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Human phthiriasis. Can dermoscopy really help dermatologists? Entodermoscopy: a new dermatological discipline on the edge of entomology.

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Abstract
The diagnosis of human phtiriasis (often referred to as the "crab" or the "pubic louse") can be more difficult than other types of pediculosis (*Pediculus corporis* and *Pediculus capitis*) because this insect has a smaller body of 1.2x0.8 mm, may be lighter in color, not as mobile and therefore harder to see to the naked eye.
Can dermoscopy aid to perform a better analysis of the skin? The clinical experience developed in two patients gives an affirmative answer, moreover adding useful information of insect and its eggs already known to entomologists but never used in dermatological diagnosis.
The identification *in vivo* can distinguish *Phthirus pubis* from other skin signs while the conical shape of the operculum and the wide fixing sleeve of egg to hair, tells what species of louse is infesting, even if the insect is unavailable or nits are elsewhere from the pubic area.
Entodermoscopy, provided that dermatologists have some knowledge of entomology, therefore promises advantages over standard microscopic examination.

Keywords
Entodermoscopy, Entodermoscope, Pediculus, Phthirus

Introduction

Phthirus pubis can be more difficult to diagnose clinically than the other forms of pediculosis, not only because being smaller it is more difficult to identify visually, but also because its flattened body can be only slightly pigmented.
In this context the utility of dermatoscope can be hypothesized not only for visual magnification [1] but also because the observation would be locally facilitated as *P. pubis* does not tend to dart about or hide as happens with the other two louse species. Diagnosis of phthiriasis could also benefit from dermatoscopy when the parasite is found on other parts of the body, such as the trunk or armpit hairs, or on more unusual areas such as the eyelashes and scalp hair.

Since the literature on the topic of infestation in these areas does not use universal terminology and as diagnosis is not so rare, this paper proposes the use of *Phthiriasis capitis, Phthiriasis oculi, Phthiriasis axillae, Phthiriasis corporis* according to the affected body parts, using the term *Phthiriasis pubis* only when the parasite primarily is mainly confined to the pubic-perineal region. A similar classification has already been formulated in the past [2]. This more detailed topographically-based attribution would also seem to be a more suitable way of

describing clinical cases of primitive extrapubic locations [3] , given that the historical nomenclature might not correspond to the affected area when it is different from pubis.

Materials and methods

Two types of dermatoscope were employed, exploiting the different characteristics of each one. The observations were performed with a technique previously known as "dry dermatoscopy" [4] *i.e.* not requiring the use of a glass plate and liquid film interface. This set-up is the only one that respects the vitality of the parasite, leaving the host micro habitat intact. The same area can therefore be examined repeatedly without causing any undue local changes.
A Delta 20 dermatoscope (Heine) manually connected to a Minolta G530 digital camera (5mpx) was used only to produce unpolarized led light images, while the Dermlite Pro II dermatoscope (3 Gens, LLC) fixed to a Sony W70 (7mpx) with an adapter, was primarily used to obtain polarized led light images. The former produces images emphasising shape and texture, whilst the latter highlights in greater detail the vital internal components of the bug and eggs.
With regard to devices, entodermoscopy [5] requires a specific dermatoscope dedicated to parasite study, capable of using different lighting sources and reaching magnifications far above 10x. [see instrumental specifications on www.entodermoscopy.net ; *Bibliography>EDS history*]
In fact, most of the photos in this paper are magnified about 30 times, by using the optical zoom, which on these cameras can magnify 3x. Multiplying the two factors of enlargement (dermatoscope and zoom) thus gives a "theoretical" magnification of thirty times. Pictures examined in full-frame format are even more enlightening. Depending on the megapixel resolution of the sensor, when the image is not reduced by the screen dimension, it can be enlarged further to show even greater detail.
An instrument designed specifically for searches such as these *(entodermoscope)* would eliminate some current drawbacks, thus making the study of ectoparasitosis simpler, more efficient and more reproducible *in situ*.

Clinical series

Case 1
A 61-year-old man experiencing itching in the inguinal-abdominal region was treated for a significant time with various moisturizing products, antiseptic soaps, cortisones or antibiotic creams, but decided to consult a specialist when the symptoms persisted.
During objective examination, the subject exhibited an excellent general and local state of hygiene, being a professional; with the naked eye, he showed no signs of macroscopic elements of interest (such as *maculae ceruleae* or excoriations), except for very rare dark spots on the pubic skin strongly suggestive of pediculosis (Fig.1).

Figure 1. Pale, isolated reddish-gray spot on pubis surronded by large area of normal skin (A), suggestive but not diagnostic. *[Minolta G530]*

Under the dermatoscope, most of his skin and annexes appeared normal but when focusing on the rare punctiform lesions, the characteristic triangular body of *Phthirus pubis* could be easily identified, clinging with its claws onto the surrounding hair (Fig.2). What appeared to the naked eye as indefinite dark spots, showed itself through dermoscopy to be made up really of red fecal granules clustered close to the caudal section and the bug's pigmented claws (Fig.2).

Figure 2. *Phthirus pubis* motionless, hooked onto the hair shafts. Dark-red fecal granules can be seen on the skin, with a reflecting surface (A). Brown claws (B). *[Dermlite, normal light. 30x].*

Despite observing the parasite for a considerable length of time, it made no attempt to escape and made no sudden movements of its limbs. On switching to polarized light, the digestive tract of the parasite (previously not visible) could clearly be seen because the red color of the blood inside and it's lively peristaltic activity. (Fig.3) [clip available on hompage of www.entodermoscopy.net]

Figure 3. *Phthirus pubis*. Under polarized light, the *Phthirus* body becomes transparent enough to distinguish the digestive tube (C) moved by peristaltic waves (see: www.entodermoscopy.net). The claws are brown (B), and faeces on the skin now appear as opaque granules (A). *[Dermlite polarized light, 30x]*

On searching for other diagnostical signs, only a very few number of nits were found on pubic hair, some with operculum, others without. The operculum of the proximal nits (i.e. those unhatched, closer to the skin) exhibited a characteristic conoid shape [6] (Fig.4) thus distinguishing them from the nits of *P. capitis*, which have a dome-shaped operculum. [7]. (Fig.5) These two different shapes are known enough to dermatologist but they are available only when lice eggs are analyzed under optical microscope.

Figure 4. *Phthirus* nits on pubis. Conoidal operculum (A) in eggs fixed at different heights along the hair shaft. Fixing sleeve at its widest part (B). *[Dermlite, detail>30x]*

Figure 5. Example of *Pediculus capitis* nit with a flattened dome shape operculum (A). A detail in the foreground (B). Basal egg pole is well distinguishable by hair shaft (C). *[Delta20, 30x; detail >30x]*

Another microstructural egg feature, never used for dermatological diagnosis but already described microscopically by P.A. Buxton in 1947, and reported by Howard V. Weems Jr. in 1980, regards segment attached to the hair shaft [8-9].
This special portion of the nit that I like to call "fixing sleeve" assumes considerable evolutionary and therapeutic importance. In fact it enables the egg to be exposed to the right degree of heat allowing proper embryo development and it imposes the use of a fine-toothed comb to mechanically remove the eggs. Rather than to believe that the egg is simply glued onto the hair shaft, the nit has really to be imagined fixed firmly onto a tubular structure (fixing sleeve) surrounding and probably tightening the shaft to create the strong adhesion we know to hair [10]. Based on my photographic experience, commonly sleeve of *P. capitis* appears as a tubule of even caliber, the same length or longer than the egg shell (Fig.6).

Figure 6. Example of *Pediculus capitis* nit without operculum (A) with basal pole detached from hair (B). Fixing sleeve has tubular shape (C). *[Delta20, 30x]*

By contrast in this patient fixing sleeve of *P. pubis* appears as a shorter sheath which increases in thickness towards the basal pole of the egg then becoming more tubular towards the proximal part of the hair shaft (Fig.7). This wider conformation can be photographed on pubis with more technical difficulties than crab nits on scalp hair.

This feature, if confirmed by further dermatoscopic observations, could be used as a pathognomonic element useful to identify *Phthirus* nits which are currently unrecognizable because lacking the operculum on unusual parts of the body. Without a specific operculum and far from usual site a nit is only a case virtually belonging to any kind of pediculus.

Figure 7. *Phthiriasis pubis.* Nit on pubis. The fixing sleeve is tubular in its proximal part towards skin (A), widening closer to its distal end (B) where it envelops part of the basal pole of the egg, clearly visible in transparency (C). Conoidal operculum (D) *[Dermlite, 30x. Small photo >30x].*

Case 2

A 38-years-old woman, a primary school teacher, decided to consult a dermatologist, not for a diagnosis (a diffused pubic phthiriasis already correctly diagnosed by another colleague) but rather to ensure that her treatment had been successful. The patient was not only worried for her health but, even more so, for her relationships with work colleagues and pupils. When she was visited, therapy had already been performed, and on her own unauthorized initiative repeated several times with different pediculicides; nevertheless, the itching did not entirely disappear and the search for new bugs became a full-time occupation for the woman. All these psychological pressures resulted in a severe lack of sleep and a growing anxiety-compulsive disorder.
The dermatoscopic observation began in the pubic region, which the patient had already completely shaved at the onset of the illness, continuing in the ocular region and finally the scalp being infestation widespread all over the body. The pubic skin looked normal, almost entirely hairless with protruding hair stems only, and of course no macroscopic sign of parasites or eggs.

On the other hand, real evidence of infestation by *P. pubis* was irrefutably confirmed by numerous nits on eyelashes, easily identifiable despite the black mascara on the patient's eyes. No parasite was detectable *in situ* and no local therapy was refered. Most of the nits were lacking operculum and black in colour as if the mascara had got through the vacated opening. However, there were also some black nits that were still closed, with a typically conoid operculum (Fig.8).

Figure 8. *Phthiriasis oculi.* Nits on eyelashes. Two lateral operculum-free nits (A) and one at center with conoid operculum (B). All are dark, stained by patient's mascara. *[Dermlite polarized, 30x]*

The reason behind this phenomenon is not immediately clear, but suggests that the embryo had somehow been stained (and probably killed) through the wall of a closed egg. Other observations would be necessary to define the type of interference caused by mascara on the normal life cycle of the lice and nits when exposed to a potentially very occlusive product.
On the scalp hairs, the dermoscopic features were equally easy to read, even if reduced to few nits only, some open (Fig.9) and others closed by a conoidal operculum (Fig.10). Here, the fixing sleeve again exhibited in both operculum cases a thickening close to the basal part of the egg.

This conformation found on the head, and not only on the pubis (Fig.4-7), confirms the hypothesis that it is a constant characteristic of the bug, expressed independently from its location.

Figure 9. *Phthiriasis capitis.* Nit without operculum (A) on hair. The hair fixing sleeve (B) is a wide structure that also envelops the basal pole of the egg, becoming tubular only towards the proximal side of the hair shaft.
[Delta20, 30x]

Figure 10. *Phthiriasis capitis.* Nit on hair with typical conoidal operculum (A), and short and wide sleeve (B). Basal egg pole is absorbed into sleeve. *[Delta 20, 30x]*

Given the several cycles of therapy (plurithерapy) with different drugs (polytherapy) which the patient had undergone, also here it was not possible to find any insects on the scalp or surrounding skin.
After the examination, the patient was reassured that the care she received had been successful, which was the main reason for her consultation. But despite her relief because therapy success, on subsequent visits she still reported significant emotional distress, requiring the use of low dose Pimozide (2mg) for 10 days. At the end of therapy, the patient showed good control of the fears that heavily compromised her working life and relationships for several weeks.

Discussion

Considerations about lice and nits are addressed below in separate sections.

-Dermatoscopic markers of mobile forms (insects).

P. pubis in these two cases shows a good ability to adapt to different temperature, humidity and light microenvironments, apparently without changing its behavior. In dermatoscopy , it was identified directly only in patients No.1 but not in No.2, because she had already been successfully treated, although some lesions could suggest a persistence of the disease as the woman believed, having fallen into a delusion of parasitosis.

In the first clinical case, previous visits failed to recognize with naked eye any kind of parasite on pubis, resulting unsuitable treatments of patient. Diagnostic delay may occur when an infestation, kept to a very low level because of scrupulous personal hygiene, is supported by a parasite population limited to few individuals. Such a situation is insufficient for immediate identification unless the doctor has already experienced this peculiar clinical eventuality.

The dermatoscope proves useful for identifying those forms of itchy dermatitis resistant to common therapies, whose cause is really a pediculosis below the diagnostic threshold, which would otherwise be misdiagnosed.

The dermoscopic markers that best define *Phthirus* are its short, triangular and little colored body, brown claws, red globular feces near its caudal section, and red-colored internal digestive tract with its peristaltic activity under polarized light (Fig. 2-3).

In the second case, entodermoscopy was unusually used to confirm eradication of the infestation, fairly inevitable given the multiple therapies, the trichotomy over almost the entire body and the interruption of any further potentially contagious contact.

More specifically, it was a useful tool for the patient because in her particular emotional state (delusion), she demanded a careful instrumental verification that treatment had been successful. In patients with symptoms suggesting active infestation, dermoscopic examination proves its utility for excluding factors which could wrongly indicate failure of treatment.

-Dermatoscopic markers of fixed forms (nits)

In cases 1 and 2, eggs were found respectively in course of infestation and as delayed testimony where trichotomy was impossible to carry out (hair and eyelashes). Removal of hairs in fact prevents any direct or indirect diagnosis with existing equipment.

In both patients, the conoidal shape of the operculum confirmed that the parasite was really crab louse, being this attribute specific for *Phthirus,* especially favoring differential diagnosis on the scalp where nits of *P. capitis* are statistically more common. The images in this paper clearly describe this microstructure, which entomologists have already well documented using optical microscopy, but which is, in dermatological world, very uncommon to see *in vivo* and *in situ* through the dermatoscope (Fig.4-7).

But also a second unexpected indicator can be documented through dermoscope. It regards the fixing sleeve which could be able to distinguish nits of *Phthirus* even when they have lost the specific operculum and the anatomic site is not typical (*i.e* head).

According to personally consulted sources, this item seems to have never been documented in dermatoscopy before this study. The fixing sleeve of *P. capitis* is generally a tubular case to which much of the nit is attached, usually leaving the proximal pole of the egg detached from the hair shaft (Fig.6) or however well distinguishable from it (Fig.5). By contrast, the fixing sleeve of *P. pubis* in these observations appears to widen as it nears the egg, to "incorporate" and partially hiding its proximal pole (Fig.4-7-9-10).

One can also have impression in side projection of a kind of "sail" or "truncated cone", between egg and the hair shaft. This morphology has been documented consistently in different patients (cases1-2) and at different sites (pubis, head) demonstrating that it is not influenced by the anatomic site in which *P. pubis* is located.

Conclusions

Dermatoscope in the guise of an "*entodermoscope*" can provide useful additional information for both direct diagnosis and differential diagnosis. Entodermoscopy [11] is a young and evolving application of traditional dermatoscope that can, now with some technical restrictions, explain those fuzzy red marks perceptible to the naked eye (made up of pigmented claws, external faecal pellets and blood within the gut), that always dermatologists have unknowingly used in macroscopic clinical diagnosis of *Phthiriasis*.

It also allows to identify *in situ* and *in vivo* certain microstructural differences between nit species (*i.e.* operculum and fixing sleeve) which are otherwise inaccessible to the naked eye. These items are useful for knowing the infesting kind of *Pediculus* even in its absence, when nits have already hatched (*i.e.* free of specific operculum) and they are in atypical locations, without interrupt ordinary visit anyway because optical microscope use.

In addition to still images, dynamic studies of the parasite can also be carried out by filming the parasites with a digital camera (clip available on homepage of www.entodermoscopy.net). Dynamic information has to be considered an indispensable complement in the search for specific markers of infestations.

All such ideas and observations, preferably obtained from a specific instrument designed "ex novo", create the groundwork for a better *in situ* and *in vivo* understanding of complex host-parasite relationship which could in future better define new pathways for diagnosis and therapeutic strategies.

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