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Veterinary Dermatology

CASE REPORT

Dorsal duplication of paw pads in the four limbs of a cat

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Abstract

An approximately one-year-old intact male domestic short hair cat was presented with plantigrade stance and dorsally duplicated paw pads in all limbs covered by hyperkeratotic material. True nails were rudimentary and located between the dorsal and ventral digital pads. Histologically, the biopsied duplicated dorsal paw pad was completely developed (paw pad choristoma).

INTRODUCTION

The term choristoma refers to normal tissue found in an abnormal location and may be used synonymously with the term heterotopia or ectopic tissue.[1,2] Choristomas and hamartomas are included within benign non-neoplastic lesions composed of mature tissues; however, while hamartomas are disorganised overgrowths resembling the tissues of their origin/location, choristomas consist of normal structured tissue in an abnormal site.[3]

Developmental malformations such as choristomas or heterotopias and hamartomas are described rarely in the cat. Ocular dermoids are the most commonly reported choristomas as they represent well-differentiated tissue in an abnormal location.[4] Heterotopic neural tissue was found in the pharynx of a seven-week-old kitten, and a neuroglial cutaneous choristoma has been described in a kitten[2,5]; however, to the best of the authors' knowledge, there are no previous reports of ectopic or heterotopic paw pads in cats. This report describes a unique case of dorsal duplication of all digital and metacarpal/metatarsal pads in a cat. The four extremities were affected, and the lack of normal dorsal–ventral polarity was accompanied by abnormalities in distal limb bones.

CASE REPORT

A male intact domestic short hair cat, rescued by an animal protection society, was presented to the internal medicine service. Physical examination showed a conscious, approximately one-year-old cat, mildly dehydrated with a poor general status (body condition score two of nine). All distal limbs showed deformities that resulted in abnormal gait and hyperextension of phalangeal joints with a plantigrade stance (Figure 1a). The more striking finding was the presence of apparently duplicated paw pads on the dorsal aspect of all limbs that gave the impression that all paws had been rotated by 180° (Figure 1a inset). The dorsalised digital and metacarpal/metatarsal pads were similar in size to their normal counterparts and covered by hard keratotic material forming cutaneous horn-like structures, which could be removed easily under sedation (Figure 1b). New accumulation of the same material was observed one month later over the rough surface of the duplicated paw pads (Figure 2a).

All of the ventral paw pads were apparently normal, but the corresponding nails were rudimentary; only the tips of the nails were visibly located between the normal and duplicated paw pads (Figures 1c and 2a). Blood samples were obtained for routine haemogram, serum biochemical evaluation and feline leukaemia, immunodeficiency and infectious peritonitis virus serology. The material covering the heterotopic pads was preserved in 10% neutered formalin and sent for histopathological examination. Microscopically, this material was composed of numerous bundles of compacted corneocytes consistent with orthokeratotic hyperkeratosis. Radiographic examination revealed bilaterally symmetrical limb abnormalities affecting the antebrachiocarpal and tarsocrural joints and all bones distal to these joints;

FIGURE 1 Paw pad duplication; cat. (a) In standing position one month after first examination. Dorsally duplicated central paw pads are visible (red arrows), as well as the plantigrade stance in all four limbs. Some of the ectopic digital pads are covered with newly formed hyperkeratotic material (yellow arrows). Inset, cat sedated and in lateral left recumbence at the first examination; the right limbs show the duplicated paw pads while the left limbs show the ventral paw pads. (b) Dorsal aspect of the right hind limb paw; duplicated paw pads are covered by large cutaneous horns that resemble dystrophic nails; the lack of normal digital flexion gives the paws a palmipede look. (c) Plantar aspect of the same paw one month after first examination. Central and digital paw pad skin within normal limits (red arrows) while duplicated dorsal paw pads are covered by newly formed keratotic material (white arrows). The tips of the rudimentary nails are visible (yellow arrows). (d) Radiograph of right hind limb showing subluxation of all interphalangeal joints.

interphalangeal joints showed subluxation with hyperextension more severe in the proximal interphalangeal joints (Figure 1d). Forelimbs showed humeroradial joint luxation and carpal bone malalignment, and the carpal accessory bone was absent in the left forelimb. Hind limbs showed the collapse of the central tarsal bone and distal tarsal bones I, II and III that caused an oblique position of calcaneus bones and lateral deviation of the paws (Figure 1d).

Haemogram and serum biochemical parameters were within the normal range of our laboratory. All serological titres for infectious diseases were negative, and one month after the first examination, the general condition of the cat was much improved. The cat was anaesthetised for neutering, and skin biopsies were obtained from the heterotopic pads and submitted for routine processing and staining for histopathological examination.

Histologically, the dorsalised paw pads were completely covered by well-differentiated stratified keratinised epithelium with a thick stratum corneum (Figure 2b,c) that continued with the normally haired skin of the limb. The dermo-epidermal junction was smooth in the duplicated paw pads and changed to papillary at the transition with haired skin. The superficial dermis comprised a dense fibrous tissue band, lacking pilosebaceous units (Figure 2b,c). The deep dermis and hypodermis consisted of abundant, well-differentiated adipose tissue and delicate fibrovascular stroma (Figure 2b,c). Throughout the dermis and adipose tissue, several acini of secretory glands were observed. The acini were lined with a monolayer of cuboidal cells delimiting a wide central lumen (Figure 2b–d), and the excretory ducts ran through the dermis and epidermis (intraepidermal convoluted ducts or acrosyringium) (Figure 2c); these features are consistent with eccrine glands. Moreover, isolated pacinian corpuscles were present in the deep dermis (Figure 2d). Occasional foci of lymphocytic and histiocytic infiltrates were observed near the dermo-epidermal junction. Overall, these microscopic findings confirmed an ectopic, dorsally developed normally structured paw pad (paw pad choristoma).

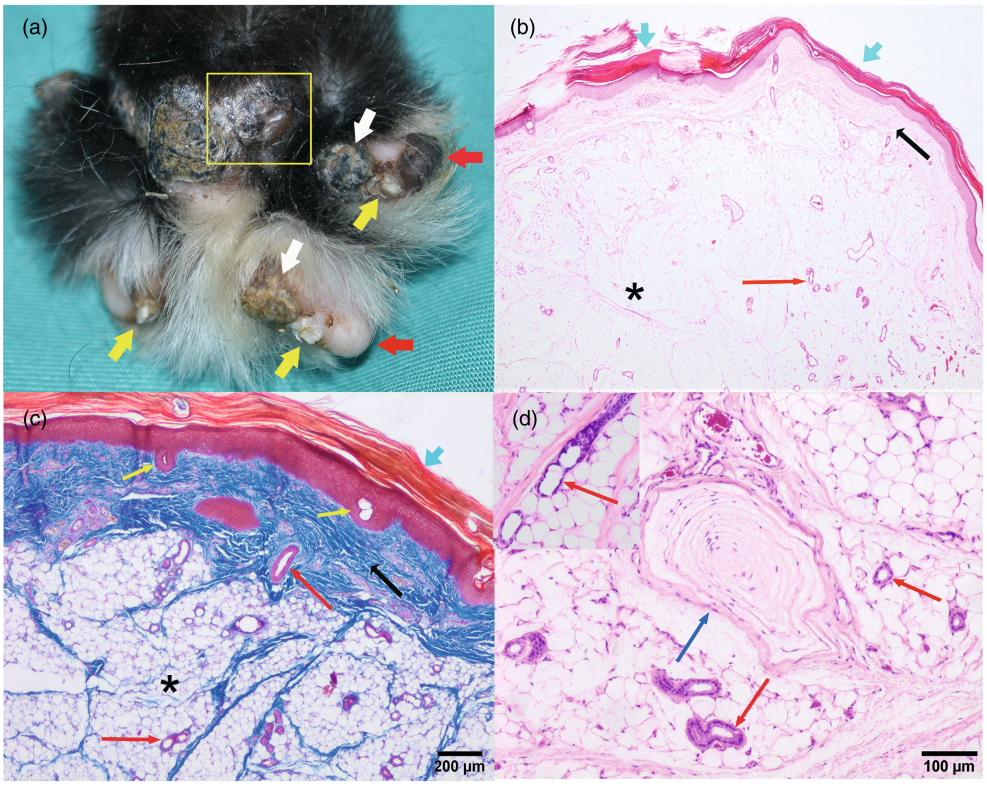

FIGURE 2 Heterotopic paw pads; cat. (a) Dorsal aspect of the left hind paw one month after first examination. The yellow square marks the area that the biopsy was taken from. The rudimentary nails (yellow arrows) are placed between the normal (red arrows) and duplicated dorsal paw pads (white arrows). (b,c) Microscopical overview of the biopsied area showing a well-differentiated paw pad structure. A hyperplastic epidermis covers the surface (cyan arrows), and various convoluted eccrine excretory ducts appear throughout it (acrosyringium) (c, yellow arrows). The outer dermis comprises a regular fibrous connective tissue band (with collagen fibres disposed in parallel to the surface) (black arrows). The deep dermis and hypodermis comprise abundant adipose tissue and delicate fibrovascular stroma (asterisks); moreover, numerous acini and excretory ducts of eccrine glands appear through these layers (red arrows). Haematoxylin & eosin (b) and Masson Trichrome (c), respectively. (d) Deep dermis features a pacinian corpuscle (blue arrow) and various eccrine gland acini (red arrows) through the adipose tissue. Inset (top left corner): detail of an eccrine gland acini and the beginning of an excretory duct (red arrow). H&E.

DISCUSSION

To the best of the authors' knowledge, this is the first report of heterotopic paw pads in a cat. Dorsal paw pads were present in the four limbs, had a size similar to ventral paw pads and were histologically normal. Their hyperkeratotic surface and horn formation could be secondary to the lack of ground contact and weight bearing and looked like dystrophic nails; normal nails were rudimentary and grew at the dorsal–ventral interface. These abnormalities resemble the palm duplication syndrome with hypoplastic nails described in humans lacking normal expression of the *WNT7A* gene. This syndrome represents the mildest form of hand ventralisation; affected children show hypoplastic/aplastic nails in all digits with ectopic dorsal palm showing thick hairless skin with flexion creases on the dorsum.[6,7]

In animals, ectopic dorsalised pads have been described in laboratory mice with a null *WNT7A* allele created by gene targeting of mouse embryonic stem cells. This gene appeared to act as dorsalising signal because its inactivation resulted in biventral autopods with foot pads on both sides.[8] Although the abnormalities found in this cat are consistent with the lack of normal dorsal–ventral polarity, no gene analysis could be done to determine whether they were associated with the expression of the *WNT7A* gene.

In conclusion, this is the first report of dorsal duplication of paw pads in the cat. Ectopic paw pads were histologically normal and were associated with rudimentary nails and limb bone deformities compatible with a lack of normal distal limb dorsal–ventral polarity. This altered limb polarity did not compromise the cat viability and general health, and apart from the limb abnormalities, body size and proportions were normal.

AUTHOR CONTRIBUTIONS

Pedro J. Ginel involved in writing—original draft, conceptualisation, methodology, investigation, writing—review and editing, resources and formal analysis. **Carmen Martínez** involved in investigation and methodology. **Manuel Novales** involved in methodology and investigation. **Elena Mozos** involved in writing—review and editing, methodology, investigation, resources, formal analysis and supervision.

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CONFLICT OF INTEREST STATEMENT
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Résumé
Un chat domestique à poil court mâle intact d'environ un an a été présenté avec une position plantigrade et des coussinets de patte dupliqués dorsalement dans tous les membres recouvert de matériel hyperkératosique. Les vrais ongles étaient rudimentaires et situés entre les coussinets digitaux dorsaux et ventraux. Histologiquement, le coussinet de la patte dorsale dupliqué biopsié était complètement développé (choristome du coussinet de la patte).

Resumen
Un gato macho doméstico de pelo corto, entero de aproximadamente 1 año de edad se presentó con una postura plantígrada y almohadillas de las patas dorsalmente duplicadas en todas las extremidades cubiertas por material hiperqueratósico. Las uñas verdaderas eran rudimentarias y estaban ubicadas entre las almohadillas digitales dorsal y ventral. Histológicamente, la almohadilla de la pata dorsal duplicada de la biopsia estaba completamente desarrollada (coristoma de la almohadilla de la pata).

Zusammenfassung
Ein etwa 1 Jahr alter intakter Kurzhaarkater wurde mit plantigrader Fussstellung und dorsal doppelten Fussballen an allen Extremitäten mit hyperkeratotischen Auflagerungen vorgestellt. Die tatsächlichen Krallen waren rudimentär angelegt und befanden sich zwischen den dorsalen und ventralen Zehenballen. Histologisch war der doppelte dorsale Fussballen vollständig entwickelt (Fussballen Choristom).

要約
およそ1歳になる雄のドメスティック・ショートヘアーは、蹠行性姿勢をとり、すべての肢の肉球が背側に二重になり、角質増殖物で覆われていた。爪は未発達で、背側、腹側の肉球の間に位置していた。組織学的には、生検された背側重複肉球は完全に発育していた(肉球分離腫)。

摘要
只大约1岁的未去势雄性家养短毛猫被呈现出跖行姿，所有四肢都被角化过度的物质覆盖，并有重复的背侧爪垫。真正的趾甲未发育，位于背侧和腹侧爪垫之间。组织学上，活检重复的背侧爪垫发现发育完全(爪垫迷芽瘤)。

Resumo
Aproximadamente um ano-velho gato de pêlo curto doméstico macho intacto foi apresentado com postura plantígrada e almofadas das patas duplicadas dorsalmente em todos os membros coberto por material hiperqueratótico. As unhas verdadeiras eram rudimentares e localizadas entre as almofadas digitais dorsal e ventral. Histologicamente, a biópsia duplicada a almofada dorsal da pata estava completamente desenvolvida (coristoma da almofada da pata).