**Abstract**

**Aim:** Invasive cervical cancer is preceded by a phase of preinvasive disease that is slow to progress and can be detected, treated, and collectively referred to as cervical intraepithelial neoplasia (CIN). Several excisional and ablative treatments for CIN have been studied, with loop electrosurgical excision procedure (LEEP) and cryotherapy being the two most commonly utilized. The objective of this systematic review and meta-analysis of randomized controlled trials (RCTs) was to compare the harms and benefits of LEEP versus cryotherapy in women with CIN.

**Methods:** Electronic databases were searched from their inception until May 2018. We included all RCTs comparing cryotherapy versus LEEP in women with CIN. We included trials evaluating both HIV-seropositive and HIV-seronegative women. The primary outcome was the persistence of the disease at 6-month follow-up. Meta-analysis was performed using the random-effects model to produce summary treatment effects in terms of relative risk (RR) with 95% confidence interval (CI).

**Results:** Four trials, including 1035 women with CIN, were identified as relevant and included in the meta-analysis. Women who received LEEP for CIN had a significantly lower persistence at 6-month follow-up biopsy (RR: 0.87, 95% CI: 0.76–0.99) and significantly lower recurrence at 12-month follow-up biopsy (RR: 0.91, 95% CI: 0.84–0.99) compared to those who received cryotherapy. No between-group differences were found in the complications rate, but the analyses were not powered for these outcomes.

**Conclusions:** In women with CIN, treatment with LEEP was associated with a significantly lower risk of persistence disease at 6 months and recurrence disease at 12 months compared to treatment with cryotherapy.

**Keywords:** Cervical cancer, cervical intraepithelial neoplasia, colposcopy, gynecology, Pap test

**Introduction**

In the developing countries, cervical cancer is the most common cancer in women, with the highest rates in sub-Saharan Africa, Latin America, and South and South East Asia.[1] Invasive cervical cancer is proceeded by a phase of the preinvasive disease that is slow to progress and can be detected, treated, and collectively referred to as cervical intraepithelial neoplasia (CIN). CIN can be confirmed histologically from a biopsy sample and divided into three stages (CIN1, 2, and 3).[2]

**Address for correspondence:** Dr. Gabriele Saccone,
Department of Neuroscience, Reproductive Sciences and Dentistry,
School of Medicine, University of Naples Federico II, Naples, Italy.
E-mail: gabriele.saccone.1990@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

It has been estimated that, in 70% of affected women, CIN2–3 can persist or progress to cervical cancer after 10–20 years.\cite{2-4}

For this reason, ablation or excisional of the transformation zone is typically offered to women with biopsy-proven CIN. Progression from CIN to cervical cancer is faster, and associated mortality is significantly higher, among HIV-seropositive compared to HIV-seronegative women.\cite{5-7}

Several excisional and ablative treatments for CIN have been studied, including loop electrosurgical excision procedure (LEEP), cryotherapy, laser vaporization, cold knife conization, and hysterectomy. LEEP and cryotherapy are the two most commonly utilized.\cite{3,8-10}

Thus, the aim of this systematic review and meta-analysis of randomized controlled trials (RCTs) was to compare the compare of LEEP versus cryotherapy in women with CIN.

**METHODS**

**Search strategy and selection criteria**

This review was performed according to a protocol designed a priori and recommended for systematic review.\cite{11}

Electronic databases (i.e., MEDLINE, PROSPERO, Scopus, ClinicalTrials.gov, EMBASE, ScienceDirect, the Cochrane Library, Scielo) were searched from their inception until May 2018. Search terms used were the following text words: “LEEP,” “cryotherapy,” “cervical cancer,” “CIN,” “intraepithelial neoplasia,” “electrosurgical excision,” “Pap test,” “meta-analysis,” “review,” “randomized,” “clinical trial,” “randomized,” and “clinical trial.” No restrictions for language or geographic location were applied. In addition, the reference lists of all identified articles were examined to identify studies not captured by electronic searches. The electronic search and the eligibility of the studies were independently assessed by two authors (MB and GS). Differences were discussed, and consensus reached.

We included all RCTs comparing cryotherapy versus LEEP in women with CIN. We included trials evaluating both HIV-seropositive and HIV-seronegative women. Any grade of CIN (CIN1, CIN2, or CIN3) was included. CIN was defined as biopsy-proven squamous intraepithelial lesions (SILs). Quasi-randomized trials (i.e., trials in which allocation was done on the basis of a pseudorandom sequence, for example, odd/even hospital number or date of birth, alternation) were excluded. Trials evaluating other therapies other than cryotherapy and LEEP were also excluded.

**Data extraction and risk of bias assessment**

The risk of bias in each included study was assessed using the criteria outlined in the Cochrane Handbook for Systematic Reviews of Interventions. Seven domains related to risk of bias were assessed in each included trial since there is evidence that these issues are associated with biased estimates of treatment effect: (1) random sequence generation, (2) allocation concealment, (3) blinding of participants and personnel, (4) blinding of outcome assessment, (5) incomplete outcome data, (6) selective reporting, and (7) other bias. Review authors’ judgments were categorized as “low risk,” “high risk,” or “unclear risk” of bias.\cite{11}

Two authors (MB and GS) independently assessed inclusion criteria, the risk of bias, and data extraction. Disagreements were resolved by discussion. Data from each eligible study were extracted without modification of original data onto custom-made data collection forms. Differences were reviewed and further resolved by common review of the entire process. Data not presented in the original publications were requested from the principal investigators, if possible.

All analyses were done using an intention-to-treat approach, evaluating women according to the treatment group to which they were randomly allocated in the original trials. Primary and secondary outcomes were defined before data extraction. Outcomes were assessed at the time of biopsy follow-up at 6 months and at 12 months after the procedure. If women did not receive for any reason (e.g., lost to follow-up, pregnancy) biopsy at follow-up, they were excluded from the analysis. All authors were contacted for missing data.

The primary outcome was the persistence of the disease, defined as disease (any grade of CIN) present at 6-month follow-up after treatment. The secondary outcomes were recurrence, defined as disease (any grade of CIN) present at 12 months after treatment and treatment complications.

**Statistical analysis**

The data analysis was completed independently by two authors (MB and GS) using Review Manager version 5.3 (the Nordic Cochrane Centre, Cochrane Collaboration, 2014, Copenhagen, Denmark). The completed analyses were then compared, and any difference was resolved by discussion. Statistical heterogeneity across studies was assessed using the Higgins I² test. Meta-analysis was performed using the random-effects model of DerSimonian and Laird to produce summary treatment effects in terms of relative risk (RR) with 95% confidence interval (CI).

Potential publication biases were assessed statistically using Begg’s and Egger’s tests. P < 0.05 was considered statistically significant.

We planned the following subgroup analyses for the primary endpoint: (1) HIV-seropositive versus HIV-seronegative women and (2) trials on CIN2 and CIN3 only.
The meta-analysis was reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.

**Results**

**Study selection and population characteristics**

Four trials, including 1035 women, were identified as relevant and included in the meta-analysis [Figure 1]. Data from one trial were also obtained by a secondary analysis published only as abstract. Publication bias, assessed statistically using Begg’s and Egger’s tests, showed no significant bias ($P = 0.47$ and $P = 0.51$, respectively). Statistically, heterogeneity within the trials was low with no inconsistency ($I^2 = 0\%$) for the primary outcome.

The quality of the RCTs included in our meta-analysis was assessed using the criteria outlined in the Cochrane Handbook for Systematic Reviews of Interventions. Most trials were at low or moderate risk of bias. All the included studies had a low risk of bias in “random sequence generation.” The appropriate method of sequence generation was used to assigned women to the treatment groups. Adequate methods for allocation of women were used in all the trials. None of the trials reported whether or not the outcome assessor was blinded, except for the trial of Chirenje et al. where the investigators collecting and analyzing the data were blinded to the treatment mode [Figure 2a and b].

Table 1 shows the characteristics of the included clinical trials. Of the 1035 enrolled women, 516 women were randomized in the LEEP group and 519 in the cryotherapy group.

LEEP was usually described as the following: staining the cervix with acetic acid solution; abnormal areas were identified and stained with Lugol’s iodine; and local anesthetic was administered around the cervix. 20 mm × 8 mm loop was used to remove the lesion. Cryotherapy was usually described as the following: lesions were identified by colposcopy, freezing the lesions for two 3-min application of nitrous oxide separated by thaw [Table 2].

Mitchell et al. and Singh et al. included women with CIN1+, while Chirenje et al. and Smith et al. included only women with CIN2+ [Table 1]. Overall, a total of 200 women with CIN1 and a total of 835 women with CIN2–3 were included in the study [Table 3].

**Synthesis of results**

Table 4 shows the primary and secondary outcomes. Overall, 94.9% of the women (982/1035) had histological biopsy results at the 6-month follow-up visit, and data were available for the primary endpoint. Pregnancy was the most common cause of loss to follow-up. About 72.9% of the randomized women (755/1035) had histological biopsy results at the 12-month follow-up. Women who received LEEP for CIN had a significantly lower persistence at 6-month follow-up biopsy (RR: 0.87, 95% CI: 0.76–0.99) [Figure 3] and significantly lower recurrence at 12-month follow-up biopsy (RR: 0.91, 95% CI: 0.84–0.99) compared to those who received cryotherapy. No between-group differences were found in the complications rate, but the analyses were not powered for these outcomes. LEEP was also associated with significantly lower risk of high-grade SIL (HSIL) at 6-month Pap smear follow-up (RR: 0.45, 95% CI: 0.28–0.75) and at 12-month (RR: 0.41, 95% CI: 0.26–0.65) Pap smear follow-up compared to cryotherapy [Table 4].
Table 1: Characteristics of the included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of participants*</th>
<th>Inclusion criteria</th>
<th>HIV status</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitchell et al., 1998[12]</td>
<td>269 (130 vs. 139)</td>
<td>CIN1+</td>
<td>HIV-seropositive and HIV-seronegative</td>
<td>Prior treatment for high-grade cytology; invasive cervical cancer</td>
</tr>
<tr>
<td>Singh et al., 2011[14]</td>
<td>200 (100 vs. 100)</td>
<td>CIN1+</td>
<td>HIV-seropositive and HIV-seronegative</td>
<td>Prior treatment for high-grade cytology; invasive cervical cancer</td>
</tr>
<tr>
<td>Smith et al., 2017[15]</td>
<td>166 (86 vs. 80)</td>
<td>CIN2+</td>
<td>HIV-seropositive only</td>
<td>Prior treatment for high-grade cytology; invasive cervical cancer; cervical lesions not appropriate for cryotherapy (&gt;75% of the cervix or lesion within the cervical canal with borders not visible)</td>
</tr>
</tbody>
</table>

*Data are presented as total number (number in the LEEP group vs. number in the cryotherapy group). HIV: Human immunodeficiency virus, CIN: Cervical intraepithelial neoplasia, LEEP: Loop electrosurgical excision procedure

Table 2: Details of procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>LEEP</th>
<th>Cryotherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitchell et al., 1998[12]</td>
<td>Staining the cervix with acetic acid solution. Abnormal areas were identified and stained with Lugol’s iodine. Local anesthetic was administered around the cervix. 20 mm × 8 mm loop was used to remove the lesion and the transformation zone in one piece if the cervix was 4 cm or smaller. If the cervix was larger than 4 cm, the tissue was removed in two section</td>
<td>Lesions identified by colposcopy. Freezing the lesions for two 3 min application of nitrous oxide separated by thaw</td>
</tr>
<tr>
<td>Mitchell et al., 1998[12]</td>
<td>Staining the cervix with 4% acetic acid solution Local anesthetic was administered around the cervix. 2 cm × 2 cm electrode was used for large lesions and 1 cm × 1 cm for smaller lesions. A few of the large lesions were removed in two sections</td>
<td>Lesions identified by colposcopy. Freezing the lesions for two 2 min application of nitrous oxide separated by thaw</td>
</tr>
<tr>
<td>Singh et al., 2011[14]</td>
<td>leep was done under short general anesthesia</td>
<td>Freezing the lesions for two 3 min application of nitrous oxide separated by 5 min of thawing</td>
</tr>
<tr>
<td>Smith et al., 2017[15]</td>
<td>Electrosurgical unit with smoke evacuation system. Staining the cervix with 5% acetic acid solution. Abnormal areas were identified and stained with Lugol’s iodine. Local anesthetic was administered around the cervix. The selection of a loop electrode was made depending on the size of lesion. A few of the large lesions were removed in two sections</td>
<td>VIA conducted by applying 5% acetic acid solution. Freezing the lesions for two 3 min application of nitrous oxide separated by 5 min of thawing</td>
</tr>
</tbody>
</table>

LEEP: Loop electrosurgical excision procedure, VIA: Visual inspection with acetic acid
Figure 3: Forest plot for the risk of persistence of the disease, defined as any grade of cervical intraepithelial neoplasia at the biopsy 6 months after the procedure

Table 3: Characteristics of the included women

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>LEEP Events</th>
<th>Cryotherapy Events</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
<td>M-H, Random, 95% CI Year</td>
</tr>
<tr>
<td>Mitchell 1998</td>
<td>4/130 (30.8) vs 47/130 (36.2)</td>
<td>70/130 (53.8) vs 76/139 (54.7)</td>
<td>1.00 [0.80, 1.24] 1998</td>
</tr>
<tr>
<td>Chinen 2001</td>
<td>25/106 (23.6) vs 27/100 (27.0)</td>
<td>23/100 (23.0) vs 17/100 (17.0)</td>
<td>1.05 [0.82, 1.35] 2001</td>
</tr>
<tr>
<td>Singh 2011</td>
<td>6/100 (6.00) vs 12/100 (12.0)</td>
<td>2.00 [0.76, 1.31] 2011</td>
<td></td>
</tr>
<tr>
<td>Smith 2017</td>
<td>65/83 (78.3) vs 66/74 (90.0)</td>
<td>0.88 [0.76, 1.01] 2017</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>499/1035 (48.1) vs 483/1000 (48.3)</td>
<td>0.87 [0.76, 0.99]</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as n (%) in the LEEP group versus n (%) in the cryotherapy group. CIN: Cervical intraepithelial neoplasia, LEEP: Loop electro surgical excision procedure, LSIL: Low-grade squamous intraepithelial lesion, HSIL: High-grade squamous intraepithelial lesion, HPV: Human papillomavirus

Subgroup analysis in trials including only women with CIN2+ and subgroup analysis in trials including HIV-positive only women concurred with the overall analysis in showing significant benefit of LEEP for the primary endpoint (RR: 0.89, 95% CI: 0.77–0.98 and RR: 0.88, 95% CI: 0.76–0.99, respectively).

DISCUSSION

Main findings

This meta-analysis of four RCTs, including 1035 women with CIN, showed that treatment with LEEP was associated with a significantly lower risk of persistence disease at 6 months and recurrence disease at 12 months compared to treatment with cryotherapy. The meta-analysis also showed a significant reduction of HSIL at 6-month and at 12-month Pap smear follow-up and nonsignificant benefits in the other secondary outcomes, including CIN3 at 6 and 12-month follow-up biopsy. No between-group differences were found in the complications rate comparing the two treatments with a nonsignificant increase in pain, infection, and bleeding in women receiving LEEP. However, the meta-analysis was not powered to detect significant differences in the complications rate.

Implications

The American College of Obstetricians and Gynecologists and the American Society for Colposcopy and Cervical Pathology in the 2012 ASCCP Consensus Guidelines Conference recommended colposcopy for women with HSIL cytology.[17] In the case of colposcopy and biopsy, women with CIN should be managed with either excision or ablation. Therefore, both LEEP and cryotherapy are reasonable and recommended treatment for women with CIN.[17] No specific recommendations are made in HIV-positive women. HIV-positive women have an increased risk of cervical cancer, as well as an increased risk of procedure-related complications.[18]
In LEEP, a wire electrical loop removes the abnormal cervical lesion within a clinical setting. Cryotherapy treatment is the local destruction of cervical tissue by application of subfreezing temperatures causing crystallization and rupture of cell membranes. Cryotherapy has the limitation that approximately 25% of CIN2+ lesions cannot be treated adequately (those that cover >75% of the cervix or extend into the cervical canal).

Our review provided evidence that LEEP treatment is superior in terms of less persistence and less recurrence rate at 6 and 12-month follow-up visit compared to cryotherapy. Our study concurred with prior findings of Santesso et al.[20]

**Conclusions**

In summary, in women with CIN, treatment with LEEP was associated with a significantly lower risk of persistence disease at 6 months and recurrence disease at 12 months compared to treatment with cryotherapy.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

### Table 4: Primary and secondary outcomes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistence at 6 months*</td>
<td>4/130 versus 7/139</td>
<td>25/186 versus 23/170</td>
<td>6/100 versus 12/100</td>
<td>65/83 versus 66/74</td>
<td>100/499 (20.0) versus 108/483 (22.4)</td>
<td>0</td>
<td>0.87 (0.76-0.99)</td>
</tr>
<tr>
<td>Recurrence at 12 months**</td>
<td>17/130 versus 26/139</td>
<td>18/168 versus 18/161</td>
<td>Not reported</td>
<td>74/83 versus 72/74</td>
<td>109/381 (26.6) versus 116/374 (31.0)</td>
<td>0</td>
<td>0.91 (0.84-0.99)</td>
</tr>
<tr>
<td>Biopsy CIN3 at 6 months**</td>
<td>Not reported</td>
<td>3/186 versus 1/170</td>
<td>Not reported</td>
<td>1/83 versus 4/74</td>
<td>6/369 (1.6) versus 10/344 (2.9)</td>
<td>0</td>
<td>0.59 (0.21-1.66)</td>
</tr>
<tr>
<td>Biopsy CIN3 at 12 months**</td>
<td>Not reported</td>
<td>4/168 versus 12/161</td>
<td>Not reported</td>
<td>4/83 versus 5/74</td>
<td>8/251 (3.2) versus 17/235 (7.2)</td>
<td>0</td>
<td>0.45 (0.20-1.04)</td>
</tr>
<tr>
<td>Pap-smear LSIL at 6 months**</td>
<td>Not reported</td>
<td>4/186 versus 8/170</td>
<td>Not reported</td>
<td>67/83 versus 67/74</td>
<td>71/269 (26.4) versus 75/244 (30.7)</td>
<td>41</td>
<td>0.77 (0.41-1.46)</td>
</tr>
<tr>
<td>Pap-smear LSIL at 12 months**</td>
<td>Not reported</td>
<td>2/168 versus 6/161</td>
<td>Not reported</td>
<td>78/83 versus 73/74</td>
<td>80/251 (31.9) versus 79/235 (33.6)</td>
<td>77</td>
<td>0.63 (0.13-3.09)</td>
</tr>
<tr>
<td>Pap-smear HSIL at 6 months**</td>
<td>Not reported</td>
<td>3/186 versus 4/170</td>
<td>Not reported</td>
<td>15/83 versus 31/74</td>
<td>18/269 (6.7) versus 35/244 (14.3)</td>
<td>0</td>
<td>0.45 (0.28-0.75)</td>
</tr>
<tr>
<td>Pap-smear HSIL at 12 months**</td>
<td>Not reported</td>
<td>4/168 versus 12/161</td>
<td>Not reported</td>
<td>16/83 versus 33/74</td>
<td>20/251 (8.0) versus 45/235 (19.1)</td>
<td>0</td>
<td>0.41 (0.26-0.65)</td>
</tr>
<tr>
<td>Pain*</td>
<td>1/130 versus 0/139</td>
<td>86/186 versus 74/170</td>
<td>43/100 versus 14/100</td>
<td>Not reported</td>
<td>130/416 (31.3) versus 88/409 (21.5)</td>
<td>85</td>
<td>1.84 (0.69-4.93)</td>
</tr>
<tr>
<td>Infection**</td>
<td>1/130 versus 0/139</td>
<td>0/200 versus 0/100</td>
<td>0/100 versus 0/100</td>
<td>Not reported</td>
<td>1/430 (0.2) versus 0/439</td>
<td>3.21</td>
<td>0.31 (0.13-7.81)</td>
</tr>
<tr>
<td>Bleeding**</td>
<td>7/130 versus 0/139</td>
<td>4/200 versus 1/200</td>
<td>4/100 versus 3/100</td>
<td>Not reported</td>
<td>15/430 (3.5) versus 4/439 (0.9)</td>
<td>28</td>
<td>3.03 (0.75-12.20)</td>
</tr>
<tr>
<td>Stenosis</td>
<td>1/130 versus 2/139</td>
<td>0/200 versus 0/200</td>
<td>0/100 versus 0/74</td>
<td>1/513 (0.2) versus 2/513 (0.4)</td>
<td>Not applicable</td>
<td>0.53</td>
<td>0.05 (0.05-5.83)</td>
</tr>
</tbody>
</table>

*Any grade of CIN at 6 months follow-up, **Any grade of CIN at 12-month follow-up. Boldface data, statistically significant. Data are presented as n (%) in the LEEP group versus n (%) in the cryotherapy group. RR: Relative risk, CI: Confidence interval, LSIL: Low-grade squamous intraepithelial lesion, HSIL: High-grade squamous intraepithelial lesion, CIN: Cervical intraepithelial neoplasia

### References


D’Alessandro, et al.: LEEP vs. cryotherapy for CIN


