Histopathological examination was performed on all the patients and during recovery period, they were prescribed physical therapy. The patients were called for control at 1, 3, 6, 12, 24 and 36 months. All patients had at least one year of follow-up.

The Acıbadem Mehmet Ali Aydınlar University Medical Research Evaluation Board (ATADEK) granted ethics committee approval with the decision number 2023-07/252.

Results

In total 27 patients were reviewed in this retrospective study, including 14 women and 13 men. Table 1 shows the distribution of neurovascular and non-neurovascular masses. The mean follow-up was 21 months. The tumor was found localized at right hand in 17 patients and left hand in 10 patients. The mean age was 39.3 years. The pain was the most common presenting complaint and observed in 13 patients. In any patient, there was no pulse over the mass lesion. Seven patients experienced hypoesthesia or paresthesia. Three patients diagnosed with neuroma had a history of trauma and there was paresthesia distal, and a positive Tinel's sign over the mass lesion.

A patient with schwannoma also observed paresthesia distal to mass lesion and positive Tinel's sign. One patient complained of pain, while three others presented a bluish lump on their hand among five cases of vascular origin.

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Table 1. The distribution of neurovascular and non-neurovascular masses

	Tumor	Number of patients	Age		Gender
			Range	Mean	F/M
Neurovascular-derived	Vascular malformation	4	21-32	26.8	3/1
	Hemangioma	1	26	26	1/0
	Traumatic neuroma	3	28-36	31.6	1/2
	Schwannoma	1	47	47	0/1
	Angioleimyoma	1	63	63	0/1
Non-neurovascular-derived	Giant cell tumor of tendon sheat	6	29-63	47.8	4/2
	Epidermal inclusion cyst	5	28-60	44.2	1/4
	Ganglion cyst	4	21-42	32.1	3/1
	Fibroma	2	39-49	44	1/1

The tumors originating from neurovascular structures were found in 10 patients (Figure 1, Figure 2, Figure 3, Figure 4). In five patients, the tumor originated from the main digital artery (Figure 3) and nerve (Figure 4). The mass lesion was removed in three cases of traumatic neuroma, followed by repair using a nerve graft (Figure 4). In the case of schwannoma, the mass was removed by preserving the digital nerve and no additional treatment was required. A rare case of angioleiomyoma originating from the digital artery was diagnosed in one case (Figure 3). During surgery, a micro-clamp was placed distal to the mass lesion to occlude blood flow, the tourniquet was opened to confirm patency of the contralateral digital artery supplying the digit, and the mass lesion was excised after the proximal and distal parts of the mass were ligated. Excision was sufficient in other vascular tumors that did not originate from the main digital artery, and no additional therapy was necessary. Moreover, no recurrence was observed in tumors of neurovascular origin.

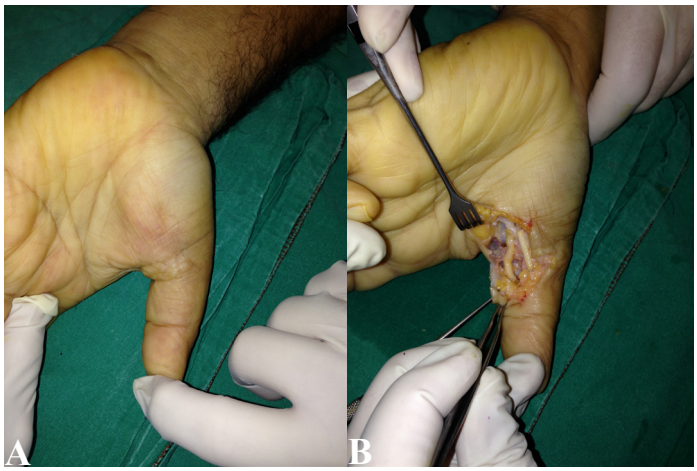

Figure 4. Neurovascular-derive tumor originating from main digital nerve. **4A.** Preoperative view of neuroma on both digital nerves after trigger finger surgery. **4B.** Intraoperative view of both digital nerve repair with otolog nerve graft

The giant cell tendon sheath tumor and epidermal inclusion cyst were the most common non-neurovascular tumors. In patients with fibroma, excision was performed by preserving the pulleys. In one of these patients, recurrence developed after 1 year and re-excision was performed.

Each patient who underwent digital bundle reconstruction used a short arm splint for 3 weeks. Other patients were given a finger splint for 2 weeks.

No iatrogenic neurovascular or tendon-pulley injury was observed in any patient.

The patients had no abnormal laboratory finding or history of previous cancer or rheumatic disorder.

Discussion

Our study showed that some of the tumors in this region are of neurovascular origin, whereas others are not. Some of these not all of the tumors may require reconstruction.

The initial step for evaluation of a mass is medical history and physical examination. The most commonly presented symptom is pain; however, it is a non-spesific finding that can be found every patient with a mass lesion [7,8]. The pain with deep palpation is suggestive of benign tumors while spontaneous pain or pain at night indicates malign etiology [9]. The size variation (growth or shrinkage) after childhood or size stability suggests a vascular origin for mass lesion [10]. Klippel-Trenaunay syndrome, Proteus syndrome and Mafucci syndrome are associated with vascular malformations and mass lesions should be considered vascular in origin in such patients [10]. The bluish or erythematous mass also suggests the vascular origin [10]. Herein, the pain was the most common presented complaint, which was exacerbated by palpation. No night pain was reported, and there was paresthesia and hypoesthesia in seven cases, four of which were of neural origin. The bluish discoloration was observed in three patients with vascular mass lesions, and none of the patients was syndromic or had malignant pathology as confirmed by histopathological examination.

At least two-plane direct radiography should be considered for evaluating the hand masses [1]. The US is used to differentiate solid and cystic masses and as a complementary test to MRI. [1]. MRI is performed to obtain information about the soft tissue relationship of the mass and its characteristics [1]. These three imaging technologies were used in our study. The imaging method revealed the character of the mass, its possible diagnosis,

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and relationship with neurovascular and other structures.

The neural tumors may originate from median, ulnar and radial nerves or their branches or small innominate nerves [11-13]. They account for minority of all hand tumors [14,15]. Lincosky et al. found that neural tumors accounted for 11.5% of all hand and forearm masses [15]. According to Gosk et al., neural tumors accounted for only 3% of cases undergoing surgery for hand problems [16]. The Gosk et al. group included benign neural tumors of the hand (excluding the wrist) and found that tumors were more common at the palmar aspect and originated from common digital nerve in only two cases [16]. The traumatic neuroma patients were excluded in that study [16]. In a case series including 24 patients, the tumor originated from digital nerve in only three of all the patients diagnosed with schwannoma [14]. In our study, four cases had tumors originating from the main digital nerve, three of which had history of trauma.

The tumor type may alter the surgical approach. While it is sufficient to remove mass lesions by preserving nerve fibrils in schwannoma cases where tumor tissue can be readily separated from neural tissue, the nerve sacrifice may be required nerve in patients with neurofibroma [17]. It is critical to repair the nerve endings without tension following tumor excision [18]. If there is a gap between the nerve endings and tensionless primary repair is not possible, an autologous nerve graft, autologous vein, and bioartificial nerve conduit can be used [18]. In three cases with post-traumatic neuroma, excision was performed until intact nerve tissue was exposed at the proximal and distal end of the tumor and defects were repaired using nerve grafts harvested from different regions (Figure 4B). One patient was diagnosed with schwannoma that was easily removed without extra surgery by preserving nerve fibrils.

The most common vascular lesions of the upper extremity are hemangioma and vascular malformations [10]. Almost 90% of hemangiomas regress before 9 years of age [10]. On the contrary, vascular malformations grow by childhood [19]. In our study, one case was diagnosed with hemangioma and four with vascular malformation. Because none of the mass lesions were in these patients was of primary digital arterial origin, the excision was sufficient.

Except for the thumb, both digital arteries in the fingers have three palmar arcs [20]. These are distal to the proximal phalanx and mid-phalanx, and proximal to the distal phalanx [20]. The circulation of the finger is not affected by possible arterial damages in the finger because of these arcs. One patient (Figure 3) was diagnosed with angioleiomyoma arising from the main digital artery, which is extremely rare, and mass lesion was excised following ligation at the proximal and distal end of the lesion. If there is no circulation in the finger after clamping, it is essential to remember that vascular repair will be necessary.

Many studies on thumb vascularization have been conducted [21,22]. Berthier et al. showed that when both digital arteries were cut, the dorsal artery system nourished the entire finger skin in 91.91% of cases [23]. After the trigger finger surgery, the patient in Figure 4A exhibited both digital bundle injuries. Clinically, the presence of finger circulation suggested the presence of dorsal arterial circulation. In this patient group, it is essential to remember to avoid applications that may impair finger circulation, such as advancing the dissection dorsally.

Although it is a nonspecific finding in cases of hypoesthesia or paresthesia, a tumor of nerve origin should be examined. The tinel's sign positivity indicates a tumor of nerve origin. In an MRI examination, in the presence of tumor originating from the main digital nerve, the patient's nerve can be repaired with an autologous nerve or vein graft; and in these cases, the patient should be informed of the expected healing potential and morbidity at the site from where the graft is obtained. Again, in MRI examination, it should be kept in mind that after the removal of tumors originating from the main digital artery, repair with a vein graft can be performed. The possibility of occlusion of the vein graft and interruption of the finger circulation should be shared with the patient. The consent form should be prepared accordingly against medico-legal situations that may occur.

Masses may originate from pulleys and tendons. Giant cell of tendon sheath tumors are the second most common entities among all hand cases [24]. Although they are generally painless mass, the nerve compression symptoms can occur in some instances [25]. It was the most common tumor in our study, presenting pain in one case and paresthesia distal to the mass in another. The tendon sheath-derived fibromas are painless masses that grow slowly [2]. The ganglion cyst is the hand's most common tumor [6]. Clinically, about one-fourth of patients have complaints [26]. In our study, it was localized at the A1 pulley in three patients and at DIP level in another; two patients had pain and two others presented with mass. In our study including patients, all of which had benign lesions, pulley, and tendons were preserved and none experienced functional problems with sufficient physical therapy after surgery. It should be remembered that reconstruction may be necessary, particularly if the A1 or oblique pulleys in the thumb and A2 and A4 pulleys in other fingers cannot be preserved. It should be considered that possible flexor tendon injuries may require repair.

The limitation of this study is that it is retrospective and involve less number of patients. In larger series, more comprehensive evaluation of mass lesions in this region will ensure accurate planning before surgery and minimize possible adverse events during surgery.

Conclusion

In conclusion, some of the tumors on the topographically digital bundle are of neurovascular in origin. The neurovascular origins may arise from the main digital bundle or surrounding tissues. The nerve lesions originated from the main digital nerve, while arterial lesions were mostly not from the main digital artery. Reconstruction can be made in tumors originating from the main digital bundle. Again, the protection of pulley and tendon structures in this region is important in terms of morbidity.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Ethics committee approval was obtained from Acıbadem Mehmet Ali Aydınlar University Medical Research Evaluation Board (ATADEK) with the decision number 2023-07/252.

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