Pyogenic granuloma (PG) is an acquired vascular lesion of the skin and mucous membranes common to the pediatric age group. PG appears as a solitary red nodule on the head or neck. The nodule is prone to hemorrhage, and bleeding is often refractory to pressure. The etiology of PG is unknown, but proposed agents include trauma, infection, and preceding dermatoses. Several surgical treatments are available with variable cosmetic results and recurrence rates.

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Pyogenic granuloma (PG) is a common vascular hyperplasia of the skin and mucous membranes that occurs in children and young adults. It is usually found on the face, trunk, and limbs. There are also subcutaneous and intravenous variants. PG is often solitary, but multiple satellite lesions may occur. PG was identified over a century ago and has been associated with minor trauma, chronic irritation, hormonal factors, and viral infections. To date, however, no significant causative relationships have been verified. The etiologic hypotheses have led to a number of terms used to describe PG that suggest a causative agent; these terms include botryomycosis hominis, granuloma telangiectodes, and granuloma pediculatum. The term pyogenic granuloma was adopted in 1925 because it was considered descriptive of the underlying process. Recently, the term lobular capillary hemangioma has been suggested because of the histologic appearance of the lesions.
Epidemiology
PG is common in children and young adults. In children, the mean age of onset is 6.7 years; 42% of cases occur by 5 years of age, 12% occur before 1 year of age, and 1.1% are present at birth. Cutaneous PG has no gender predisposition and accounts for 0.5% of all skin nodules in children. The incidence of oral mucosal nodules peaks in the second or third decade of life; oral mucosal nodules occur in a 2:1 female-male ratio and are associated with pregnancy and oral contraceptive use. Multiple PGs usually occur in young adults but have been reported in children.

Etiology and Pathogenesis
The etiology of PG is unknown, but because PG regresses when potential initiating stimuli are removed, it qualifies as a vascular hyperplasia. Possible predisposing factors include trauma, chronic irritation, increased levels of female sex hormones, infections, viral oncogenes, and microscopic arteriovenous anastomoses.

As many as 50% of individuals with PG have a history of local trauma. Further, multiple PGs often develop following surgical manipulation of primary nodules. It has been postulated that excessive production of an angiogenic factor following trauma may be responsible for the vascular hyperplasia. However, some studies report little association between trauma and PG.

Female sex hormones also may play a role in the pathogenesis of PG. Oral mucosal nodules occur at an increased frequency in pregnant women and in women who use oral contraceptives. This increased occurrence is thought to be due to an imbalance between angiogenesis enhancers and inhibitors. A recent study demonstrated that female sex hormones enhance the expression of angiogenic factors, including vascular endothelial growth factor, basic fibroblast growth factor, and interleukin 1β. A decreased rate of endothelial cell apoptosis also was seen. Recurrence of an excised nodule is not uncommon during pregnancy, and conversely, lesions tend to resolve after childbirth. There is no relationship between sex hormones and cutaneous PG.

Bacterial infection is another suspected cause of PG, yet no etiologic agents have been found. Bartonella infection may manifest as a spectrum of lesions, ranging from solitary PG to widespread bacillary angiomatosis. There was a statistically significant association between PG and seropositivity for Bartonella. Gram-positive bacilli have also been observed on microscopic examination of PG tissue samples.

Clinical Features
Commonly recognized variants of PG include cutaneous, oral mucosal (granuloma gravidarum), satellite, subcutaneous, intravenous, and congenital types. Cutaneous PG often arises as a painless, red, and crusted or ulcerated papule on the skin surface (Figure). The mean diameter of a cutaneous PG is 6.5 mm. The lesion develops over weeks, and growth typically stabilizes over several months. Eventually, it shrinks to become a fibrotic “angioma.” Some nodules spontaneously infarct and involute. Solitary cutaneous PGs are commonly located on the head and neck (62.5%), trunk (19.7%), or limbs (17.9%), with the upper limbs involved more often than the lower.

Oral mucosal nodules account for up to 70% of PGs in women. These lesions may develop on the gingiva, lips, or buccal mucosa. Lesions
often arise during the second or third trimester of pregnancy or with the use of oral contraceptives.\textsuperscript{13,20-23} PG on the oral mucosa has a higher rate of recurrence than cutaneous PG if excised during pregnancy and often resolves spontaneously after childbirth. Mucosal PG also has been reported on the tongue,\textsuperscript{34} in the larynx,\textsuperscript{35} and on the glans penis.\textsuperscript{16,36}

Satellite PGs are rare, usually occurring after treatment or manipulation of a solitary nodule.\textsuperscript{7,25,37} Spontaneous occurrence is rare.\textsuperscript{7,38} Satellite lesions are smooth, red, sessile papules that range in diameter from 1 to 10 mm. Unlike solitary PGs, satellite PGs most commonly appear on the trunk.\textsuperscript{7,39}

Subcutaneous PGs also are uncommon and appear as nonspecific subcutaneous nodules.\textsuperscript{4,11,40} Because the clinical appearance of this tumor is quite different from that of cutaneous PG, subcutaneous PG is often difficult to diagnose based on clinical features. It is sometimes mistaken for a hemangioma or an epidermal cyst. Biopsy results readily distinguish it from granulation tissue or from other vascular entities.

Intravenous PGs may appear as subcutaneous nodules with nonspecific features, most common developing on the upper limb.\textsuperscript{6,41} Intravenous PG also may be evident as a red-brown polyp.\textsuperscript{41} Clinical diagnosis of intravenous PG can be difficult, as it can be mistaken for an organizing thrombus.

Congenital PG is an uncommon disseminated variant.\textsuperscript{2,42} Multiple lesions, similar in appearance to the cutaneous form, are present at birth. The condition appears to follow a benign course, with spontaneous resolution over 6 to 12 months.

**Differential Diagnosis**
The differential diagnosis of PG should include amelanotic melanoma,\textsuperscript{43} angiosarcoma, basal cell carcinoma, squamous cell carcinoma, Kaposi sarcoma,\textsuperscript{34} hemangioma, bacillary angiomatosis,\textsuperscript{45-47} metastatic visceral malignancies,\textsuperscript{48} and granulation tissue. A case of hepatocellular metastases to the gingiva mimicking PG also has been reported.\textsuperscript{49}

**Histology**
Early PG is histologically identical to granulation tissue, appearing as highly vascularized connective tissue with capillaries and venules in an edematous matrix.\textsuperscript{2,3} As the lesion matures, a fibro-myxoid stroma separates the lesions into lobules containing aggregates of capillaries and venules with plump endothelial cells.\textsuperscript{3} By this point, the edema has resolved. The epidermis exhibits inward growth at the lesion base, forming a so-called epidermal collarette and causing slight pedunculation. Extensive fibrosis signifies the final stage of regression.

**Treatment and Prognosis**
Various treatment modalities have been used to remove PG. Effective means include excision, shave excision, laser surgery, sclerotherapy, electrodesication, curettage, ligation, or a combination of methods.

Excision with linear closure offers the lowest recurrence rate and allows histologic examination of a tissue sample. Closure, however, leaves a linear scar.\textsuperscript{50} Shave excision followed by argon laser photocoagulation is an effective therapeutic alternative that minimizes scar formation while preserving the ability to confirm the diagnosis with histologic examination.\textsuperscript{50}

More conservative methods such as 585-nm flashlamp-pumped pulsed-dye laser surgery are beneficial but require multiple treatments and can only be used for small lesions.\textsuperscript{51} A 100% cure rate was observed with ethanalamine oleate sclerotherapy on both large and small lesions.\textsuperscript{52} Recurrence rate with shave excision plus cautery or cautery alone has been reported to be 43.5%.\textsuperscript{2} None of these tissue-preserving methods allows histologic examination. The lack of histologic confirmation should not pose a problem for experienced dermatologists or in clinically obvious cases. However, in one series, 18% of PGs were incorrectly diagnosed.\textsuperscript{50}

Surgical debulking of cutaneous lesions followed by cauteryization with silver nitrate has been advocated as an effective yet inexpensive treatment. Follow-up should occur weekly, with repeat cauteryization as needed. This regimen results in an 85% resolution rate in an average of 1.6 treatments.\textsuperscript{53}

Peduncular PGs may be ligated at the base using absorbable suture.\textsuperscript{54} The tumor is lifted with forceps and ligated at the base with tight suture knots. The tumor will become necrotic and fall off over several days. The procedure isatraumatic and inexpensive and requires no anesthesia or special equipment. Persistence or recurrence can be treated with excision or laser surgery. However, the procedure does not allow histologic examination.

**Conclusion**
PG is an acquired vascular neoplasm of considerable interest.\textsuperscript{35-60} Its friability often produces an enhanced level of clinical concern. PG needs to be distinguished from Kaposi sarcoma, melanoma, and metastatic carcinoma, as well as an important systemic bacterial infection, bacillary angiomatosis.
Pyogenic Granuloma

REFERENCES

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