Cervical mucus status can be accurately estimated by transvaginal ultrasound during fertility evaluation

Examinations of the cervical mucus for determining its quantity and physical characteristics are used to provide a clinical marker for the timing of ovulation. We propose that transvaginal ultrasound, which is routinely used as a tool for monitoring follicular growth in patients undergoing ovulation induction, might also be used simultaneously for estimating cervical mucus measurements. With no additional effort or expense, these data may help to optimize individual patient management. (Fertil Steril 2009;■:■–■. ©2009 by American Society for Reproductive Medicine.)

Key Words: Transvaginal ultrasonography, cervical scoring

The morphological configuration of the uterine cervix and the unique biochemical structure of the cervical mucus with its cyclical changes have several functions in the cervix (1). While this microenvironment is inhibitory in terms of sperm propagation during other parts of the cycle, these two elements provide a periovulatory receptive environment for spermatozoa by acting as a reservoir, providing a defense against the hostile acidic vaginal secretions, fulfilling the energy demands, refining the ejaculate of the morphologically abnormal and dismotile sperm, and providing conditions for sperm capacitation. The chemical composition of the cervical mucus, its physical characteristics and the volume secreted, and the dimensions and structure of the cervix itself show cyclical changes throughout the menstrual cycle (2). These changes are hormone dependent: estrogen induces secretions of large volumes of clear acellular watery mucus, which is highly receptive for spermatozoa. P, on the other hand, inhibits the secretory activity of the cervical epithelium to produce low volumes of thick, cellular mucus that cannot be penetrated by the spermatozoa. The “open window” for fertilization, at least as far as the cervix is concerned, starts with the estrogen peak just before ovulation, which provides maximal stimulation to the cervical glands. It lasts for only 2–3 days after ovulation, when P levels rise. Based on this knowledge, the results of an examination of the cervical mucus for determining its quantity and physical characteristics are used to provide a clinical marker for the timing of ovulation as well as an indicator of the cervical reaction to estrogenic stimulation (2).

There are five accepted parameters for scoring cervical mucus: amount, stretchability (spinnbarkeit), ferning, viscosity, and cellularity (2). The scoring systems that are based on these parameters were found to be highly reliable as indicators for folliculogenesis and the dating of LH surge and ovulation (3).

Conception depends on an adequate response of target organs to these stimuli more than it does on the normal dynamics of ovulation and sufficient estrogen secretion. If the uterine cervix as a target organ fails to respond by creating an optimal passage for spermatoocytes, the resultant low sperm receptiveness leads to infertility (1).

Poor cervical mucus at ovulation as a consequence of a poor hormonal milieu, prior morphological damage, or pharmacological treatment, for example, clomiphene citrate, should be diagnosed and treated either by estrogenic boost or by IUI (4, 5).

Although transvaginal ultrasound (TVUS) is the mainstay of follow-up during ovulation induction, it is mostly used to evaluate the ovarian follicles and endometrial width. The possible applicability of this modality for cervical status assessment has not been considered before. The aim of this study was to compare the width of the cervical canal as measured by TVUS with the usual cervical mucus parameters in women undergoing an infertility work-up or treatment.

The study group consisted of all consecutive women who were being evaluated and treated for infertility in our institute. We used data that were routinely collected for these patients as part of the routine follow-up and treatment. Since the data in this study were obtained from an ultrasound evaluation of ovarian follicular growth that was routinely performed as part of our follow-up of infertility patients, Institutional Review Board approval was not independently requested.

The participants were divided into three subgroups according to treatment protocol: natural cycle (during preliminary investigation; subgroup 1), treatment by clomiphene citrate (Ikaclomin, Teva Nethanya, Israel) for ovulation induction (subgroup 2), and treatment by menotropins...
A total of 101 women were recruited into the study. Twenty-three were in the natural cycle group (subgroup 1), 56 were undergoing treatment by clomiphene citrate for ovulation induction (subgroup 2), and 22 were being treated by menotropins for ovulation induction (subgroup 3). A positive linear correlation was found among the number of follicles, the diameter of the dominant follicle, and the serum E2 level \( (r = 0.51, P < .001; \text{and} \ r = 0.59, P < .001, \text{respectively}) \). The cervical canal diameter showed a positive correlation \( (r = 0.47, P = .008) \) with serum E2 levels in subgroups 1 and 3. There was no correlation between serum E2 levels and cervical TVUS parameters in subgroup 2.

The mean cervical mucus score was 5.6 (range, 3–9). The mean score (± SE) was 6.1 ± 0.5 for subgroup 1, 6.8 ± 0.4 for subgroup 2, and 4.9 ± 0.3 for subgroup 3. The cervical canal diameter measurements correlated well with the amount and quality of the mucus (1.0 ± 0.2 mm for scant amount, 2.9 ± 0.2 mm for abundant amount, 0.8 ± 0.1 mm for poor quality, and 1.8 ± 0.1 mm for good quality of cervical mucus; \( P < .001 \)).

Using a cervical mucus score of 5 as the cutoff between favorable and hostile mucus, the mean cervical canal diameter was 0.9 ± 0.1 mm for women with a low (≤ 5) cervical score and 2.1 ± 0.1 mm for women with a high (> 5) cervical score \( (P < .001) \). Furthermore, a cervical canal diameter of 0.97 mm correlated with a cervical mucus score of 5 (Table 1), and so 1 mm may serve as a cutoff between a favorable and an unfavorable cervical environment for fertilization.

The sensitivity and specificity of measuring the cervical canal diameter by TVUS as a predictor of cervical mucus quality were 83.7% and 80.8%, respectively, with a positive predictive value of 82.2%.

**FIGURE 1**

(A) Cervical canal measurement near ovulation (the arrows represent the point of measurement). (B) Cervical canal after ovulation (day 21).
Cervical mucus volume, quality, and stretchability (spinnbarkeit) are well-accepted parameters of cervical receptiveness under estrogenic influence (6). We prospectively studied TVUS as a method for evaluation of the cervical mucus. Whereas estrogen levels correlated well with mucous quality in the natural and menotropins-treated groups, it did not correlate well with mucous quality in the clomiphene citrate–treated group. The cervical canal diameter, however, did correlate well with mucous quality in all three groups.

It is a well-recognized fact that due to its local antiestrogenic effect, clomiphene citrate may interfere with the estrogenic effect on the cervix(7). Thus, estrogen levels may be high and the size of the follicles may be good, but the cervix may still be hostile to the sperm and thus impede fertilization. This possibility emphasizes the importance of evaluating the mucus of clomiphene-treated patients to identify the ones who have an unfavorable cervix and will benefit from IUI.

Measurements by TVUS revealed a positive correlation between cervical mucus parameters and cervical diameter size. Since the latter correlated with the various inspected cervical ones, we evaluated its validity as a predictor of cervical mucus quality. At a cutoff of 1 mm, the canal diameter size had a good discriminative value between favorable and unfavorable cervical mucus (sensitivity = 83.7%, specificity = 80.8%, positive predictive value = 82.2%).

TVUS has become an essential tool in the follow-up of ovulation in both natural and induced cycles. It is usually performed to evaluate the ovaries for the number and diameter of the follicles as well as to evaluate the width of the endometrium. We believe that this is the first attempt to use this procedure to measure the cervical canal. The diameter of the cervical canal can easily be demonstrated during the regular examination of the endometrium and ovaries just by tilting the probe toward the cervical canal. It is very easy to perform, and the results are easy to interpret. Thus, TVUS, a routinely used tool for follicular growth monitoring in patients undergoing ovulation induction, might also be implemented for evaluating the cervical mucus at no additional effort or expense. The resulting data may help to optimize individual patient management.

### REFERENCES


### TABLE 1
Cervical score below and above cervical canal diameter of 1 mm.

<table>
<thead>
<tr>
<th>Canal diameter</th>
<th>Low score (≤5; n = 52)</th>
<th>High score (&gt;5; n = 49)</th>
<th>P</th>
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<tbody>
<tr>
<td>≤1 mm</td>
<td>42 (84)</td>
<td>8 (16)</td>
<td></td>
</tr>
<tr>
<td>&gt;1 mm</td>
<td>10 (19.6)</td>
<td>41 (80.4)</td>
<td>&lt;.001</td>
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Note: Data in parentheses are percents.


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