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The 'PDA Nail'

Traumatic Nail Dystrophy in Habitual Users of Personal Digital Assistants

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Abstract

All-in-one devices with mobile phone, web browser, and organizer are now owned by over 6 million people and their popularity is increasing. These devices are often called personal digital assistants (PDAs) or 'BlackBerry®' devices, after a popular brand name of these appliances. The use of PDAs is associated with exposure of distal thumbs and nails to repeated pressure with a frequency of up to a few thousand times per hour and several tens of thousands of times per day.

We describe two cases of traumatic thumb nail dystrophy associated with using a PDA keyboard for several hours per day. Both patients developed median nail plate dystrophy after 4–8 months of habitual PDA use. One patient also developed thumb nail psoriasis and paronychia. All symptoms resolved a few months after discontinuing PDA use. Analysis of nail biomechanics, performed by using a finite element fingertip model, showed that maximal stress reaches approximately 3 MPa and appears near the root on the internal surface of the nail, while it reaches approximately 2 MPa and appears around one-third from the root on the outside surface.

In conclusion, biomechanical stress resulting from overuse of PDAs may result in various types of nail dystrophy. We suggest the general term 'PDA nails' for these nail abnormalities.

The personal digital assistant (PDA) or the BlackBerry® (Research in Motion, Waterloo, ON, Canada) is a handheld device, which is an all-in-one mobile phone, e-mail device, web browser, and organizer. The device was first introduced a few years ago and is increasing in popularity. It is now owned by over 6 million people and the number is rapidly growing. It has been shown that these types of devices may have an impact on psychology and mental health.[1]

We describe two cases of thumb nail changes associated with habitual PDA use and present an analysis of fingertip deformations and biomechanical stresses in the nail during keypad compression.

1. Case Reports

1.1 Case 1

A 42-year-old, otherwise healthy woman experienced onset of median nail plate dystrophy of both thumbs, which she first observed after 4 months of using the PDA device for 2–6 hours per day. Her nails were fragile, with Beau lines and prominent nail plate dystrophy (figure 1a). These changes were more pronounced on the right thumb and no other nails were affected. The patient was advised to reduce the use of the handheld device as much as possible. No other therapy was applied. Twelve months later, the nail structure improved significantly and was close to normal (figure 1b).

1.2 Case 2

A 33-year-old, otherwise healthy man visited the dermatologist's office with yellow-red discoloration in the thumb nail bed, nail plate dystrophy, Beau lines, and pronounced subungual hyperkeratosis leading to onycholysis. These changes were characteristic of median nail plate dystrophy accompanied by isolated nail psoriasis (figure 2a). Dermoscopy confirmed the diagnosis of nail psoriasis.[2] The patient indicated that he had been using a PDA for over 8 months, for 4–10 hours

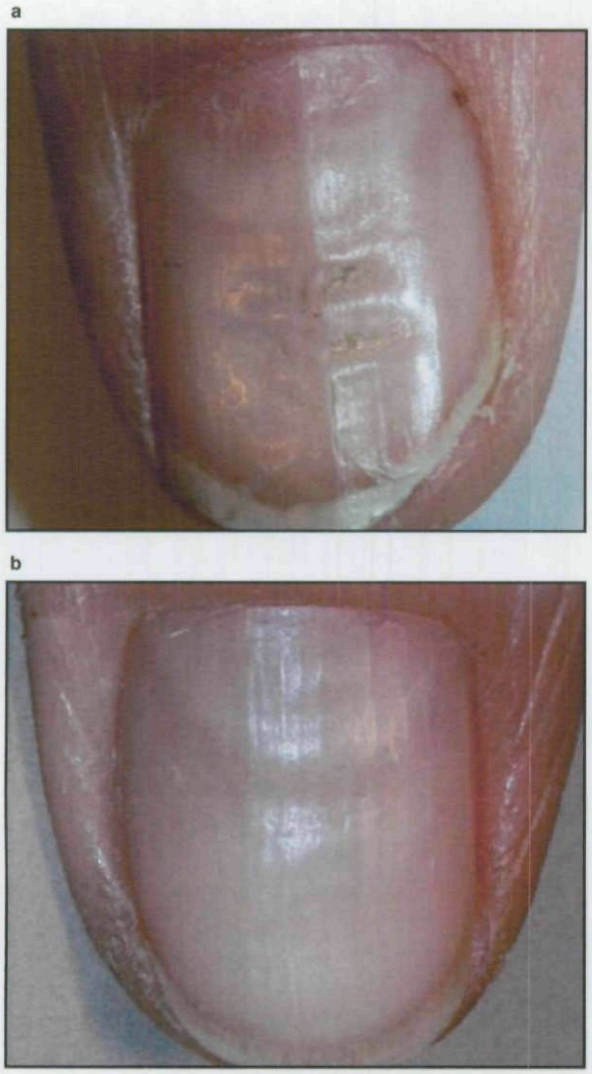

Fig. 1. (**a**) Median nail plate dystrophy in a 42-year-old woman. (**b**) Significant improvement after discontinuation of personal digital assistant use.

per day. He first noticed nail changes after he had been using the device for 6 months and reported that these changes became progressively worse.

Detailed history and skin examination excluded psoriatic lesions in other localizations, with the exception of a history of occasionally occurring dandruff, which might have in reality been mild scalp psoriasis. The patient was advised to reduce PDA use as much as possible. No other therapy was applied. Twelve months later, nail bed and nail changes improved significantly (figure 2b). Despite the physician's advice to avoid thumb micro-traumatization, the patient subsequently intensified PDA use to 4 or more hours per day. With increased use of the device, nail abnormalities were exacerbated again.

1.3 Biomechanical Analysis

In order to verify our hypothesis that these changes were induced by mechanical forces related to PDA use, we performed a biomechanical analysis of key pressing forces by using a fingertip model adopted from the literature.[3] Typical dimensions (25 mm long, 25 mm wide, and 18 mm deep) were presumed for a thumb. The nail was assumed to have a thickness of 0.6 mm and an elastic modulus of 170 MPa.[3] The material properties of the dermis and epidermis skin layers, subcutaneous tissue, and bone are adopted from the literature.[4] The fingertip is compressed by approximately 2 mm against a rigid flat surface, simulating the key pressing in PDA operations (figure 3a). We analyzed the distributions of the deformation and stress of the fingertip during key pressing. The distribution of the stress is expressed in terms of

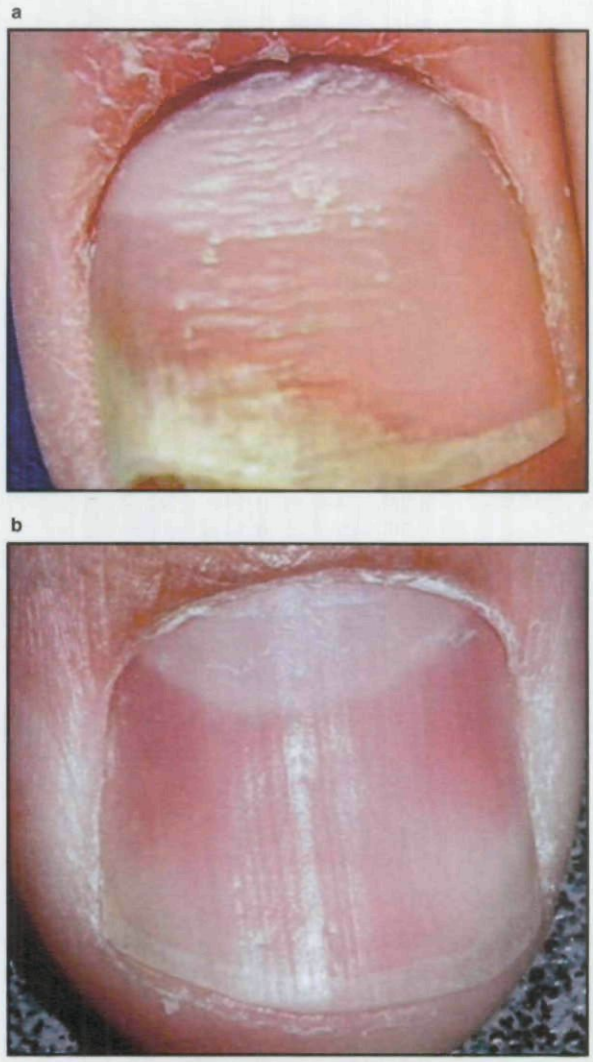

Fig. 2. (**a**) Beau lines and median nail plate dystrophy accompanied by nail psoriasis with paronychia in a 33-year-old man. (**b**) Significant improvement after discontinuation of personal digital assistant use.

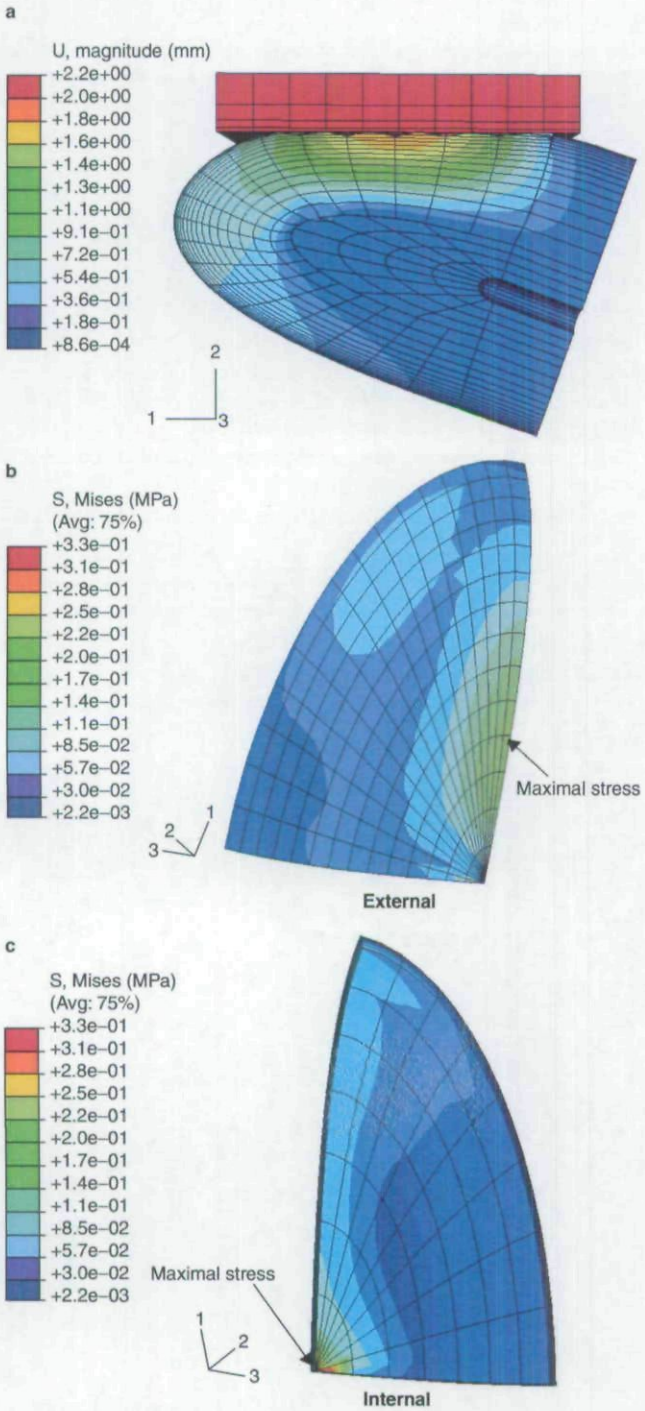

Fig. 3. Finite element modeling of a thumb tip in contact with a flat surface. (**a**) The deformation distributions in the longitudinal cross-section of the fingertip. (**b-c**) The distributions of the von Mises stress in the fingernail. The fingertip model has a width of 25 mm, a length of 25 mm, and a depth of 18 mm. **Avg** = average.

von Mises stress, which is a parameter characterizing the intensity of the stress level. At compressed states, the deformation in the fingertip is found to be concentrated in the soft tissues around the contact region. The analysis of von Mises stress in the nail indicates that the stress intensity on the inside of the nail (figure 3c) is greater than that on the outside of the nail (figure 3b). The maximal stress reaches approximately 3 MPa and appears near the root on the internal surface of the nail, while it reaches approximately 2 MPa and appears about one-third of the way up from the root on the outside surface.

2. Discussion

In both cases, median nail plate dystrophy was observed several months after acquiring a PDA and resolved after subsequent discontinuation of PDA use. The etiology of median nail plate dystrophy is not precisely known. It is suggested that, in most cases, it results from repeated trauma.[5,6] The use of PDA devices is associated with exposure of distal thumbs and nails to repeated pressure, with a frequency of up to a few thousand times per hour and several tens of thousands of times per day.

From a biomechanical point of view, the thumb nail abnormality may be a consequence of the degeneration induced by the excessive, repetitive mechanical loading. Our simulations indicate that the stress intensity on the inside of the nail is greater than that on the outside of the nail, and that the stress levels in the nail are relatively low, compared with those that appear in bone. The nail stresses during the keypad compression are unlikely to cause direct damage to the nail. However, considering that nails are subjected to very small mechanical loading under homeostatic or physiologic conditions, stress concentrations in the nail that appear during key compression are substantial with respect to the normal physiologic state. In response to the local mechanical stress concentrations, the nail may produce hyperkeratosis to increase the thickness at the location of the stress concentration. The nail may also try to vary the mechanical properties or change shape, resulting in transverse grooves and variations as observed clinically, in an effort to minimize the local stress and to increase the nail stiffness, withstanding the excessive bending. From a biomechanical analysis, the nail abnormality should initiate from a region about one-third of the nail height from the nail root, which is consistent with our clinical observations.

Thus, nail plate biomechanics show that trauma to the distal nail plate may result in undesirable forces on the proximal nail fold, which may lead to proximal paronychia, as in our patient with nail psoriasis.

Psoriatic nail changes may be related to the application of repeated pressure to distal thumbs and thumb nails in a mechanism known as the Koebner phenomenon.[7] In our

patient, discontinuation of PDA use resulted in rapid improvement and during an observation time of 18 months no other psoriatic changes were observed.

3. Conclusion

It should be emphasized that, with the rapidly growing popularity of all-in-one handheld devices, the problem of 'thumb overload' health consequences may also be rapidly increasing, as is the case with the 'PlayStation® thumb.'[8] Non-ergonomic keyboards in PDAs may trigger different types of thumb nail abnormalities. For this group of abnormalities, we suggest the general term 'PDA nails.'

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