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Rev Un Med 2013 2(1): 27-36

Anatomical variability of the penile coronal sulcus and possible clinical implications: A histological study of 12 cases

ABSTRACT

Although the knowledge of the penis microanatomy is essential for proper surgical management and staging of penile tumors there are few anatomical studies of the penis. The vast majority of primary carcinomas affect the distal penis, mostly glans or foreskin, but a small percentage arises in the coronal sulcus, a *cul-de-sac* located in the distal penis between the glans corona and the inner foreskin. Microanatomy of glans and foreskin has been previously described in detail but we found no studies about the histology of coronal sulcus. Twelve penectomy specimens with unaffected coronal sulcus were selected from a larger series of patients with penile carcinomas. Microscopically, the histological layers of the coronal sulcus varied from 3 to 4. In 5 cases (42%) the 3 anatomical levels observed were a squamous epithelium, a lamina propria and the connective tissue corresponding to the penile fascia. In the remainder 7 cases (58%) fascicles of smooth muscle corresponding to the dartos layer were noted between the lamina propria and the penile fascia adding up a total of four layers. Our findings may have prognostic implications for carcinomas predominantly or exclusively affecting the coronal sulcus and suggest that in the absence of a dartos layer, penile carcinomas would infiltrate more rapidly the penile fascia, a known low-resistance pathway for local spread. In these situations is reasonable to expect a higher risk for tumor recurrence and inguinal involvement and a worse outcome.

Keywords: penis anatomy; penile cancer; coronal sulcus.

INTRODUCTION

There are few anatomical studies of the penis and most of them are based on cadaver specimens. The vast majority of these studies focuses purely on the morphological features out of their pathological context or do not highlight their importance for the proper surgical management of penile lesions. This anatomical approach is particularly important in the staging and treatment of penile tumors. Carcinomas of the penis are considered a rare disease in the United States, Canada and Europe but it is fairly prevalent in some regions of the world such as South America, Africa and Asia. The majority of penile carcinomas originate in the distal penis, mostly in the glans (about 80% of all primary tumors) but some cases are restricted to the foreskin or coronal (also named balanopreputial sulcus). Previous

studies have shown that depth of invasion and anatomical level of maximum tumor infiltration are, among others, important prognostic factors for predicting inguinal nodal metastasis and, ultimately, survival. Since most carcinomas originate in the distal penis the proper knowledge of the microanatomy at this region may be relevant for therapeutic planning and risk estimation of regional spread. Anatomical levels of the glans and foreskin have been previously described but we found no studies of the coronal sulcus microanatomy. The aims of this study are to describe the anatomical levels present in the coronal sulcus and to highlight the possible implications of this knowledge for the staging and management of penile carcinomas affecting this region.

MATERIALS AND METHODS

Forty formalin-fixed specimens corresponding to partial or total penectomies for penile carcinomas were retrieved from the files of the Instituto de Patología e Investigación (Asunción, Paraguay). Museum specimens consisted in penectomy halves. In 28 cases the coronal sulcus region was available but it was grossly replaced by penile carcinoma and hence excluded from the study. In the remainder 12 cases the anatomical boundaries of the coronal sulcus were intact, uninvolved by tumor. In these specimens 2-4 parallel dorsal and ventral sections were submitted for histological evaluation. Tissues were embedded in paraffin and stained with H&E. Each section included adjacent glans and foreskin compartments.

RESULTS

Grossly the coronal sulcus was a narrow and circumferential cul-de-sac located between the proximal glans corona and the distal foreskin inner mucosa (Figure 1). In penectomies halves the sulcus was present in both dorsal and ventral portions of the distal penis although in the ventral midline it was interrupted by the insertion of the frenulum. The frenulum, a mucosal fold fixing the foreskin to the inferior portion of the glans, was located just below the slit-like opening of the meatus urethralis. The soft pink mucosa of the glans continued to cover this region as well as the inner surface of the foreskin.

Microscopically we found 2 different groups of cases, one composed of 3 and the other of 4 histological layers. In 5 cases (42%) the 3 anatomical levels observed were a squamous epithelium, a lamina propria and the connective tissue corresponding to the penile fascia. In the remainder 7 cases (58%) fascicles of smooth muscle corresponding to the dartos layer were noted between the lamina propria and the penile fascia adding up a total of four layers (Figure 2). The squamous epithelium corresponded to a stratified epithelium covered by a thin keratinized stratum, and composed of prickle cells (5-12 cells thick) with abundant eosinophilic cytoplasm, and rounded nuclei with a visible nucleoli (Figure 3). Evident intercellular bridges separated the squamous cells and cellular boundaries were well-defined. In the basal layer epithelial cells were smaller and darker and a well-developed basement membrane was noted underneath.

The lamina propria was composed of loose connective tissue containing numerous capillary and lymphatic vessels as well as peripheral nerves (see Figure 3). Paccini bodies, although rare, were also present. The thickness of lamina propria varied from 2 to 6 mm.

The limits between lamina propria and penile fascia were not sharply delineated. The penile (also named Buck's) fascia was composed of fibrous connective tissue containing small and medium sized blood vessels, peripheral nerves and occasional adipocytes (Figure 4). Finally, the dartos layer, a wide and loose layer (6-15 mm thick) surrounding the coronal sulcus (see Figure 3), showed fibrous connective tissue, small blood and lymphatic vessels, and irregular bundles of smooth muscle (Figure 5). This layer, when present, extended from the shaft and continued to the foreskin (see Figure 2).

DISCUSSION

Anatomical studies made from the point of view of the surgical pathologist differ from the usual descriptive and topographic post mortem evaluation in the emphasis given to some particular anatomical features that are related to specific pathological issues. In the present study we were concerned about the lack of information regarding the microscopic anatomy of the coronal sulcus which may be of utility to handle specimens with penile carcinomas originating in this region. Carcinomas exclusive of the coronal sulcus are very rare and we found no reports on the subject. However, in our experience we have encountered several such cases and the interpretation of tumor thickness and invasion of the anatomical levels were problematic. It is known that in penile carcinomas there is a gradient correlation of depth of invasion, tumor thickness and penetration of anatomical levels, and prognosis. Previous studies have shown the value of determining the maximum level of tumor invasion for predicting regional metastasis and survival in carcinomas exclusive of the glans or foreskin, especially when combined with other pathological factors such as histological grade and perineural invasion. Therefore, the same approach may be useful in those unusual penile carcinomas originating and limited to the coronal sulcus.

Although more studies are needed to corroborate an apparently frequent anatomic variation in the coronal sulcus layers it is noteworthy the absence of a dartos layer in almost one-half of all cases in this series. We are not certain about the implications of such anatomical variation but, since in this situation the lamina propria merges imperceptibly with the penile fascia, it is reasonable to assume that in those cases tumors may progress more rapidly. The penile fascia, probably because its high vascularity and innervation, is a frequent site of surgical margin involvement and may act as a facilitator to tumor progression. Although there is no previous demonstration of the dartos layer acting as a barrier to tumor spread we hypothesize that patients

with carcinomas involving the coronal sulcus may have different risks for local spread depending on the presence or absence of a limiting dartos layer between lamina propria and penile fascia. A study of a series of patients with such tumors will be of great interest. By analogy with carcinomas of other sites, the knowledge of the histological layers of the coronal sulcus will allow a better evaluation of the true anatomical point of maximum tumor infiltration. This information may then be used to predict the likelihood of inguinal involvement and to tailor the optimal management of the disease for each particular case.

In summary, the histological layers of the coronal sulcus varied from 3 to 4. In more than one-half of all cases a dartos layer separated lamina propria from

penile fascia. However, this layer was absent in 42% of the specimens. This finding may have prognostic implications for carcinomas predominantly or exclusively affecting the coronal sulcus. We suggest that in the absence of a dartos layer penile carcinomas would infiltrate more rapidly the Buck's fascia which is a low-resistance pathway for local spread. In these situations is reasonable to expect a higher risk for tumor recurrence and inguinal involvement and a worse outcome.

ACKNOWLEDGMENTS

We are thankful to ML Ruiz Díaz, E Torres, and L Sanabria for the help in gathering data for this study.

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