Human papillomavirus (HPV) genotype distribution in women with abnormal cervical cytology in the Basque Country, Spain

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\textbf{ABSTRACT}

\textit{Introduction:} The aim of this study was to analyze the distribution of human papillomavirus (HPV) genotypes in cytologically abnormal cervical samples from 106 women living in a region of the north of Spain.

\textit{Methods:} Cytological classification was reported according to the 2001 Bethesda System and HPV genotyping was performed by Roche Linear Array.

\textit{Results:} The overall HPV prevalence was 69.8% with 30 different HPV genotypes detected. The prevalence of HR (high-risk) HPV types and pHR (probable high-risk) HPV types in positive samples was 94.3%, 78.1% and 100% in patients with ASCUS, LSIL and HSIL/CC, respectively, with no significant differences. The most frequent type was the HPV 16, present in 29.7% of all positive samples, followed by HPV 51 (17.5%), HPV 53 and 42 (16%), HPV 52 (12%), HPV 39 (10.8%), HPV 18 and 58 (9.4%) and HPV 66 (8.1%). No significant differences in the percentage of any HPV genotype with the grade of the cytological lesion were detected. The prevalence of HPV co-infection was 58.1% of HPV positive.

\textit{Conclusions:} This study confirms the high prevalence of high-risk genotypes in women with abnormal cytology living in our geographical area. This information may be useful for the formulation of algorithms for patient management according to the different risks associated with specific high-risk genotypes.

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\textbf{Distribución de genotipos del virus del papiloma humano en mujeres con citología de cérvix anormal en el País Vasco, España}

\textbf{RESUMEN}

\textit{Introducción:} El objetivo de este estudio es analizar la distribución de genotipos del virus del papiloma humano (HPV) en citologías anormales de cérvix de 106 mujeres residentes en una región del norte de España.

\textit{Métodos:} La clasificación de las citologías se realizó mediante el sistema Bethesda 2001 y el genotipado del HPV por el sistema Linear Array de Roche.

\textit{Resultados:} La prevalencia del HPV fue del 69,8% y se detectaron 30 genotipos distintos de HPV. La prevalencia de genotipos de alto riesgo y probable alto riesgo en las muestras positivas fue del 94,3, 78,1 y 100% en pacientes con ASCUS, LSIL y HSIL/CC, respectivamente, sin alcanzar significación estadística. El genotipo 16 fue el más frecuente (29,7% de todas las muestras positivas), seguido por los genotipos HPV 51 (17,5%), HPV 53 y 42 (16%), HPV 52 (12%), HPV 39 (10,8%), HPV 18 y 58 (9,4%) y HPV 66 (8,1%). Para ningún genotipo se observó diferencia en la prevalencia dependiendo del grado de citología. La prevalencia de coinfección fue del 58,1% de los casos positivos.

\textit{Conclusión:} Este estudio confirma la alta prevalencia de los genotipos de alto riesgo en mujeres con citología anormal residentes en nuestra área geográfica. La información obtenida puede ser útil en la elaboración de algoritmos para la gestión de pacientes en función del riesgo asociado a genotipos específicos de alto riesgo.

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Introduction

Genital human papillomavirus (HPV) infection is considered to be one of the most common sexually transmitted infections (STIs) worldwide and has been associated with cervical cancer, the second most common cancer in women with ages ranging from 15 to 44 years. The worldwide HPV prevalence in women with normal cytology is estimated to be 10.4%. The prevalence of infection varies greatly, being dependent on the target population, age distribution and the severity of the disease. In Spain, the prevalence in women with normal cytology ranges from 3% to 8.3%, depending on the geographical area; these values are similar to those in the surrounding countries, such as Italy, with prevalence data of around 7%. The prevalence is higher in Latin American women living in Spain (21% in Argentinians and 27% in Colombians). According to a recent study, prevalence is even higher in several high-risk groups such as commercial sex workers and women in prison, being 29.9% in Spaniards, 23.1% in migrant Africans and 32.8% in migrant Latin Americans belonging to these risk groups.

More than 100 genotypes of HPV have currently been identified based on the nucleotide sequences comparison of specific regions, such as coding regions of E6, E7 and L1 proteins. In Spain, HPV types 16, 31, 52, 68, 51, 53, 18, 33, 45, 56 and 66 were most common in women from the general population. A retrospective cross-sectional worldwide study including 10,575 cases of invasive cervical cancer from 38 countries in five continents has shown that HPV types 16, 18 and 45 were the three most common types in each histological group (squamous cell carcinoma, adenocarcinoma and adenosquamous cell carcinoma). Invasive cervical cancers associated with types 16, 18 and 45, irrespective of the histological type, are diagnosed at a much younger age (<50 years), and at an average of 4 years earlier than are those caused by other high-risk HPV types. The HPV prevalence increases as the grade of the cytological lesion increases. Knowledge of the distribution of HPV types in patients with cervical abnormalities in a specific area could contribute to providing information regarding regional variations in the HPV type spectrum, to evaluating the level of cross-protection between related HPV types, and to designing second generation multivalent vaccines targeting the HPV types that predominate in different geographical areas.

The main aim of this study was to assess the prevalence of single HPV and multiple HPV in a cohort of 106 women with cytological abnormalities and its association with squamous intra-epithelial lesions (SIL). HPV genotyping was performed on cell suspensions from the cervix by Roche Linear Array which differentiates 37 HPV genotypes. The HPV genotype distribution has been compared to that obtained in other Spanish regions.

Methods

Sample collection and processing

From January 2009 to January 2010, 106 consecutive women attending the Gynaecology Outpatients Clinic of Santiago Hospital in Vitoria (capital of the Basque Country, Spain) were prospectively enrolled. These women were referred for HPV testing due to an abnormal Papanicolaou smear. The population studied was considered as being at a low epidemiological risk, and all cases came from screening programs (secondary screening) implemented by their local health services. A single cytological sample per woman was studied. The women were stratified by age groups: 18–25 years (n = 28), 26–35 (n = 35), 36–45 (n = 27) and >45 (n = 16). Cytological classification was reported according to the 2001 Bethesda System, scoring as atypical squamous cells of undetermined significance (ASCUS), low grade squamous intra-epithelial lesion (LSIL), high-grade intra-epithelial lesion and cervical carcinoma (HSIL/CC).

The mean age of the 106 women included in the study was 33.6 ± 10.6 years (range 18–68). Fifty-seven (53.8%) patients had an ASCUS lesion, 40 (37.5%) an LSIL, 8 (7.5%) an HSIL and 1 patient had cervical cancer (Table 1).

HPV DNA detection

Cervical cells samples were obtained with an endocervical cytobrush, and placed into 20 ml of PreservCyt Solution (Cytomyx Corporation, USA). A ThinPrep slide (Cytomix Corporation, USA) was prepared from the cytology specimen and this was used for HPV testing by Linear Array HPV Genotyping Test (Roche Diagnostics, USA). One aliquot was removed from each 20 ml of PreservCyt vial before cytology analysis with a ThinPrep slide. For isolation of nucleic acid, 850 μl of material was used with an AmpliLute Liquid Media Extraction kit (Roche) and was performed on the automated COBAS AmpliPrep (Roche Diagnostics, USA) assay system according to the manufacturer’s protocol. Nucleic acid was resuspended in a final volume of 85 μl; 50 μl was used for PCR analysis.

The Linear Array HPV Genotyping Test (Roche Diagnostics, USA) employs biotinylated primers (PGMY) to define a sequence of nucleotides within the polymorphic L1 region of the HPV genome that is approximately 450 base pairs long. A pool of HPV primers is used to amplify HPV DNA from 37 HPV genotypes (types 6, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, 52, 53, 54, 56, 57, 58, 59, 61, 62, 64, 66, 67, 68, 69, 70, 71, 72, 73, 81, 82, 83, 84, IS39 and CP6108). An additional primer pair targets the human β-globin gene as a control for cell adequacy; extraction and amplification were also used. Amplification was performed following the manufacturer’s instructions. The resulting PCR product was reverse hybridized to genotype-specific probes immobilized as parallel lines on a nitrocellulose strip. The hybridization reaction and detection were carried out with the automated ProfiBlot T48 (Tecan, Switzerland) according to the manufacturer’s instructions. The Linear Array HPV Genotyping strips were read visually by comparing the pattern of blue lines with the Reference Guide and the results were evaluated by two of the authors (A.C. and J.L.B.). Thirty-seven HPV genotypes can be identified simultaneously in a single hybridization step. An unambiguous, continuous band was judged to indicate that amplions had hybridized to complementary sequences of the probes bound to strips and was considered a positive result. For this analysis, we considered types 16, 18, 31, 33, 35, 39, 40, 45, 51, 52, 56, 58, 59, 69, 73 and 82 to be high-risk types (HR HPV). Types 26, 53, 66 are considered to be probable high-risk types (pHR HPV) and types 34, 57, 62, 71, 83, 84, 85 and 89 as undetermined-risk types. The rest of the genotypes are considered to be low-risk types.

Statistical analysis

For statistical analysis we used the WINPEPI Computer Programs for Epidemiologists (Abramson, J.H. Epidemiologic Perspectives and Innovations 2011, version 11.3). Contingency tables were used to assess the degree of association between variables and Pearson’s chi-squared test was performed to determine the level of statistical significance. Statistical significance was defined as p < 0.05.

Results

HPV DNA was detected in 74 out of the 106 women studied (69.8%). The prevalence increased with the increasing grade of the cytological lesion (Table 1), although it was not significant.

The prevalence of HR HPV types and pHR HPV types in positive samples was 94.3%, 78.1% and 100% in patients with ASCUS, LSIL and HSIL/CC, respectively. No significant differences were detected.
In this study, genotype 16 reached 29.7% of the cases. How-
Table 3
HPV prevalence and HPV co-infections by age distribution.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>HPV positive, n (%)</th>
<th>Cytology samples with HR HPV, pHR PV and UR HPV, n (%)</th>
<th>HPV 16</th>
<th>HPV 51</th>
<th>HPV 53</th>
<th>Cytology samples with LR HPV, n (%)</th>
<th>Multiple infection, n (%)&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–25 years (n=28)</td>
<td>24 (85.7)</td>
<td>22 (91.6)</td>
<td>4 (16.7)</td>
<td>8 (33.3)</td>
<td>5 (20.8)</td>
<td>2 (8.4)</td>
<td>15 (62.5)</td>
</tr>
<tr>
<td>26–35 years (n=35)</td>
<td>23 (65.7)</td>
<td>19 (82.6)</td>
<td>9 (39.1)</td>
<td>3 (13.04)</td>
<td>3 (13.04)</td>
<td>4 (17.4)</td>
<td>14 (60.8)</td>
</tr>
<tr>
<td>36–45 years (n=27)</td>
<td>19 (70.4)</td>
<td>18 (94.7)</td>
<td>7 (36.8)</td>
<td>2 (10.54)</td>
<td>4 (21.05)</td>
<td>1 (5.3)</td>
<td>12 (63)</td>
</tr>
<tr>
<td>&gt;45 years (n=16)</td>
<td>8 (50)</td>
<td>8 (100)</td>
<td>2 (25)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>2 (25)</td>
</tr>
<tr>
<td>Total (n=106)</td>
<td>74 (69.8)</td>
<td>67 (90.5)</td>
<td>22 (29.7)</td>
<td>13 (17.5)</td>
<td>12 (16.2)</td>
<td>7 (9.5)</td>
<td>43 (58.1)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Percentage of the total.

<sup>b</sup> Percentage of HPV-positives.

<sup>c</sup> Percentage of HPV-positives in age group.

<sup>d</sup> Percentage of total of single HPV infections.

<sup>e</sup> Percentage of HPV positive. HR HPV (high-risk types), pHR PV (probable high-risk types), UR HPV (undetermined-risk types) and LR HPV (low-risk types).

<sup>*</sup> P<0.05.

Table 4
Prevalence of HPV coinfections per cytological lesion type.

<table>
<thead>
<tr>
<th>Lesion Type</th>
<th>ASCUS (n=57)</th>
<th>LSIL (n=40)</th>
<th>HSIL/CC (n=9)</th>
<th>Total (n=106)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPV-positive</td>
<td>35</td>
<td>32</td>
<td>7</td>
<td>74</td>
</tr>
<tr>
<td>HPV co-infections, n (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19 (54.3)</td>
<td>22 (68.6)</td>
<td>2 (28.5)</td>
<td>43 (58.1)</td>
</tr>
<tr>
<td>2 genotypes, n (%)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8 (42.1)</td>
<td>12 (54.5)</td>
<td>1 (50)</td>
<td>21 (48.8)</td>
</tr>
<tr>
<td>3 genotypes, n (%)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5 (26.3)</td>
<td>4 (18.1)</td>
<td>1 (50)</td>
<td>10 (23.3)</td>
</tr>
<tr>
<td>4 genotypes, n (%)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6 (31.6)</td>
<td>3 (13.7)</td>
<td>0</td>
<td>9 (40.9)</td>
</tr>
<tr>
<td>&gt;4 genotypes, n (%)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0</td>
<td>3 (13.7)</td>
<td>0</td>
<td>3 (7)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Percentage of HPV-positives.

<sup>b</sup> Percentage of HPV coinfections. ASCUS (atypical squamous cells of undetermined significance), LSIL (low grade squamous intra-epithelial lesion), HSIL (high-grade intra-epithelial lesion) and CC (cervical cancer).

Fig. 1. Distribution of HPV genotypes according to the study design, the background of the women included and the Spanish geographical area.
In our study, 30 different HPV types were identified, and HPV types not included in commercial vaccines were detected more frequently than viruses included in the vaccines. Most of these viral genotypes had an oncogenic character; this is consistent with other studies performed in our country, both in screening studies and in women with abnormal cytology.

Differences in the relative prevalence of HPV types might be related to the complex interplay between different HPV genotypes with host immunogenetic factors, or due to impairment in cellular immunity. Another explanation is that the use of different sets of primers in HPV PCR methods does not amplify all genotypes with exactly the same sensitivity.

Although it is known that the infection by oncogenic types of HPV increases with the grade of the cytological lesion and in 5.1% of women with low-grade lesions, whereas type 45 was found in 0.3% of women with normal cytology and in 2.5% of women with low-grade lesions; this compares with HPV 16 (2.3% and 19.4%, respectively). The under-representation of HPV 18 and HPV 45 detected in pre-neoplastic lesions and the early presentation of cases of invasive cervical cancer that are positive for genotypes 18, 45, and not only the genotype 16, may be indicative of a short time of progression to invasive cancer, with or without transition through the pre-invasive stages and lends support to a high early integration rate into the human genome. Interestingly, one or more of genotypes 16, 18 and 45 were detected in a quarter of the women with ASCUS and in a third of the women with LSIL. It is important to note that these genotypes are related to developing cancer at a much younger age (<50 years) than other types.

It is well known that the prevalence of HPV infection and the occurrence of multiple infection decrease with an increase in age. In our study, the prevalence of HPV co-infections peaked in women with LSILs. Among authors who have reported the percentage of coinfection associated with the cytological lesion, most described a peak in women with mild to moderate abnormalities: ASCUS or LSIL who are positive for these genotypes in the Linear Array HPV genotyping should be offered an increase in surveillance, and severity of the lesion was detected. However, whether the co-infection implies a higher risk of cancer is still unresolved.

Persistent HPV increases the risk of cervical abnormalities and women with short-term persistent HPV 16 are at high risk for cervical intraepithelial neoplasia grade 2 (CIN2) and grade 3 (CIN3), although the persistence alone is not sufficient for carcinogenicity of the cervix. Most incidents of infection in young women either clear or demonstrate CIN3 within five years. CIN3 lesions can develop very quickly (within 2–3 years) following HPV exposure. CIN3 lesions are initially very small and it takes years for them to grow enough for detection by cytology and then colposcopy. Following HPV infection, prognosis is significantly linked to the HPV type. The early presentation of cases of invasive cervical cancer that were positive for HPV 16, 18 or 45 suggests that women with ASCUS or LSIL who are positive for these genotypes in the Linear Array HPV genotyping should be offered an increase in surveillance, including the endocervical zone, which is the site of most adenocarcinomas, or more aggressive management in selected patients at risk of loss-to-follow-up. A study with primers does not amplify all genotypes with exactly the same sensitivity, and such differences remain a source of variation in the detection of genotypes. However, the Linear Array HPV Genotyping Test used in the present study has been studied extensively; it is robust and has been standardized for routine microbiology.


28. http://www.ine.es/inemenu/mnu_cifraspob.htm [01.08.11, date last accessed].


