Original Article

Defining the Cervical Transformation Zone and Squamocolumnar Junction: Can We Reach a Common Colposcopic and Histologic Definition?

Olaf Reich, M.D., Sigrid Regauer, M.D., W.G. McCluggage, M.D., Christine Bergeron, M.D., and Charles Redman, M.D.

Summary: Quality assurance and research in colposcopy and cervical pathology require standardized terminologies and reporting. However, clinical and histologic definitions of the cervical transformation zone (TZ) and squamocolumnar junction (SCJ) vary considerably. We aimed to identify areas of agreement and areas where work is required to standardize the definitions of the TZ and the SCJ. We conducted a survey among the board members of the European Federation of Colposcopy member societies and members of the International Society of Gynecological Pathologists. Overall, 22 expert colposcopists and 34 gynecologic pathologists responded. There was broad agreement that the TZ is the area where squamous metaplasia has occurred. There was consensus that the original SCJ can appear colposcopically indistinct in cases of maturation of the metaplastic squamous epithelium but can be identified histologically by the presence of the so-called last cervical gland. It was agreed that the border between the metaplastic squamous epithelium and the columnar epithelium on the surface of the cervix is called the new SCJ. Areas where work is required include the questions as to whether the cervical crypts lined by columnar epithelium in the field of squamous metaplasia are an integral part of the TZ or not and whether the individual microscopic borders between the metaplastic squamous epithelium of glandular crypts and the residual columnar epithelium of glandular crypts should be considered as part of the new SCJ or not. This paper is a step in an attempt to standardize colposcopic and histologic definitions among colposcopists and pathologists. Key Words: Cervix—Transformation zone—Squamocolumnar junction—Quality assurance—Terminology.

The concept of transformation from a glandular epithelium to a squamous epithelium (squamous metaplasia) is central to the understanding of the pathogenesis of cervical squamous cell carcinomas. The distribution of squamous cervical cancer precursors correlates with the extent of the transformed metaplastic squamous epithelium, typically referred to as the transformation zone (TZ) (1,2). The original squamocolumnar junction (SCJ) represents the border between the original squamous epithelium and the metaplastic squamous epithelium of the TZ. The border between the transformed metaplastic squamous epithelium of the TZ and the mucinous columnar epithelium of the cervix is the new SCJ (1,2). Within the TZ, the World Health Organization (3) recognizes two types of high-grade squamous intraepithelial lesion (HSIL): classic HSIL and thin HSIL (3). Classic HSIL develops through a low-grade squamous intraepithelial lesion in mature stratified metaplastic squamous
epithelium of the TZ and in the original squamous epithelium of the cervix (3,4). Thin HSIL can develop in early metaplastic squamous epithelium of the TZ near the new SCJ without anteceding low-grade squamous intraepithelial lesion (5,6). Clinical documentation of whether the SCJ between the metaplastic squamous epithelium and the columnar epithelium can be visualized is important and is a quality indicator for colposcopy (7,8). The location of a lesion in relation to the TZ was reintroduced in the 2011 International Federation for Cervical Pathology and Colposcopy (IFCPC) colposcopic terminology (7,9).

Quality assurance and research in colposcopy and cervical pathology require standard terminologies and reporting. However, clinical and histologic definitions of the TZ and the SCJ vary considerably (1–3,7,10,11). At present, the most commonly used colposcopic definition of the TZ refers to the area where transformation has occurred, in other words the area of metaplastic epithelium between the original SCJ and the new SCJ (1,2,7). It refers to the columnar epithelium that has undergone metaplastic transformation into immature and mature squamous epithelium. Some colposcopists, however, refer to the TZ as the area where squamous metaplasia potentially may occur (10), rather than the area where squamous metaplasia has already occurred. Following this definition, the TZ would extend from the original SCJ all the way across the cervix and along the endocervix to the epithelium of the uterine isthmus. In histopathology practice, the term TZ usually refers to the area where squamous metaplasia has occurred. It may involve the surface epithelium and/or the crypts and can consist of immature and/or mature stratified metaplastic squamous epithelium. Metaplasia may be a focal process, and metaplastic squamous epithelium may be bordered by mucin-producing columnar epithelium, both on the surface and in the glands (Figs. 1, 2). Given these variations, we undertook a survey of board members of the European Federation for Colposcopy (EFC) member societies and members of the International Society of Gynecological Pathologists (ISGyP). The aim was to identify areas of agreement and areas where work is required to standardize definitions of the cervical TZ and the SCJ.

**METHODS**

This internet-based survey was conducted among board members of EFC member societies and members of the ISGyP. The EFC comprises 30 member states and 5 associate member countries; the ISGyP is an international community of gynecologic pathologists. Board members of the national EFC member societies were circulated a consensus definition of the TZ and the SCJ, and were asked about the strength of agreement or disagreement (Table 1). ISGyP members were circulated different histologic definitions of the TZ (Table 2) and the SCJ (Tables 3, 4) available in the literature and were asked to identify the definition they considered best.

**RESULTS**

Overall, 22/35 (63%) member states and associated member countries of EFC responded. Of them, 16/22 (73%) reported complete agreement with the proposed colposcopic definitions of the TZ and the SCJ, and 6/22 (27%) suggested changes (Table 1). A total of 34 ISGyP members undertook the survey. Most ISGyP
members agreed that the TZ is the area where squamous metaplasia has occurred. Of them, 3/34 (9%) ISGyP members defined the TZ as an area in which transformation will potentially occur (Table 2). The answers (Table 2) yielded little agreement on the questions of whether the cervical crypts lined by columnar epithelium in the field of squamous metaplasia are an integral part of the TZ or not. In detail, 11/34 (32%) ISGyP members agreed that the cervical crypts lined by columnar epithelium in the field of squamous metaplasia are an integral part of the TZ; 10/34 (29%) did not agree and 8/34 (25%) were undecided. A total of 29/34 (85%) ISGyP members agreed that the new SCJ is the border between the metaplastic squamous epithelium and the mucin-producing columnar epithelium (Table 4). Following critical discussion, the authors of this paper suggest using the following colposcopic and histologic definitions of the TZ and the original and new SCJ, which take into account the survey results. These definitions are schematically illustrated in Figure 1.

**Colposcopic Definitions**

**TZ**

TZ is an area that extends from the smooth original squamous epithelium to the dark red columnar epithelium of the cervix. On examination,
it can appear as a nonspecific red area, but application of acetic acid turns the red epithelium grayish-white depending on the degree of maturity of the metaplastic epithelium. The TZ often shows openings of cervical glands, ovuli Nabothi, small islands of residual columnar epithelium, and a fine vascular pattern.

The original SCJ is the border between the smooth original squamous epithelium and the squamous epithelium of the TZ after application of acetic acid. Colposcopically it can appear indistinct.

The new SCJ is typically a sharp and step-like colposcopic border between the TZ and the glandular epithelium after application of acetic acid.

**Histologic Definitions**

**TZ**
Histologically the term TZ refers to the area where squamous metaplasia has occurred. It may involve the surface epithelium and/or the crypts and may consist of immature and/or mature stratified metaplastic squamous epithelium. Metaplasia may be a focal process and metaplastic squamous epithelium may be bordered by mucin-producing columnar epithelium, both on the surface and in glands.

**New SCJ**
The new SCJ is typically a sharp and step-like colposcopic border between the TZ and the columnar epithelium after application of acetic acid.

**TABLE 1. Colposcopic definitions of the TZ and the SCJ submitted to board members of EFC member societies**

<table>
<thead>
<tr>
<th>Definition</th>
<th>n (%)</th>
<th>Changes required</th>
</tr>
</thead>
<tbody>
<tr>
<td>The TZ is an area extending from the smooth original squamous epithelium to the dark red columnar epithelium of the cervix. The TZ often shows openings of cervical glands, ovuli Nabothi, small islands of residual columnar epithelium, and fine vascular pattern. It can appear as a nonspecific red area, but application of acetic acid turns the red epithelium grayish-white.</td>
<td>16 (73)</td>
<td>6 (27)</td>
</tr>
<tr>
<td>The original SCJ is the border between the smooth original squamous epithelium and the squamous epithelium of the TZ after application of acetic acid. Colposcopically it can appear indistinct.</td>
<td>19 (86)</td>
<td>3 (14)</td>
</tr>
<tr>
<td>The new SCJ is usually a sharp and step-like colposcopic border between the TZ and the glandular epithelium after application of acetic acid</td>
<td>20 (91)</td>
<td>2 (9)</td>
</tr>
</tbody>
</table>

EFC indicates European Federation for Colposcopy; SCJ, squamocolumnar junction; TZ, transformation zone.

**TABLE 2. Histologic definitions of the TZ submitted to members of the ISGyP**

<table>
<thead>
<tr>
<th>Definition</th>
<th>Agreed [n (%)]</th>
<th>Changes required</th>
</tr>
</thead>
<tbody>
<tr>
<td>The TZ is where squamous metaplasia occurs. It extends from the original nonkeratinizing squamous epithelium of the ectocervix to the mucin-producing columnar epithelium of the endocervix. The columnar epithelium underneath the metaplastic epithelium is part of the TZ</td>
<td>11 (32)</td>
<td></td>
</tr>
<tr>
<td>The TZ is where squamous metaplasia occurs. It extends from the original nonkeratinizing squamous epithelium to the mucin-producing columnar epithelium of the cervix. The columnar epithelium underneath the metaplastic epithelium is not part of the TZ</td>
<td>10 (29)</td>
<td></td>
</tr>
<tr>
<td>The TZ is the zone in which transformation will potentially occur. It is characterized by the presence of metaplastic squamous epithelium, which may extend not only across the ectocervix but also to within the cervical canal (10)</td>
<td>3 (9)</td>
<td></td>
</tr>
<tr>
<td>The TZ is the zone between the original and current SCJ and the area around that junction where the epithelium is thinnest (3)</td>
<td>1 (3)</td>
<td></td>
</tr>
<tr>
<td>The TZ consists of surface squamous epithelium in continuity with surface columnar epithelium (SCJ) (11)</td>
<td>1 (3)</td>
<td></td>
</tr>
</tbody>
</table>

ISGyP indicates International Society of Gynecological Pathologists; SCJ, squamocolumnar junction; TZ, transformation zone.

**TABLE 3. Histologic definitions of the original SCJ submitted to members of the ISGyP**

<table>
<thead>
<tr>
<th>Definition</th>
<th>Agreed</th>
<th>Changes required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original SCJ is the border between the original squamous epithelium and the original columnar epithelium (2)</td>
<td>29 (85)</td>
<td>5 (15)</td>
</tr>
</tbody>
</table>

ISGyP indicates International Society of Gynecological Pathologists; SCJ, squamocolumnar junction.

**TABLE 4. Histologic definitions of the new SCJ submitted to members of the ISGyP**

<table>
<thead>
<tr>
<th>Definition</th>
<th>Agreed</th>
<th>Changes required</th>
</tr>
</thead>
<tbody>
<tr>
<td>New SCJ is the border between the metaplastic squamous epithelium and the mucin-producing columnar epithelium (2)</td>
<td>32 (94)</td>
<td>2 (6)</td>
</tr>
</tbody>
</table>

ISGyP indicates International Society of Gynecological Pathologists; SCJ, squamocolumnar junction.
**DISCUSSION**

We present suggestions for colposcopic and histologic definitions with respect to the terms TZ and SCJ. This survey identified areas of agreement and areas where work is required to achieve scientifically sound and clinically workable definitions.

There was broad agreement between the expert colposcopists that the original SCJ can appear colposcopically indistinct in cases of maturation of the metaplastic squamous epithelium but can be identified histologically by the presence of the so-called last cervical gland. It was agreed that the border between the metaplastic squamous epithelium and the columnar epithelium on the surface of the cervix is called the new SCJ (Table 1). The responses showed a broad agreement between gynecologic pathologists that the TZ is the area where squamous metaplasia has occurred (Table 2). Biopsies obtained from the TZ may show the following structures: mature and immature squamous surface epithelium, crypts lined by columnar and by mature and immature metaplastic squamous epithelium, and the intervening vascularized stroma (Fig. 1).

The suggestions for colposcopic and histologic definitions of the TZ and the SCJ (see the Results section) are based on the principle that in human prenatal life, a dual mechanism for cervical epithelialization is seen: the epithelium of the vaginal fornices and the original squamous epithelium of the cervix up to the original SCJ is of vaginal Mullerian origin, whereas the columnar epithelium of the cervix is of uterine Mullerian origin (12,13). The original SCJ can be recognized within the cervical canal from week 24 onwards. In late fetal life, columnar epithelium invaginates from the surface of the cervix into the underlying stroma to develop cervical glands. These glands migrate in a caudal and oblique direction. Consequently, the original SCJ descends toward the ectocervix to produce an ectopy in newborns (12,13). The original SCJ is a lifelong anatomic landmark defined by the so-called last cervical gland, a concept introduced by Hamperl et al. (14). The term transformation refers to metaplastic transformation of columnar epithelium to squamous epithelium (squamous metaplasia), which occurs after menarche due to vaginal pH changes, hormonal changes, mechanical irritation, and chronic inflammation (1,2). The SCJ is thus shifted by the development of the TZ to some distance from the original SCJ, resulting in a new SCJ (15). In consequence, the original SCJ represents the anatomic landmark between the original squamous epithelium and the metaplastic squamous epithelium of the TZ, whereas the new SCJ separates the metaplastic squamous epithelium of the TZ and the columnar epithelium.

The survey also demonstrated the difficulties in reconciliation between colposcopic and histologic definitions (Fig. 1): colposcopically, only the surface of the cervix can be seen; in other words, only 2 dimensions can be visualized. In biopsies, however, another (third) dimension becomes visible, namely, the tissue underneath the surface epithelium of the cervix consisting of stroma and glandular crypts. Colposcopy and histology can show multifocal patches of remnant columnar epithelium between areas of squamous metaplasia both on the surface and also within the glandular crypts. Each of these patches features its own microscopic SCJ (Figs. 1, 2). The existence of these multiple microscopic junctions throughout the TZ has not been addressed in the recent literature on the SCJ (16–22).

Areas where further work is required include the questions of whether the cervical crypts lined by columnar epithelium in the field of squamous metaplasia are an integral part of the TZ or not and whether the individual microscopic borders between the metaplastic squamous epithelium of glandular crypts and the residual columnar epithelium of glandular crypts should be considered as part of the new SCJ or not.

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**REFERENCES**