Histopathology of the More Common Viral Skin Infections

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Abstract
We describe the histopathological characteristics of viral skin infections. Herpes simplex virus and varicella-zoster virus produce an intraepidermal vesicle with variable degrees of epithelial necrosis. Typical findings include keratinocytes with balloonsized nuclei with a ground-glass appearance and giant multinucleated keratinocytes. In the endothelial cells of the dermal blood vessels, cytomegalovirus produces large eosinophilic nuclear inclusions surrounded by a clear halo. Human herpes virus 8 is etiologically associated with Kaposi sarcoma. In its early stages, this tumor contains blood vessels with a fine endothelium passing through the dermal collagen bundles. In the plaque and nodular stages, the vessel lumens are more clearly visible and there is a progressive increase in the number of neoplastic spindle cells with a low degree of pleomorphism and atypia, and occasional mitoses. The infiltrate is made up of lymphocytes and plasma cells. Contagious ecthyma and milker’s nodule give rise to an acanthotic epidermis with balloonsized keratinocytes containing eosinophilic cytoplasmic viral inclusions. Molluscum contagiosum shows lobules of epithelium that open onto the epidermal surface and characteristic inclusion bodies. Acanthosis, papillomatosis, and hyperkeratosis are observed in common warts, with confluence of the epidermal ridges in the center of the lesion and koilocytes.

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Resumen
En este trabajo describimos las características histopatológicas de las infecciones viricas cutáneas. El herpes simple y el virus varicela-zóster producen una vesícula intraepidermática con grados variables de necrosis epitelial. Son característicos los queratinocitos con núcleos balonizados con aspecto de vidrio esmerilado y los queratinocitos gigantes multinucleados. El citomegalovirus produce grandes inclusiones nucleares eosinófilas rodeadas de un halo claro en los endotelios de los vasos dérmicos. El herpes virus tipo 8 se relaciona etiológicamente con el sarcoma de Kaposi, que en sus fases iniciales muestra luces vasculares de endotelios finos disecando los haces de colágeno dérmicos. En las fases en placa y
Table 1 lists the most common viral skin infections, whose histopathologic features will be reviewed here.

**Histopathologic Features of Skin Infections Due to Herpes Simplex Virus and Varicella-Zoster Virus**

Histopathologic findings of biopsies of fully developed labial (Figure 1) and genital (Figure 2) vesicles due to herpes simplex virus, and vesicles caused by varicella virus (Figure 3) consist of an intraepidermal blister with varying degrees of epithelial necrosis. The most typical changes in the nuclei of epidermal keratinocytes involve the peripheral margination of chromatin, which seems to attach to the nuclear membrane. The resulting ballooned nuclei appear ringed and acquire a ground-glass appearance. The earliest noteworthy abnormality in the cytoplasm of these keratinocytes is the presence of vacuolization. Initially changes are found along the basal layer of the epidermis, but they soon spread upward until the entire thickness of the epidermis becomes affected. Two mechanisms are nodular las luces vasculares son más visibles, aumenta progresivamente el número de células fusiformes tumorales con discreto grado de atipia y pleomorfismo y algunas mitosis. El infiltrado se compone de linfocitos y células plasmáticas. El orf y el nódulo de los ordeñadores inducen una epidermis acantósica con queratinocitos balonizados que contienen inclusiones viricas citoplasmáticas eosinófilas. El molusco contagioso muestra lóbulos de epitelio abiertos a la superficie epidérmica con características cuerpitos de inclusión. En las verrugas vulgares aparece acantosis, papilomatosis e hiperqueratosis, con confluencia de las crestas epidérmicas hacia el centro de la lesión y coliloctios.
Histopathology of the More Common Viral Skin Infections

Table 1  The Most Common Viral Skin Infections

<table>
<thead>
<tr>
<th>Virus Type</th>
<th>Disease Name</th>
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<tbody>
<tr>
<td>Herpes virus</td>
<td>Herpes simplex types 1 and 2</td>
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<td></td>
<td>Varicella and herpes zoster</td>
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<td></td>
<td>Kaposi varicellaiform eruption</td>
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<td>Cytomegalovirus</td>
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<td>Epstein-Barr virus</td>
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<td></td>
<td>Human herpesvirus 6</td>
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<td>Human herpesvirus 7</td>
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<td></td>
<td>Human herpesvirus 8</td>
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<tr>
<td>Parapoxvirus</td>
<td>Contagious ecthyma (orf ulcer)</td>
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<td></td>
<td>Milker’s nodule</td>
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<td></td>
<td>Molluscum contagiosum</td>
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<tr>
<td>Papillomavirus</td>
<td>Warts</td>
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<td></td>
<td>Focal epithelial hyperplasia (Heck disease)</td>
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<td></td>
<td>Bowenoid papulosis</td>
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<tr>
<td></td>
<td>Epidermodysplasia verruciformis</td>
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<tr>
<td>Parvovirus</td>
<td>Infectious erythema</td>
</tr>
<tr>
<td></td>
<td>Purpuric glove-and-sock syndrome</td>
</tr>
<tr>
<td>Coxsackievirus</td>
<td>Hand-foot-mouth disease</td>
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</table>

involved in the formation of intraepidermal vesicles: one is the ballooning of keratinocytes and the other is the reticular degeneration of the epidermis. It is common to see ballooned keratinocytes in viral infections. Affected cells appear swollen and isolated from neighboring cells because of the loss of intercellular connections. This process has been termed secondary acantholysis to differentiate it from the primary form, which appears in autoimmune diseases by way of antidesmosomal antibody mediation, as in variants of pemphigus. The cytoplasm of ballooned cells have an even, eosinophilic staining, and giant multinucleated cells are often present. These nuclei also display the aforementioned abnormalities, which can be observed in Tzanck cytodiagnostic smears.

Reticular degeneration is the result of swelling, or progressive hydropic degeneration, of epidermal keratinocytes, which appear large and clear, with traces of cytoplasm remaining at the periphery. As the cells swell, they break, contributing to the formation of intraepidermal vesicles. Unlike ballooning, reticular degeneration is not confined to viral infections, but can also be seen in acute contact dermatitis. Keratinocyte ballooning is generally more evident in cells at the base of a vesicle, whereas reticular degeneration is more intense on the vesicle surface and around the edges.

It is easier to see intranuclear eosinophilic inclusions in herpes lesion biopsies than in smears obtained by the Tzanck cytodiagnostic procedure. Inclusions are more evident in the nuclei of giant multinucleated cells, particularly if lesions are already several days old. In addition to the presence of isolated cells with the characteristic nuclear abnormalities, neutrophils and fibrin can also be detected inside herpes vesicles. Leukocytoclastic vasculitis in the superficial dermis underlying the lesion has been described in herpes simplex, varicella, and herpes zoster histopathology2,3 (Figure 4). The dermal inflammation that typically accompanies these lesions is more marked in herpes simplex than in herpes zoster and it is not unusual to find atypical lymphocytes in herpes simplex infiltrates.4 A recent study reported intense lymphocytic infiltrates giving the appearance of cutaneous lymphoma on histopathologic evaluation of skin infections due to either herpes simplex or varicella-zoster virus5 (Figure 5, A and B). Immunohistochemical analysis of the infiltrate showed that it was composed mainly of T cells and that CD30 and CD56 expression was variable. Polymerase chain reaction (PCR) demonstrated monoclonal T-cell populations in 2 cases, increasing the difficulty of differential diagnosis with true lymphoma.

It is not unusual for herpes zoster lesions to affect epithelial cells of the pilosebaceous unit. The exclusive involvement of that unit, with subtle cytopathologic findings typically confined to the epithelium of the hair follicle and the sebaceous gland, without epidermal participation, has recently been proposed to be a specific sign of the onset of a herpes zoster lesion6 (Figure 6). These subtle histopathologic findings indicate the so-called herpes incognito lesions, or herpetic folliculitis,7 and they appear before vesicles develop. Epithelial cells of the outer root sheath and sebaceous cells are ballooned and their nuclei have a ground-glass appearance. They are multinucleated or mummified as a result of cellular necrosis secondary to varicella-zoster virus infection. Clinically, the onset is characterized by painful, erythematous papules. Several days pass before the vesicles typical of herpes zoster develop. More unusual is epithelial eccrine gland involvement, whether of the secretory portions or of the dermal or intraepidermal excretory ducts.8 Cytologic characteristics cannot be identified in some tissue samples from herpes lesions of the adnexal epithelium, so that only serial slices can

Figure 4  Histopathology of a herpes zoster lesion showing leukocytoclastic vasculitis in the dermis underlying the intraepidermal vesicle. (Hematoxylin-eosin stain; A, magnification \( \times 10 \); B, \( \times 40 \); C, \( \times 200 \); D, \( \times 400 \)).
demonstrate the presence of giant multinucleated cells with a ground-glass appearance. Immunohistochemical analyses have also demonstrated viral antigen presence in nerve fibers of the dermis underlying herpes vesicles in varicella-zoster viral infections.\textsuperscript{9,10}

The histopathologic differential diagnosis of herpes simplex and varicella-zoster viral infections may be established immunohistochemically. Commercial monoclonal antibodies are currently available for herpes simplex virus type 1 (Figure 7), type 2 (Figure 8), and varicella-zoster virus (Figure 9).\textsuperscript{11,12} Immunohistochemical findings reveal diffuse staining of infected nuclei, although staining is more intense at the edges, confirming the observation of cells with peripheral margination of chromatin. However, these studies also demonstrate viral antigens not only in the epidermis but also in epithelial hair follicles and sebaceous glands, most often in varicella-zoster viral infections. These antigens are found in lower proportions in nerves and dermal structures. In contrast, herpes simplex viral antigens are usually located in epidermal keratinocytes and only occasionally affect the superficial portion of the follicular infundibulum and never the sebaceous glands or nerves of the dermis. Based on such immunohistochemical studies and the demonstration of viral antigens in various cutaneous structures, it has been possible to establish the sequence of herpes zoster lesion reactivation. In the initial phases, the varicella-zoster virus travels from the dorsal root ganglion to the sensory nerves of the...
dermis and to perineural dendrocytes. (This is not the case in varicella lesions.) By means of these nerves, the virus reaches the pilosebaceous units, which are highly innervated and are the first epithelial structures infected. From the pilosebaceous unit the infection extends to epidermal keratinocytes. In other words, a histopathologic finding of pilosebaceous involvement is characteristic of incipient erythematous lesions, whereas epidermal involvement and the formation of vesicles will be found in fully developed lesions. The main cytopathologic findings inside varicella-zoster virus infected hair follicles are the keratinocytes of the outer root sheath of the isthmus and its connection with the sebaceous gland. These cells are much less evident in the epithelium of the infundibulum and the lower segment, apparently because the varicella-

zoster virus has a tendency to migrate along myelinated sensory nerve fibers in the follicular isthmus. This virus has no predilection for nonmyelinated sensory nerve fibers innervating the epidermis.6

Many processes have been described as forming in scars left by herpes zoster lesions13-51 (Table 2). These new lesions may appear immediately after resolution of the herpes zoster vesicles or some time later. The pathogenesis is poorly understood, although type II or IV hypersensitivity mechanisms and the Koebner phenomenon have been suggested as possible triggers. Results have been variable in studies attempting to demonstrate the presence of varicella-zoster viral material in lesions that form in scars. Discrepancies are probably attributable to variations in the interval between an acute episode and the appearance of secondary lesions after scarring; positive results are more likely in lesions that have formed recently than in those that develop over a longer period.

### Histopathology of Cutaneous Infection Due to Cytomegalovirus

In cytomegalovirus infections the characteristic observations are made in endothelial cells of dermal blood vessels. The

<table>
<thead>
<tr>
<th>Comedones 13</th>
<th>Xanthomas 14</th>
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<tbody>
<tr>
<td>Annular granuloma 15-28</td>
<td>Sarcoïd granuloma 16,29</td>
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<tr>
<td>Tuberculoid granuloma 20</td>
<td>Granulomatous vasculitis 16,31</td>
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<tr>
<td>Unclassifiable granulomatous dermatitis 16</td>
<td>Tinea 12</td>
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<tr>
<td>Acneiform rash 11</td>
<td>Furunculosis 14</td>
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<tr>
<td>Contact dermatitis 14</td>
<td>Nodular elastotic degeneration 16</td>
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<td>Pseudolymphoma 16</td>
<td>Psoriasis 16</td>
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<td>Lichen planus 16,37,38</td>
<td>Morphea 19,40</td>
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<tr>
<td>Lichenoid graft-vs-host disease 41</td>
<td>Lichenoid graft-vs-host disease 41</td>
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<tr>
<td>Eosinophilic dermatosis 42</td>
<td>Reactive perforating collagenosis 43,44</td>
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<tr>
<td>Lymphoma 45</td>
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<tr>
<td>Kaposi sarcoma 47</td>
<td>Angiosarcoma 48</td>
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<tr>
<td>Basal cell carcinoma 49</td>
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<td>Cutaneous metastasis from internal carcinoma 50</td>
<td>Sclerotic and atrophic lichen 16</td>
</tr>
<tr>
<td>Rosai-Dorfman disease 50</td>
<td>Granulomatous folliculitis 16</td>
</tr>
<tr>
<td>Chronic localized urticaria 51</td>
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**Figure 8** Immunohistochemical staining for herpes simplex virus type 2 of the lesion shown in Figure 2. (A, magnification ×10; B, ×40; C, ×200; D, ×400).

**Figure 9** Immunohistochemical staining showing hair follicle and eccrine gland epithelial cell positivity for varicella-zoster virus in a herpes zoster lesion. (A, magnification ×10; B, ×40; C, ×200; D, ×400).
nuclei of these cells have large eosinophilic inclusions surrounded by a clear halo\textsuperscript{52} (Figure 10). Neutrophilic invasion of the walls of affected vessels is often also seen, although unequivocal leukocytoclastic vasculitis is rare.\textsuperscript{53} Less frequently, inclusions in the nuclei of endothelial cells have also been described in fibroblasts and macrophages as well as in the epithelium of eccrine ducts in cytomegalovirus infections.\textsuperscript{54} In congenital cytomegalovirus infections, extramedullary hematopoiesis may be present in the skin.\textsuperscript{55} The presence of cytomegalovirus in cutaneous lesions may be confirmed by immunohistochemical analysis\textsuperscript{56,57} or PCR techniques.\textsuperscript{58}

**Histopathology of Cutaneous Infection by the Epstein-Barr Virus**

The Epstein-Barr virus, or Human herpesvirus 4, is a \(\gamma\)-herpes virus that causes infectious mononucleosis, hairy leukoplakia in patients with AIDS, a variety of lymphoproliferative processes, and nasopharyngeal lymphoepithelial carcinoma. In dermatology, it is also common to see a maculopapular rash in patients with mononucleosis who have been treated with ampicillin, because of the presence of immunoglobulin (Ig) G or IgM antibodies against penicillin. The rash is not attributable to IgE antibodies, as is the case in hypersensitivity reactions to penicillin. Histopathologic findings in these rashes are nonspecific. Observations include epidermal spongiosis and a superficial perivascular lymphohistiocytic infiltrate.

In hairy leukoplakia at the edges of the tongue, acanthosis with parakeratosis can be observed, along with large, pale keratinocytes particularly in superficial epithelial strata, and a variety of types of intranuclear inclusions.

**Histopathology of Herpesvirus-6 and Herpesvirus-7 Skin Lesions**

Human herpesvirus types 6 and 7 are \(\gamma\)-herpes viruses. Human herpesvirus 6 produces exanthem subitum, an infection also known as roseola infantum or the sixth disease of childhood. Human herpesvirus 7 has been linked to the reactivation of exanthem subitum caused by the type 6 virus and to some cases of pityriasis rosea, also known as Gilbert disease.

Histopathologic findings are nonspecific. Epidermal spongiosis is observed. Some degree of vacuolar degeneration might be present in the basal layer of the epidermis along with superficial perivascular lymphocytic infiltrate as in other viral exanthems.

**Histopathology of Kaposi Sarcoma**

Herpesvirus type 8 has now been shown to be involved with the development of all the epidemiologic variants of Kaposi sarcoma.\textsuperscript{59-61} The initial patch stage of Kaposi sarcoma is characterized by relatively subtle histopathologic findings that may be confused with an inflammatory process.\textsuperscript{62} Under low magnification, a discrete inflammatory infiltrate of mononuclear cells can be observed perivascularly in both superficial and deeper layers of the lesion, along with an increase in the number of irregularly shaped vascular spaces, with narrow lumens and slits, with flattened endothelial cells lining small vessels and scattered through

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**Figure 10** Histopathology of a genital lesion due to cytomegalovirus, showing typical inclusions in endothelial cells. (Hematoxylin-eosin stain; A, magnification \(\times10\); B, \(\times40\); C, \(\times200\); D, \(\times400\)).

**Figure 11** Histopathology of a Kaposi sarcoma patch showing spindle cells dissecting dermal collagen bundles. (Hematoxylin-eosin stain; A, magnification \(\times10\); B, \(\times40\); C, \(\times200\); D, \(\times400\)).
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the entire thickness of the dermis (Figure 11). These irregularly shaped, thin-walled vascular spaces tend to surround blood vessels as well as nerve and adnexal structures of the dermis; when they dissect pre-existing capillaries the so-called promontory sign appears (Figure 12). The inflammatory infiltrate appearing throughout the lesion mainly consists of lymphocytes and plasma cells; the latter are a finding that should lead to suspicion of Kaposi sarcoma in all incipient vascular lesions with irregularly shaped vessels and thin walls.63 On rare occasions, the newly formed vessels are grouped into lobules, making the lesion resemble a small hemangioma. Another characteristic feature of Kaposi sarcoma lesions in their initial stages is the presence of scattered necrotic endothelial cells, which may be observed under either an optical microscope64 or an electron microscope.65 Hemosiderophages are also present in abundance, scattered in the stroma. These histopathologic findings that characterize the early stages of these lesions have also been described as present in apparently normal skin areas of patients with Kaposi sarcoma elsewhere, supporting the view that this disease is a generalized, diffuse process from the onset.66,67

Plaque lesions tend to affect the entire thickness of the dermis and they often spread to superficial areas of the subcutaneous cellular tissue. Spindle cells, arranged in fascicles between collagen bundles of the dermis and around newly formed vascular channels, become more numerous in this stage. These cells also line irregularly shaped slit-like or narrow vascular channels that contain a single blood vessel. Cellular atypia is not usually observed and mitotic count is very low.

When the number of spindle cells increases, Kaposi sarcoma lesions form nodules. The spindle cells then group themselves in intersecting fascicles with red blood cells scattered in the intercellular fluid (Figure 13). The degree of pleomorphism and cell atypia in these nodules is greater and some mitoses can be seen, although the number is not usually large. However, on rare occasions, particularly in the African variant of the disease, lesions may be made up of highly atypical spindle cells, and there may be a large number of mitoses observed. The presence of so-called hyaline globules is a finding that is fairly typical, though not strictly specific to Kaposi sarcoma. This observation is more common in plaque lesions or nodules but may be found during any phase of the disease. The globules, which stain positive with the periodic acid-Schiff technique and are diastase resistant, are eosinophilic spheres measuring between 1 and 10 µm and can be found both inside and outside cells. It seems that hyaline globules are red blood cells that have degenerated from phagocytes and that are included within phagolysosomes of neoplastic cells.68,69

In any case, these structures should not be considered specific to Kaposi sarcoma, given that they have been described in other contexts of vascular proliferation such as angiosarcomas, pyogenic granulomas, or granulation tissue.69

On rare occasions when Kaposi sarcoma skin lesions are bullous, histopathologic findings mimic those of a lymphangioma given the presence of irregularly shaped, thin-walled vessels lined with a broken line of flattened endothelial cells; red blood cells are found neither inside the vessels nor outside in the stroma70,71 (Figure 14). The absence of hemosiderin deposits and the scarcity of spindle cells are other observations that make these globules similar in appearance to lymphangiomas. The lymphangiomatous pattern can be found focally in lesions that are otherwise typical of Kaposi sarcoma; in fact we have observed patients with classic Kaposi sarcoma in whom some lesions showed this pattern while other lesions from the same patient had more typical Kaposi characteristics, with numerous extravasated red blood cells and abundant hemosiderin deposition. It has been suggested that chronic lymphoedema or a history of
radiotherapy applied to the affected area may favor the development of Kaposi sarcoma lesions that are reminiscent of lymphangioma.

Histogenetic evidence currently indicates that Kaposi sarcoma results from the proliferation of lymphatic endothelial cells, given that immunohistochemical analysis demonstrates that the proliferating cells express lymphatic markers (vascular endothelial growth factor receptor 3, podoplanin, lymphatic vessel endothelial hyaluronan receptor 1, and prospero-related homeobox protein 1). Immunohistochemistry can also demonstrate the presence of herpesvirus 8 in the nuclei of proliferating cells in Kaposi sarcoma lesions in all its epidemiologic variants and from the earliest phases of the process (Figures 15 and 16).

**Figure 14** Histopathology of the so-called lymphangiomatous variant of Kaposi sarcoma, showing irregularly shaped vessels resembling lymph vessels dissecting the collagen bundles of the reticular dermis. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).

**Figure 15** Immunohistochemical staining for human herpesvirus type 8 in the lesion classified as the so-called lymphangiomatous variant of Kaposi sarcoma. Some nuclei of neoplastic cells show positive. (A, magnification ×10; B, ×40; C, ×200; D, ×400).

**Figure 16** Immunohistochemistry for human herpesvirus type 8 of a Kaposi sarcoma nodule in which most neoplastic cells stain positive. (A, magnification ×10; B, ×40; C, ×200; D, ×400).

**Figure 17** Histopathology of an orf ulcer (contagious ecthyma), showing abundant eosinophilic inclusion bodies in epidermal epithelial cells. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).

Kaposi sarcoma lesions in all its epidemiologic variants and from the earliest phases of the process (Figures 15 and 16).

**Histopathology of Orf Ulcer (Contagious Ecthyma), Milker’s Nodule, and Molluscum Contagiosum**

Skin infections due to parapoxvirus also have characteristic histopathology.

In contagious ecthyma, observations are irregular acanthosis with large keratinocytes that have abundant cytoplasm and appear pale because of ballooning; they are found mainly in superficial dermal layers (Figure 17). Eosinophilic inclusions in cytoplasm are often seen.
Epithelial damage is sometimes more intense, showing so-called spongiform degeneration of the epidermis and epithelium of hair follicles; this pattern consists of intense vacuolization of epithelial cells with eosinophilic granules of different sizes. The dermis contains marked proliferation of blood vessels, which can at times be intense enough to mimic a hemangioma, and there is an inflammatory infiltrate of lymphocytes, eosinophils, histiocytes, and plasma cells. Atypical CD30-positive lymphocytes are sometimes seen, but should not be mistaken for an indication of primary cutaneous CD30-positive anaplastic large cell lymphoma.

The histopathology of milker’s nodule is very similar, although the entire thickness of the epidermis is less often affected than it is in orf ulcers (Figure 18).

Molluscum contagiosum lesions contain epithelial nodules that open onto the surface of the skin and that penetrate the dermis (Figure 19). The epithelium of follicular infundibula are often involved, and in such cases the lesion may appear cystic. Many keratinocytes contain characteristic cytoplasmic inclusion bodies that increase in size from the basal layers to the more superficial layers of the epidermis. Basophil counts also increase toward more superficial layers. The inflammatory infiltrate is scant in the underlying dermis, although cases in which there is an intense lymphocytic infiltrate may resemble cutaneous leukemia or a cutaneous CD30-positive lymphoma (Figures 20 and 21).
Histopathology of Verrucous Lesions

Skin infections caused by human papillomavirus differ according to clinical variant.

The common wart shares its histopathologic profile with the filiform mosaic plantar warts. Structurally, these warts are characterized by papillomas with acanthosis and hyperkeratosis, with parakeratotic columns extending from the points on the papillomatous surface (Figure 22). The papillomas take on a radial pattern, with confluence of the underlying epidermal rete ridges toward the center of the lesion. Under higher magnification, vacuolar cell changes can be seen. Cells have small, hyperchromatic nuclei surrounded by a clear halo and pale cytoplasm. Keratohyaline granules are not present. These vacuoles are more evident at papillomatous elevations in the granular layer. Parakeratotic columns continue in the stratum corneum. The cells of these columns have rounder nuclei than those usually found in other forms of parakeratosis. Depressions in the stratum granulosum contain granular cells with collections of degranulated keratohyaline granules that are rough, thickened. Staining is variable. All these histopathologic findings are less evident in or entirely absent from long-standing warts but they can be easily detected in recently formed lesions.

Filiform warts are similar, but with more intense hyperkeratotic and papillomatous formations and capillary dilation in the papillary dermis alternating with small hemorrhagic points.

Plane, or flat-topped, warts present the same hyperkeratosis and acanthosis seen in other viral warts, but they lack papillomatous and parakeratotic structures. The most characteristic finding in this variety is thickening of the granular layer, where the cells are larger than expected, vacuolized, and have small, centrally located, and basophilic nuclei (Figure 23). Vacuolization is also seen in corneocytes in the stratum corneum.

Mosaic plantar warts are also histopathologically similar to common warts. Other plantar warts, such as the myrmecia variety, in contrast, have specific features (87-89). Numerous intracytoplasmic eosinophilic granules can be seen in the cytoplasm of cells throughout the epidermis. The granules are larger in higher strata, where they fuse to form inclusion bodies that are homogenously colored and irregularly shaped. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).

Condyloma acuminata lesions show marked acanthosis and papilloma formation, but hyperkeratosis is lacking or
very faint (Figure 25). Unlike warts in other locations, these anal or genital warts have a more basophilic staining of the acanthotic epithelium and contain a considerable number of mitoses. Vacuoles are also in evidence. It should be remembered, however, that normal cells of the mucosal epithelium are typically vacuolated; the vacuoles of anal-genital warts, in contrast, can be found even in the deeper strata of the epidermis. The giant Buschke-Löwenstein condyloma is a verrucous carcinoma found on the genitals. The histopathology of this lesion is similar to that of other verrucous carcinomas (Figure 26).

Bowenoid papulosis may be histologically indistinguishable from Bowen disease, although atypia and intraepidermal dysplasia are traditionally thought to be more circumscribed rather than distributed throughout the thickness of the epidermis (Figure 26). Other findings that are more typical of Bowenoid papulosis than of Bowen disease are the presence of multinucleated monster cells, more abundant vacuolization of the cytoplasm, and the presence of a well-developed stratum granulosum without cellular atypia.

Figure 25 Histopathology of a condyloma acuminatum with a more basophilic epithelium than is seen in other common warts. Koilocytes are scarce. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).

Figure 26 Histopathology of a giant Buschke-Löwenstein condyloma with an exophytic architecture and the cytology of a verrucous carcinoma. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).

Figure 27 Histopathology of bowenoid papulosis, showing atypia and intraepidermal dysplasia. These findings are more focal than those seen in Bowen disease. Here they do not affect the entire thickness of the epidermis. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).

Figure 28 Histopathology of epidermodysplasia verruciformis. Evident are large, swollen keratinocytes that are irregularly shaped. The cytoplasm is abundant and basophilic. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).
The epithelial wall of a verrucous cyst has a papillomatous luminal lining, showing acanthosis and marked hypergranulosis of rough, thick and irregularly shaped keratohyaline granules (Figure 29).

Inverted follicular keratosis has the same general architecture of a common wart, but growth is more endophytic than exophytic in the former; a peculiarity of this type of keratosis is the arrangement of squamous cell swirls, or eddies, arising from hyperplastic follicular infundibula (Figure 30). The lesion usually has an overlying layer of orthokeratotic hyperkeratosis, but as in other common wart variants it is not unusual to find parakeratotic columns rising vertically from points on the dermal papillae. The stratum granulosum is typically thickened, at least focally, and it is not unusual to see thick keratohyaline granules. Noteworthy in the underlying dermis are congested, twisting capillaries that contain red blood cells in abundance, and also a predominantly lymphocytic inflammatory infiltrate located around the vessels. There is no consensus on the origin of the so-called squamous eddies evident in cross-sections of epithelial lobules of inverted follicular keratosis lesions, although serial slices of these structures often show them to be in contact with an adjacent sebaceous gland. Therefore, they may be hyperplastic sebaceous ducts trapped inside the lesion, with squamous metaplasia developing later. In any case, these squamous eddies are not specific to inverted follicular keratosis, as they can be seen fairly often in irritated seborrheic keratosis and, more sporadically, in keratoacanthomas.

Trichilemmoma has the general architecture of a common wart and under low magnification seems to consist of 1 or more hyperplastic follicular infundibula whose epithelium displays differentiation similar to that of an external root sheath of the inferior segment of active hair follicles. Several adjacent follicular infundibula are usually involved. Most of these lesions have both an exophytic and endophytic component and they generally adopt a vertical position. The surface of the lesion is discretely papillomatous or markedly verrucous. Hypergranulosis may sometimes be seen in the depressions of papillae on the lesion surface, while the vertices of these papillae have parakeratotic columns, findings reminiscent of common warts. Adnexal epithelial cords are often found around the edges of these lesions. A trichilemmoma, properly categorized, is formed of solid epithelial lobules of clear, monomorphic cells with eosinophilic cytoplasm that is pale...
or optically transparent due to abundance of glycogen and a small-sized nucleus that has a vesicular appearance, is round, and eccentrically located (Figure 31). In many areas, threads of cells showing peripheral palisading lie over a thick basement membrane similar to the vitreous membrane that surrounds a normal hair follicle. On occasions, a cross-section of these epithelial lobules made up of clear cells reveals squamous eddies similar to those of inverted follicular keratosis, demonstrating that these 2 lesions are closely related. A trichilemmoma has a fairly scant stroma made up of collagen fibers. In dermal papillae, the collagen contains dilated, twisted capillaries with an abundance of red blood cells. There is often a discrete lymphocytic inflammatory infiltrate in the dermis underlying the lesion. So-called desmoplastic trichilemmoma has a configuration that is generally similar to the preceding type, but in some areas of the lesion, particularly deep portions, the epithelial lobules are prolonged by cords of pale or basaloid epithelial cells that are trapped with sclerotic collagen bundles in a desmoplastic stroma. This pattern can cause problems of differential histopathologic diagnosis, particularly in relation to morpheaform basal cell carcinoma (Figure 32). However, the general architecture of these desmoplastic trichilemmomas is that of a benign lesion. In addition to areas where epithelial cords are embedded in the desmoplastic stroma solid clear-cell epithelial lobules can be found on the surfaces and sides of the lesion. They display peripheral cell palisading overlying the thick basement membrane—characteristic of trichilemmoma.

In focal epithelial hyperplasia (Heck disease), the histopathologist sees acanthosis, papillomatosis with openings in the interpapillary ridges at deeper layers of the epithelium, as well as vacuolated cells in superficial layers. A scattering of so-called mitosoid cells is a characteristic finding. These cells are keratinocytes with irregularly shaped, hyperchromatic nuclei that simulate mitoses but that are in fact degenerated nuclei without mitotic ability. (Hematoxylin-eosin stain; A, magnification ×10; B, ×40; C, ×200; D, ×400).
Histopathology of Cutaneous Infections Due to Parvovirus B19

Generally speaking, the histopathologic findings in infectious erythema and purpuric gloves-and-socks syndrome are nonspecific. The histopathologist will note varying degrees of epidermal spongiosis, parakeratotic foci, and a discrete perivascular infiltrate around a superficial vascular plexus in the dermis. Gloves-and-socks syndrome also usually presents with extravasated red blood cells around superficial dermal capillaries (Figure 34). The presence of parvovirus B19 in the endothelial cells of these capillaries can sometimes be demonstrated immunohistochemically (Figure 35).

Histopathology of Hand-Foot-Mouth Disease

The cutaneous lesions of hand-foot-mouth disease due to coxsackievirus A16 consist of intraepidermal vesicles with marked ballooning of keratinocytes in higher layers of recent-onset lesions (Figure 36) and reticular degeneration throughout the dermis in longer-standing ones. Papillary edema can be seen in the dermis along with a discrete, predominantly lymphocytic inflammatory infiltrate mainly positioned around vessels.

Conflicts of Interest

The authors declare they have no conflicts of interest.

References


