

RESEARCH ARTICLE

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Comparative Analysis of Quality of Cell Collected from the Cervix: Conventional versus Liquid-Based Cytology

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Abstract

Objectives: To compare the qualitative and quantitative differences in several cell types between conventional cytology and liquid-based cytology samples in patients diagnosed with high-grade cervical intraepithelial neoplasia. **Methods:** A prospective, observational, cross-sectional study was conducted with 84 female patients at Santa Casa de Misericórdia de São Paulo Hospital (São Paulo, Brazil) between May 2019 and November 2020. Patients who underwent colposcopy-guided biopsy and were subsequently diagnosed with high-grade cervical intraepithelial neoplasia were included in this study. After the patients' selection, relevant information, conventional cytology, and liquid-based cytology samples were collected in the same session. **Results:** Liquid-based cytology presented less neutrophilic infiltrate and a clean background, when compared to conventional cytology. We observed a larger amount of cell types (mature, basal, metaplastic, endocervical cells) in conventional cytology when compared to liquid-based cytology, with statistically significant results in all four cell types. We also observed a concordance rate of 90.6% in the cytological diagnosis between conventional and liquid-based cytologies. **Conclusion:** Even though we found a greater amount of cells in conventional cytology, the diagnostic accuracy of both cytologies is similar. Therefore, in places in where conventional cytology is employed as the main screening method, a proper diagnosis is achieved.

Keywords: Human papillomavirus viruses- Uterine cervical neoplasms- Vaginal smears- Cytological Techniques-

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Introduction

According to the American Cancer Society, the estimate of cervical cancer in the United States was 14,100 new cases and 4,280 deaths in 2022 [1]. In Brazil, the estimate of new cases of this type of cancer in 2022 was 16,710 cases, with an estimated risk of 16.35 cases per 100,000 women. In general, cervical cancer is diagnosed after the age of 30, with a rapid increase in risk until reaching the age peak between 50 and 60 years of age [2]. Cervical cancer is directly related to human papillomavirus (HPV) infection; its DNA is found in more than 95% of cases. Certain strains of HPV are responsible for 5% of malignant neoplasms in the world, including cervical and other anogenital cancers (vulva, vagina, penis and anal), as well as oropharynx cancer [3].

As cervical cancer is directly related to HPV infection, primary prevention of this disease is associated with the use of condom (thus avoiding contact with the virus) or vaccination against this virus. Secondary prevention aims the diagnosis of precursor lesions through cervical cytology and/or HPV DNA research, associated with colposcopy when indicated [4]. Cervical cytology has

been employed as an essential public health strategy for detecting pre-neoplastic and neoplastic lesions of the uterine cervix, having contributed to the reduction of morbidity and mortality from this cancer in the world and in Brazil. However, in recent years, several studies have indicated that the HPV DNA test has better sensitivity in screening this type of cancer [5,6].

In Brazil, the public health system recommends cervical cytology for cervical cancer screening, due to the scarcity of financial resources allocated to the public health sector. This screening test is available in two forms: in slide (conventional cytology) and in a liquid medium (liquid-based cytology); however, the second type sometimes is not available in remote areas of Brazil [2].

Some studies have demonstrated that liquid-based cytology presents a smaller number of unsatisfactory samples, as it allows the preparation of a slide with a cleaner background, with no superposition of cells and obscuration of other elements, resulting in a monolayer or thin-layer cytology. However, different research groups have observed similar diagnostic accuracy for both cytological methods [7,8].

It is currently being discussed whether the presence

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of cells representative of the transformation zone (TZ) (endocervical and/or metaplastic cells) in cervical cytology would lead to an improvement in the detection of precancerous and cancerous lesions of the cervix. This fact could be suggested since most of these lesions occur at the squamocolumnar junction, which is the site of origin of these cells [9].

However, distinct studies have reached controversial results regarding the amount of TZ cells in relation to the different types of cytology exams, conventional or liquid-based. In a comparative study, with an analysis of 1,030,482 cytology exams, it was observed that liquid-based cytology had a lower number of TZ cells (52.7%) when compared to conventional cytology (73.2%) [10]. Due to the small number of studies with this evidence, the objective of the present research is to compare the qualitative and quantitative differences of different cell types in samples of conventional and liquid-based cytology collected from the same patients.

Materials and Methods

This was a cross-sectional prospective observational study in which 111 women with a diagnosis of high-grade cervical intraepithelial lesion (CIN2/3), in preparation for conization were selected at Santa Casa de Misericórdia de São Paulo Lower Genital Tract Pathology Outpatients Clinic (São Paulo, Brazil), from May 2019 to November 2020. This study was approved by the Research Ethics Board of the aforementioned hospital, under the number 12763019.8.0000.5479. All patients included in this study have signed an informed consent form.

Patients in menopause, patients with local inflammatory process and vaginal bleeding at the time of examination, unsatisfactory cytology samples, disagreement between cervical cytology and conization histological report, and patients whose conization was recommended by low-grade repetition intraepithelial neoplasia were excluded from this study. Exclusions totaled 27 patients; so 84 patients remained in the study group. The sample calculation was performed using Pearson's correlation, adopting a significance level of 5%, 80% of power and minimum correlation of 0.4. With these numbers in mind, the study sample was established as 47 patients. However, due to the large number of patients treated at the outpatient clinic in the aforementioned period, we favored to include a larger number of participants, in an attempt to increase the statistical power of the study.

Following patient selection, a complete anamnesis was performed (including personal, gynecological, obstetric and sexual history) and all data was transcribed into an individual medical record file. Next, the patients were submitted to a gynecological examination. The cervical cytology collection occurred on the day of the conization, before the surgical procedure. Firstly, material from the ectocervix was collected with an Ayre spatula, and then material from the endocervix was collected with a cytobrush. For the preparation of the conventional cytology slide, cytobrush and spatula contents were smeared each in different halves of the slide, respectively, followed by fixation with a specific spray. Subsequently,

both collection instruments were introduced in a Cell Preserv liquid cytology bottle, shaking each bottle at least ten times, vigorously. The slides were prepared, stained and assessed by two pathologists.

Cell counting was performed using high-power magnification fields (400x). Initially, the number of cells per field was counted in a total of 10 fields; the total number of cells summed in these 10 fields was divided by 10. In this way we obtained the main number of cells in 10 fields. A high-power field is 0.5mm in diameter (D), so we calculated its area with this formula: circle area = $\pi \times (D/2)^2$, where π equals 3.1415; therefore the area of a high-power field equals to 0.196 mm². In order to facilitate the statistical calculations, the number of cells per mm² was obtained.

The fields were randomly assessed, following the premise of selecting those with no overlapping of cells and with good differentiation of the nuclei. In conventional cytology, five fields from the ectocervix area and five fields from the endocervix area were counted. On liquid-based cytology slides, the counting was performed on the entire area. Cells were counted one by one in each field.

Neutrophilic infiltrate was classified as mild, moderate and intense, according to the number of leukocytes per squamous cell in both types of cytology. Mild infiltrate contained from 1 to 3 leukocytes per squamous cell, moderate from 4 to 8 leukocytes per cell, and intense with more than 8 leukocytes per cell. The background of the sample was the area of smear in-between cells. It was classified as clean, proteinaceous (presence of debris, remnants of sloughed cells), mucous and hemorrhagic (presence of red blood cells). The number of abnormal cells was evaluated in high power fields (HPF) under 400 times magnification, counting the number of cells in a field.

Cytological results were classified based on the 2001 Bethesda system into: Negative for Intraepithelial Lesion or Malignancy (NILM) (no cellular abnormality); ASC-US (atypical squamous cells of undetermined significance, possibly non-neoplastic); ASC-H (atypical squamous cells, cannot exclude HSIL); AGC (atypical glandular cells); LSIL (low-grade intraepithelial lesion); HSIL (high grade intraepithelial lesion); invasive SCC (squamous cell carcinoma); AIS (adenocarcinoma in situ); invasive adenocarcinoma; invasive endometrial adenocarcinoma and HSIL cannot exclude microinvasion. Statistical tests were performed according to calculation needs, adopting a significance level of 5%.

Results

The patients' ages ranged from 21 to 54 years, with a mean of 35.68 years (SD±7.8) and a median of 36 years. The percentage of smokers was 20.2% (17 out of 84) and the mean age of sexual activity onset was 16.3 years (SD± 2.0), with a median of 16 years (ranging from 13 to 23 years old). The average number of sexual partners during their active sexual life was 5.3 (SD±4.1), with a median of 4 partners (ranging from 1 to 25 partners). Of the total number of women, 20.2% (17 out of 85) had no steady partner.

Table 1. Mean Amount of Cells in Conventional Cytology and Liquid-based Cytology in Patients Diagnosed with Cervical Intraepithelial Neoplasia, per mm²

	Mature cells	Basal cells	Metaplastic cells	Endocervical cells	CGA
Conventional cytology	149.8	25.9	26,1	26.5	38.2
Liquid-based cytology	69.4	14.9	9,9	8.3	18.7
p value	<0.001	<0.001	<0.001	<0.001	<0.001

Wilcoxon Test; CGA, Abnormal cells

Regarding the presence of neutrophilic infiltrate on the cytology slides, it was absent in 10.7% of the cases (9 out of 84), mild in 77.4% (65 out of 84), moderate in 10.7% (9 out of 84) and intense at 1.2% (1 out of 84), for liquid-based cytology. In conventional cytology, no patients had absence of infiltrate; it was mild in 20.2% (17 out of 84), moderate in 73.8% (62 out of 84) and intense in 6% (5 out of 84). These data suggest that liquid-based cytology presents less neutrophilic infiltrate than the conventional one by cytology.

The background in liquid-based cytology was clean in 89.3% (75 out of 84) of the samples, and proteinaceous in 10.7% (9 out of 84). In conventional cytology, it was clean in 4.8% (4 out of 84) of the samples, mucous in 7.1% (6 out of 84), proteinaceous in 72.6% (61 out of 84) and hemorrhagic in 15.5% (13/84). Thus, we can infer that liquid-based cytology presents a cleaner background than the conventional one.

A greater number of cells in conventional cytology when compared with liquid-based cytology (for all cell types) was observed, with statistical significance of this difference. The data of these comparisons can be found in Table 1. The variables age, contraceptive method, smoking and parity were analyzed separately in order to assess their influence on the final number of cells in each type of cytology. It was observed that patients that delivered more children had a smaller amount of metaplastic cells in liquid-based cytology (Kruskal Wallis Test; $p=0.042$). The other variables (age - Pearson correlation coefficient, contraceptive method - Kruskal Wallis test, and smoking - Mann-Whitney Test) did not influence the number of cells.

We assessed the comparison of the diagnostic results between liquid-based and conventional cytology. When evaluating these results, based only on the cytological diagnosis, we found an agreement rate of 72.7%. When the results were classified as negative, low-grade (ASCUS and LSIL) and high-grade (AGC, ASC-H, HSIL and SCC) and applied the Mc Nemar test, the agreement rate was 90.6%, thus denoting good agreement between both cytology types. Regarding the histological report of

the tissue removed during the conization, 79.8% (67/84) had grade 3 cervical intraepithelial neoplasia (CIN) as diagnosis. Table 2 depicts the histological results of the conizations of the 84 patients. Three cases of CIN 1 in the conization were maintained in the study, since the biopsy prior to the procedure was diagnosed as high-grade (CIN 2 and CIN 3) and one case of CIN 1 was preceded by two high-grade cytologies (cytological discordance).

In order to assess the correlation between the histological report of the conization and the result of the liquid-based and conventional cytology collected, we divided the histological report of the conization into low grade (CIN 1), high grade (CIN 2 and CIN 3) and cancer, as well as the cytology collected in low grade (ASCUS and LSIL), high grade (ASC-H, HSIL and AGC) and cancer.

Thus, as to the results of conization, 94% (79 out of 84) had a histological report of high-grade lesion, 4.8% (4 out of 84) of low-grade lesion and 1.2% (1 out of 84) of cancer. Regarding conventional cytology, 86.9% (73 out of 84) of the cases had high-grade cytology, 8.3% (7 out of 84) had low-grade cytology and 4.8% (4 out of 84) had negative cytology diagnosis. As far as liquid-based cytology, 82.1% (69 out of 84) had high-grade cytology, 10.7% (9 out of 84) had low-grade cytology and 7.1% (6 out of 84) had negative cytology diagnosis (Table 3).

Although we observed that conventional cytology showed 81% of agreement with the histological report of conization, while liquid-based cytology depicted 76.2% agreement, no statistically significant difference was observed. Regarding the low discordance rate, that is, the cytology presented a result of a lower degree than the histological report, this rate in conventional cytology was 14.3% with a confidence interval of 6.8% to 21.8% and in the liquid cytology of 19% with a confidence interval of 10.6% to 27.6%, showing no statistically significant difference.

Concerning the high discordance rate, meaning that the cytology presented a result of a higher degree than the histological report of conization, the values for liquid-based and conventional cytology were the same, 4.8% (with a confidence interval of 0 to 10.1 %). Thus, we can infer that both methods present similar results in terms of detection of lesions.

Table 2. Final Histological Result of Conization

Histology	N	%
CIN 3	67	79.8
CIN 2	12	14.3
CIN 1	4	4.8
SCCC	1	1.2
Total	84	100

CIN, cervical intraepithelial neoplasia; SCCC, squamous cell cervical cancer

Table 3. Results of Cytology Collected on Conization Day

	Conventional cytology	Liquid-based cytology
Negative	4.80%	7.10%
Low-grade	8.30%	10.70%
High-grade	86.90%	82.10%

Discussion

Cervical cancer screening aims to diagnose precursor lesions that may have been induced by HPV, in order to reach an appropriate treatment, thus preventing that these lesions become invasive. As a result, conventional cervical cytology, being an easy-to-perform method, has become the exam of choice in developing countries for this screening [11].

In our study, carried out with 84 patients with cervical intraepithelial neoplasia, a concomitant collection of conventional cytology and liquid-based cytology was carried out to compare the number of cells between both cytologies. We observed that liquid-based cytology samples have a smaller neutrophilic infiltrate and a cleaner sample background when compared to conventional cytology samples. Based on this finding, we can infer that liquid cytology generates a lower rate of unsatisfactory samples, which is corroborated by Pankaj et al. (2018), Honarvar et al. (2022) and Khakwani et al. (2022) [12-14].

Regarding cell counts in the samples collected, the presence of mature, basal and endocervical cells was significantly higher in conventional than in liquid-based cytology. However, in the study by Haghghi et al. [15], the presence of squamous and endocervical cells was 85.5% and 25.4% respectively in conventional cytology, and 88.5% and 66.7% in liquid-based cytology. These results were statistically significant and different from those presented in our series.

This discrepancy may have occurred due to the difference in the cytology samples collection methodology. In our study, we used an Ayer spatula (ectocervix collection) and a cytobrush (endocervix collection) to smear the slide and then we placed both artifacts in the liquid medium. In the study by Haghghi et al. [15], a spatula and swab were used for conventional cytology and another brush for liquid-based cytology. The methodology that we used was based on data published by Hutchinson et al. [16]. These researchers observed that only 20% of the material contained in the collection artifacts is used in the preparation of a conventional cytology slide, leaving about 80% of cells for transferring into liquid medium.

The study published by Campaner and Fernandes [10] observed a significantly higher number of TZ cells in conventional cytology when compared to liquid-based cytology; they assessed over one million cytology slides. They also observed that the number of these cells decreased as patients' age increased. It is postulated that the glandular cells, due to their smaller size, would escape the filter during the slide preparation process, determining a decrease in endocervical cells in liquid-based cytology, which would justify our finding. However, abnormal TZ cells, due to their larger size, would be retained in the filter, thus maintaining the diagnostic power.

The rate of metaplastic cells was higher in conventional cytology than in liquid-based cytology in our study, which was in agreement with the study by Haghghi et al. [15].

To this date, no studies that compared the amount of cells in conventional cytology to liquid-based cytology in the same patient (as described in our methodology) have been published yet. However, during our bibliographical

survey, we found other studies comparing both cytologies in terms of diagnostic power/accuracy.

In our study, the agreement between liquid-based and conventional cytology results was 90.6%. Although we observed that conventional cytology showed greater agreement with histological report of conization, with this value being 81%, while liquid-based cytology depicted agreement of 76.2%, there was no statistically significant difference in detection rates. Thus, we could infer that both methods present similar results in the detection of lesions. The classic studies published by Ronco et al. [17], Arbyn et al. [18] and Siebers et al. [19] compared both cytologies noting that there are no significant differences in sensitivity and specificity for detecting CIN 2+ cases.

In addition, even though a greater number of cells was observed in conventional cytology, when compared to liquid-based cytology, the diagnostic power of both tests was similar, with no statistical difference between them.

One limitation of our study is that both traditional and liquid-based cytology samples were collected simultaneously from the same patient. Initially, the conventional cytology slide was prepared, and subsequently, the samples collected with the spatula and brush were placed in the liquid medium. This collection sequence could have contributed to the increased cellularity observed in conventional cytology. However, the diagnostic performance of both methods was similar, with no statistically significant difference between them, showing a 90.6% concordance in cytological results.

Another limitation is that sample collection was not performed exclusively by the main researcher; however, the collection technique was standardized among all professionals involved, minimizing procedural variability. All slides were processed in a single laboratory, which reduced potential biases related to sample preparation. Furthermore, all slides were analyzed by a single pathologist, a factor that provides greater consistency and reliability in both cell counting and result interpretation.

Due to the scarcity of financial resources in Brazil, liquid-based cytology is only used in large urban centers, while conventional cytology is a more widespread method. Before carrying out this study, we were concerned that conventional cytology would turn out to be an unsatisfactory method in terms of diagnosis, but our study results inferred the opposite. In other words, our findings suggest that conventional cytology remains a useful resource in places where liquid-based cytology and HPV testing are not accessible.

In general, although LBC offers operational advantages [such as a lower rate of unsatisfactory samples, the possibility of performing additional tests (e.g., HPV) from the same specimen, and greater standardization], its initial implementation costs (equipment, consumables, and maintenance) are substantially higher than those of CC. So, in low-resource health services, CC remains a more accessible and easily implemented alternative, given the existing infrastructure and well-established staff training.

However, cost-effectiveness analyses suggest that, in the long term, LBC may become more advantageous when incorporated into comprehensive screening programs that include molecular testing, as it can reduce

repeat examinations and enhance diagnostic accuracy. Consequently, the choice between LBC and CC should balance initial implementation costs, logistical feasibility, and the sustainability of the local healthcare system.

In this study, a greater amount of mature, basal, metaplastic and endocervical cells was observed in conventional cytology, when compared with liquid-based cytology. Although a larger number of cells was observed in conventional cytology, the diagnosis results were similar in both methods. Conventional cytology is a reliable method when collected under appropriate conditions and high technical rigor, especially in areas in which conventional cytology is the only screening method available.

Author Contribution Statement

Adriana Bittencourt Campaner conceived and designed the study. Flavia Salomão d'Avila Curi and Ana Carolina Alves Rosario de Sica were responsible for data collection, analysis, and interpretation. Flavia Salomão d'Avila Curi and Adriana Bittencourt Campaner drafted the manuscript. All authors critically reviewed and approved the final version of the article. Adriana Bittencourt Campaner supervised and guided the work.

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Scientific Body approved

The study was approved by the Scientific Committee of the Department of Obstetrics and Gynecology, Santa Casa de Sao Paulo School of Medical Sciences, São Paulo, SP, Brazil. The study was the doctoral thesis of the corresponding author.

Ethical issue

The study was approved by the Ethics Committee of Santa Casa de Misericórdia de São Paulo (SCMSP) under the number 12763019.8.0000.5479.

Availability of data

The data from the present study are not publicly available in any repository.

Any conflict of interest

The authors declare that they have no conflict of interest.

References

1. American Cancer Society (ACS) Institute. Cervical cancer screening guidelines [Internet]. EUA: American Cancer Society; 2022 [citado 2022 nov 30]. Available from: <https://www.cancer.org/cancer/cervical-cancer/detection-diagnosis-staging/cervical-cancer-screening-guidelines.html>
2. Corrêa FM, Migowski A, de Almeida LM, Soares MA. Cervical cancer screening, treatment and prophylaxis in brazil: Current and future perspectives for cervical cancer elimination. *Front Med (Lausanne)*. 2022;9:945621. <https://doi.org/10.3389/fmed.2022.945621>.
3. de Sanjosé S, Brotons M, Pavón MA. The natural history of human papillomavirus infection. *Best Pract Res Clin*

4. John-Akinola YO, Ndikom CM, Oluwasanu MM, Adebisi T, Odukoya O. Cervical cancer and human papillomavirus vaccine knowledge, utilisation, prevention educational interventions and policy response in nigeria: A scoping review. *Cancer Control*. 2022;29:10732748221130180. <https://doi.org/10.1177/10732748221130180>.
5. Hortlund M, Mühr LSA, Lagheden C, Hjerpe A, Dillner J. Audit of laboratory sensitivity of human papillomavirus and cytology testing in a cervical screening program. *Int J Cancer*. 2021;149(12):2083-90. <https://doi.org/10.1002/ijc.33769>.
6. Li ZF, Jia XH, Feng X, Zhang S, Zhang X, Pan QJ, et al. Comparison of primary cytology, primary hpv testing and co-testing as cervical cancer screening for chinese women: A population-based screening cohort. *BMJ Open*. 2022;12(10):e063622. <https://doi.org/10.1136/bmjopen-2022-063622>.
7. Jeong H, Hong SR, Chae SW, Jin SY, Yoon HK, Lee J, et al. Comparison of unsatisfactory samples from conventional smear versus liquid-based cytology in uterine cervical cancer screening test. *Journal of pathology and translational medicine*. 2017;51(3):314-9. <https://doi.org/10.4132/jptm.2017.03.17>.
8. Phaliwong P, Pariyawateekul P, Khuakoonratt N, Sirichai W, Bhamarapratana K, Suwannarurk K. Cervical cancer detection between conventional and liquid based cervical cytology: A 6-year experience in northern bangkok thailand. *Asian Pac J Cancer Prev*. 2018;19(5):1331-6. <https://doi.org/10.22034/apjcp.2018.19.5.1331>.
9. Bai A, Wang J, Li Q, Seery S, Xue P, Jiang Y. Assessing colposcopic accuracy for high-grade squamous intraepithelial lesion detection: A retrospective, cohort study. *BMC Womens Health*. 2022;22(1):9. <https://doi.org/10.1186/s12905-022-01592-6>.
10. Campaner AB, Fernandes GL. Detection of transformation zone cells in liquid-based cytology and its comparison with conventional smears. *Diagn Cytopathol*. 2020;48(8):752-8. <https://doi.org/10.1002/dc.24468>.
11. Anschau F, Gonçalves MAG. Liquid-based cervical cytology versus conventional cytology. *Femina*. 2006;34(5):329-35.
12. Pankaj S, Nazneen S, Kumari S, Kumari A, Kumari A, Kumari J, et al. Comparison of conventional pap smear and liquid-based cytology: A study of cervical cancer screening at a tertiary care center in bihar. *Indian Journal of Cancer*. 2018;55(1):80-3. https://doi.org/10.4103/ijc.IJC_352_17.
13. Honarvar Z, Zarisfi Z, Salari Sedigh S, Masoumi Shahrababak M. Comparison of conventional and liquid-based pap smear methods in the diagnosis of precancerous cervical lesions. *J Obstet Gynaecol*. 2022;42(6):2320-4. <https://doi.org/10.1080/01443615.2022.2049721>.
14. Khakwani M, Parveen R, Azhar M. Comparison of pap smear and liquid based cytology as a screening method for cervical carcinoma. *Pak J Med Sci*. 2022;38(7):1827-31. <https://doi.org/10.12669/pjms.38.7.5742>.
15. Haghighi F, Ghanbarzadeh N, Atae M, Sharifzadeh G, Mojjarrad JS, Najafi-Semnani F. A comparison of liquid-based cytology with conventional papanicolaou smears in cervical dysplasia diagnosis. *Adv Biomed Res*. 2016;5:162. <https://doi.org/10.4103/2277-9175.192735>.
16. Hutchinson ML, Isenstein LM, Goodman A, Hurley AA, Douglass KL, Mui KK, et al. Homogeneous sampling accounts for the increased diagnostic accuracy using the thinprep processor. *Am J Clin Pathol*. 1994;101(2):215-9. <https://doi.org/10.1093/ajcp/101.2.215>.
17. Ronco G, Cuzick J, Pierotti P, Cariaggi MP, Dalla Palma

- P, Naldoni C, et al. Accuracy of liquid based versus conventional cytology: Overall results of new technologies for cervical cancer screening: Randomised controlled trial. *Bmj*. 2007;335(7609):28. <https://doi.org/10.1136/bmj.39196.740995.BE>.
18. Arbyn M, Bergeron C, Klinkhamer P, Martin-Hirsch P, Siebers AG, Bulten J. Liquid compared with conventional cervical cytology: A systematic review and meta-analysis. *Obstet Gynecol*. 2008;111(1):167-77. <https://doi.org/10.1097/01.AOG.0000296488.85807.b3>.
19. Siebers AG, Klinkhamer PJ, Grefte JM, Massuger LF, Vedder JE, Beijers-Broos A, et al. Comparison of liquid-based cytology with conventional cytology for detection of cervical cancer precursors: A randomized controlled trial. *Jama*. 2009;302(16):1757-64. <https://doi.org/10.1001/jama.2009.1569>.



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