Embryo transfer using the SureView catheter-beacon in the womb

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Objective: To compare the performance of the SureView catheter, a new ultrasonic embryo transfer (ET), with the classic Wallace catheter during ultrasound-guided ET.

Design: Prospective, randomized study.

Setting: Private, academically affiliated clinic.

Patient(s): 175 patients undergoing donor egg in vitro fertilization with ET (IVF-ET).

Intervention(s): Ultrasound-guided ET by a single physician with a standardized technique randomly using one of the two catheters.

Main Outcome Measure(s): Implantation rate, pregnancy rate, ease of transfer, and visualization of catheter.

Result(s): The echo-dense tip and the entire length of the SureView catheter were consistently seen with ultrasound guidance. Visualization was statistically significantly better, but there was no statistically significant difference with regard to the ease of transfer. Comparing the SureView with the classic Wallace catheters, the implantation rate (27.76% vs. 23.56%, respectively) and clinical pregnancy rate (41.02% vs. 43.29%, respectively) were similar in both groups. However, the physician using the SureView catheter noted a remarkably superior ease of transfer.

Conclusion(s): The SureView catheter with its ultrasonic contrast properties simplifies ultrasound-guided ET, but pregnancy rates are similar to those obtained when a classic Wallace catheter is used. (Fertil Steril 2010;93:344–50. ©2010 by American Society for Reproductive Medicine.)

Key Words: Embryo transfer, SureView catheter, Wallace catheter, ultrasound

Despite the fact that embryo transfer (ET) is the rate-limiting factor on the way to a pregnancy in assisted reproduction technology (ART), traditionally ET has been viewed as an unimportant variable in the success of an ART treatment cycle. Only recently have publications stressed that, despite its apparent simplicity, the technique of ET is of utmost importance in maximizing the chances of pregnancy (1–3). There is now a general agreement in the in vitro fertilization (IVF) community that smooth, atraumatic ET is critical for achieving high success rates, and both the choice of technique and choice of embryo replacement catheter may play a crucial role in the uterine embryo replacement.

Two recent meta-analyses have confirmed that ultrasound-guided ET significantly increases the clinical pregnancy and embryo implantation rates compared with the clinical touch method (4, 5). In addition, an even more recent systematic review and meta-analysis evaluating the firmness of the ET catheter as a single variable in relation to a successful transfer concluded that using soft ET catheters results in a significantly higher pregnancy rate as compared with firm catheters (6). The whole process of ultrasound-guided ET has been further simplified by the strong, hyperechoic, extraordinary catheter images produced during ET with the next generation of ultrasonic ET catheters. We compared the performance of the SureView catheter (Wallace/Smiths Medical International, Hythe, Kent, UK), a new ultrasonic soft ET catheter, with the soft Wallace catheter (Wallace/Smiths Medical International) during ultrasound-guided ET.

MATERIALS AND METHODS

Our prospective, randomized study was conducted in a private, academically affiliated infertility center. The randomization was done by the principal investigator (G.N.A.) when each patient was admitted for ET. We provided sealed, randomly marked envelope to randomize 175 women into two treatment groups, SureView versus Wallace ET catheter. We used a computer-generated random list, with serial...
numbers from 1 to 175, and the envelope was opened by the principal investigator (G.N.A.) at the time when the patient was admitted for ET. There was allocation concealment until the ET, and the patients and the statistician were blinded to the treatment allocation. Institutional review board approval was obtained for this study, and the patients gave oral consent to be included in this study.

A single physician performed the ultrasound-guided ET by with a standardized technique randomly using one of the two catheters for 175 patients who were undergoing donor egg IVF-ET. The women were not allowed to enter the clinical trial more than once, and the same woman never received oocytes from more than one donor; at the most, one egg donor gave her crop of eggs to two recipients. The main outcome measures studied were clinical pregnancy rates, and the secondary outcome measures were implantation rates, ease of transfer, visualization, and status of the catheter tip.

Mock or trial ET was performed in both study groups, and the preparation for ET was the same for both groups. Patients were placed in the lithotomy position, and the cervix was exposed using a bivalve speculum. The exocervix was flushed with 1 to 2 mL of IVF flushing media connected to a syringe. Before ET, the endometrial thickness, the distance from the external cervical os to the fundal endometrial surface, and the point that the tip of the catheter should reach for proper embryo replacement (approximately 15 mm from the fundal surface of the endometrium) was measured by means of transabdominal transvesical (with full bladder) ultrasonography. To facilitate this measurement, the speculum was withdrawn a little distance or manipulated vaginally, if necessary, so that the external cervical os could be seen.

The transfer was performed by the same clinician (G.N.A.) in all patients, and the same transfer technique was scrupulously maintained with all patients. The Wallace embryo replacement catheters, either the standard catheter or the SureView, were connected to an insulin syringe used for ET. Both catheters possess a stiffer outer sheath that stabilizes the softer inner cannula that carries the embryos and actually enters the endometrial cavity for ET.

The catheter was first loaded with transfer medium, taking care to avoid air bubbles. Then the embryos were loaded in the catheter. Under ultrasound transabdominal guidance, the soft inner catheter was introduced into the cervix and passed through the internal cervical os without using the outer sheath whenever possible. If resistance was met, the inner sheath was withdrawn, and the outer sheath of the catheter was then passed through the endocervix and placed at or just through the internal os, not advanced into the uterine cavity. The inner catheter was now threaded through the outer sheath and advanced under real-time ultrasound guidance to the preselected position. At this point, the distance between the catheter tip and the fundal endometrial surface was again measured using ultrasonography and was considered valid if it was found to be within 15 ± 2 mm of the uterine fundus. Otherwise, the inner catheter tip was gently advanced or withdrawn and thus appropriately relocated, keeping its movement to an absolute minimum.

Ultrasound visualization of the catheter to obtain the preselected position for ET was assessed as excellent/good when the catheter could be easily tracked during the first pass with any or minimal transducer movement in the transverse plane. Fair/poor visualization during the procedure was recorded if marked transducer or catheter movements were necessary for appropriate catheter placement or suboptimal identification of the catheter was obtained.

The ease of each transfer procedure was assessed according to the following criteria: very easy, when the catheter passed smoothly through the cervix; easy, when the rigid outer Teflon sheath was required; and difficult, when the use of a tenaculum was necessary in addition to the previous. Also, if there was any presence of blood coming from the cervix or presence of blood on the tip of the catheter or on the outer wall of the catheter, the classification in the grading was upgraded to difficult. In all transfers, only 30 µL of transfer medium, containing the embryos, was gently expelled into the uterine cavity under sonographic control, which allowed visualization of the transfer-associated air bubbles (two air bubbles used to bracket the embryos) into the uterine cavity.

The catheter was gently removed immediately after transfer and then checked under a stereomicroscope to ensure that all embryos had been transferred. At the end of the procedure, patients remained resting in bed for 120 minutes as per our routine standard operating procedure.

RESULTS
The echo-dense tip and the entire length of the SureView catheter were consistently seen with ultrasound guidance.
(Fig. 1), minimizing the need for catheter movement to identify the tip (Table 1). A two-tailed Fisher’s exact test was used to analyze the nominal variables, described in Table 1, in the form of frequency tables. \( P < .05 \) was considered statistically significant. Visualization was statistically significantly better with the SureView catheter \( (P < .02) \), but there was no statistically significant difference with regard to the ease of transfer \( (P = .25) \). Comparing the SureView with the classic Wallace catheter, the implantation rate \( (27.76\% \text{ vs. } 23.56\%, \text{ respectively}) \) and clinical pregnancy rate \( (41.02\% \text{ vs. } 43.29\%, \text{ respectively}) \) were similar in both groups (Table 2).

A power analysis showed that assuming a baseline pregnancy rate of 30\% in the standard Wallace catheter group and expecting an increase in pregnancy rate to 50\% in the SureView catheter group at a significance level (alpha level) of 0.05 and a power (beta) of 0.80, 104 patients should be included in each group. However, our study showed excellent visualization with the SureView catheters. Also, the physician using the SureView catheter noted that the ease of transfer was remarkably superior.

## DISCUSSION

*You can’t have a light without a dark to stick it in.*

—Arlo Guthrie (1947–)

Since the advent of IVF, most clinicians have been transferring embryos by clinical touch only, which is sometimes described as blind ET. Ultrasound, introduced into the practice of ET, has ended this dark era of blind ET, and we have now entered the next era of ET by the use of ultrasonic ET catheters. These catheters act as torches or beacons in the uterine cavity. The only product on the current market that combines the advantages of the traditional ultra-soft Wallace catheter and the echogenic properties that make the entire length of the catheter visible to the physician doing the ET under ultrasonography guidance is the Wallace SureView ET catheter. The same company now has introduced the Sure-Pro and the Sure-Pro Ultra ET catheter sets for difficult ETs. These sets include the echogenic properties of the SureView catheters along with an obturator and stylet.

Embryos are routinely transferred through the transcervical route, with the catheter being inserted in two ways: blindly by “clinical touch” or guided by ultrasound. Many services use the sensitivity of the clinician to place the embryos within the uterine cavity at a point close to the fundus, similar to the description published by Edwards more than 20 years ago \( (7, 8) \). With that more traditional type of ET, no attempt has been made to document the variables that might have a negative impact and cause low pregnancy rates and failure of the whole process, such as inadvertent touch of the catheter tip on the fundal endometrial surface or inappropriate embryo placement in the uterine cavity.

## TABLE 1

**Visualization and ease of transfer.**

<table>
<thead>
<tr>
<th>Visualization(^a)</th>
<th>Wallace (n = 97)</th>
<th>SureView (n = 78)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent/Good</td>
<td>83</td>
<td>75</td>
</tr>
<tr>
<td>Fair/Poor</td>
<td>14</td>
<td>3</td>
</tr>
</tbody>
</table>

\( ^a P < .02. \)

<table>
<thead>
<tr>
<th>Ease of transfer(^b)</th>
<th>Very easy</th>
<th>Easy</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wallace</td>
<td>89</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>SureView</td>
<td>75</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

\( ^b P = .20. \)


## TABLE 2

**Comparison of cycle outcomes between the classic Wallace and SureView embryo transfer catheters.**

<table>
<thead>
<tr>
<th></th>
<th>Wallace (n = 97)</th>
<th>SureView (n = 78)</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of pregnancies</td>
<td>52</td>
<td>39</td>
<td>.63</td>
</tr>
<tr>
<td>Cycles</td>
<td>97</td>
<td>78</td>
<td>.94</td>
</tr>
<tr>
<td>Biochemical pregnancies</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Clinical pregnancies</td>
<td>42</td>
<td>34</td>
<td>.96</td>
</tr>
<tr>
<td>Ectopic Pregnancies</td>
<td>1</td>
<td>0</td>
<td>.55</td>
</tr>
<tr>
<td>Missed abortions</td>
<td>5</td>
<td>2</td>
<td>.42</td>
</tr>
<tr>
<td>Multiple gestations</td>
<td>26</td>
<td>22</td>
<td>.83</td>
</tr>
<tr>
<td>Sacks</td>
<td>86</td>
<td>83</td>
<td>.77</td>
</tr>
<tr>
<td>Clinical pregnancy rate</td>
<td>43.29%</td>
<td>41.02%</td>
<td>.94</td>
</tr>
<tr>
<td>Biochemical pregnancy rate</td>
<td>4%</td>
<td>4%</td>
<td>.94</td>
</tr>
<tr>
<td>Ectopic pregnancy rate</td>
<td>1%</td>
<td>0</td>
<td>.55</td>
</tr>
<tr>
<td>Abortion rate</td>
<td>5.15%</td>
<td>2.56%</td>
<td>.42</td>
</tr>
<tr>
<td>Total implantation rate (TIR)</td>
<td>23.56%</td>
<td>27.76%</td>
<td>.50</td>
</tr>
<tr>
<td>Multiple gestation rate</td>
<td>27%</td>
<td>28.21%</td>
<td>.83</td>
</tr>
</tbody>
</table>

Ultrasoundographic observation has many potential advantages: it prevents touching the fundus of the uterus, it confirms that the catheter is beyond the internal os, and it permits guidance of the catheter along the endometrial line, which facilitates the use of more flexible catheters (9–11). In addition, the full bladder required for transabdominal ultrasound itself is useful for the correction of uterine axis through the cervical route in cases of pronounced anteflexion–antireflexion. Strickler et al. (12), who reported that guided transfer was easier and less associated with catheter distortion, first described the use of ultrasound to assist ET. Later, several other studies showed that ultrasound-guided ET yielded better implantation and pregnancy rates in addition to facilitating the transfer procedure (13, 14).

Ultrasound also has provided new insights into the process of ET. One interesting aspect is the site in the endometrial cavity where the embryos are placed, with some reports correlating this variable with the site of implantation. Baba et al. (15) analyzed 60 ETs that resulted in 22 pregnancies and 32 gestational sacs. Twenty-six of the 32 sacs were detected by three-dimensional ultrasound in the area where the air bubble had been observed immediately after transfer (15). Liedholm et al. (16) placed small spheres in a column containing 50 mL of fluid and performed a simulated ET immediately before hysterectomy. The uterine cavity was then inspected, and the microspheres were found within a distance of 1 cm from the presumed deposition site. These results emphasize the importance of the site where the embryos are transferred (16).

It has been traditionally accepted that embryos should be placed 5 to 10 mm below the surface of the uterine fundus (17, 18). However, some investigators have suggested that placing embryos lower in the endometrial cavity may improve pregnancy rates (19, 20). Waterstone et al. (21) reported the results of ET performed by two clinicians who followed different techniques. The first introduced the catheter until he felt the fundus and then pulled it back 5 mm before injecting the embryos; he achieved a final pregnancy rate of 24%. The second clinician introduced the catheter until a depth of 5 cm from the external os of the cervix and deposited the embryos without touching the fundus; he obtained a pregnancy rate of 46%. When the first clinician modified his technique according to that of the second, an improvement in pregnancy rates was observed (21).

Coroleu et al. (22) analyzed 180 patients who underwent guided ET, with the transfers being divided into three groups according to the distance between the uterine fundus and the site of embryo placement: group 1, 10 ± 1.5 mm; group 2, 15 ± 1.5 mm; and group 3, 20 ± 1.5 mm. The best implantation and pregnancy rates were observed for groups 2 and 3, in which the distance from the uterine fundus was greater than in group 1 (22). Frankfurter et al. (23) retrospectively analyzed 23 patients who underwent two cycles of ultrasound-guided ET each, considering for each patient a transfer that resulted in pregnancy and one that did not. The results showed better pregnancy rates when the site of embryo placement relative to the length of the endometrial cavity was more distant from the uterine fundus (23).

Among the various aspects of ET, the site of embryo placement in the uterine cavity has been postulated to influence embryo implantation rates. Whereas some investigators have suggested that improved ET results are obtained when the embryos are placed at lower levels in the uterine cavity; others believe that higher levels in the endometrial cavity closer to the uterine fundus lead to higher rate. The attending physician can be very accurate as regards the embryo deposition site when using the SureView catheter (Fig. 2).

Embryo transfer has emerged as a significant aspect influencing the success of IVF. Considerable attention now is paid to atraumatic passage of the catheter through the uterine cavity and the precise location of the catheter tip and site of transfer of the embryos. Easy and atraumatic transfers of embryos placed in the middle of the uterine cavity are considered essential for successful implantation (1, 20). A diversity of techniques, monitoring, and catheters has been evaluated to enhance and refine this process (2, 20, 24–27). In this respect, transabdominal ultrasound-guided ET is designed to follow the movement of the catheter into the uterus, with the aim of enhancing transfer efficiency. Using the SureView catheter may help to refine the transfer technique by tracking the position of the cannula and placement of the catheter in relation to the endometrial surface and uterine fundus, thus avoiding even minimal endometrial damage (Fig. 3).

Accordingly, two recent papers have provided robust evidence that ultrasound-guided ET using transabdominal ultrasound is more effective than ET by clinical touch alone (4, 28). Catheters should be made more readily detectable by ultrasound to further refine transfer techniques. Some catheters already on the market have this feature in the form of an echodense tip (the Cook Echo-Tip catheter [Cook Ob/Gyn, Spencer, IN] is a modification of the soft-tip Wallace catheter with an echogenic stainless steel band at the tip of the inner sheath) or echogenicity extending along the whole length of the catheter (the Wallace SureView Embryo Replacement catheter). These echogenic catheters could be immediately imaged by transabdominal ultrasonography, and with small movements of the transducer in the transverse plane, the echodense catheter would be easily tracked during passage through the entire uterine cavity into the fundal region during the first pass. This would minimize any to-and-fro motion necessary to identify the catheter tip, which, in turn, would minimize disruption of the endometrium with a subsequent improvement in implantation rates (29).

In our experience, the SureView Wallace catheter combines all of the characteristics of the classic soft Wallace catheter, with the unique opportunity to view the entire length of the catheter under ultrasound (Figs. 1–3). The echogenicity is brought about by small air bubbles contained within the polyurethane of the catheter lumen itself that are used along the whole length of the catheter (Fig. 4). The catheter picture under ultrasound could be likened to a candle or torch in the
uterus (Figs. 1–3). The exact mechanism whereby ultrasound-guided ET improves clinical pregnancy rates and embryo implantation is unclear, although confirming the position of the tip of the ET catheter within the uterine cavity obviously is a major benefit.

A number of studies have suggested other mechanisms whereby the IVF outcome is improved with ultrasound-guided ET, by increasing the frequency of “easy” transfers, by avoiding bloody and/or repeated transfers, or by properly replacing the embryos in the midcavity and in the area of the central stripe. What could also be added is improving successful ET implantation and pregnancy rates further by use of the echogenic SureView catheter.

A total of 63 pregnancies (47 singleton, 15 twin, 1 triplet) from intracytoplasmic sperm injection cycles were analyzed (17). In all ETs, the catheter was introduced into the endometrial cavity guided by abdominal ultrasound, with the catheter tip placed at the middle point of the endometrial cavity. Gestational sacs were located 21 to 24 days after transfer (gestational age 5 weeks) by two-dimensional and three-dimensional transvaginal ultrasound. The uterine cavity was divided into three parts: upper, middle, and lower. Furthermore, the upper region was subdivided into right, middle, and left areas, and the middle region was subdivided into right and left areas. The frequency of gestational sacs in each area was evaluated. In singleton pregnancies, 66.0% (31 out of 47) of the gestational sacs were detected in the upper region, 29.8% (14 out of 47) in the middle region, and 4.2% (2 out of 47) in the lower region. In multiple pregnancies (twins and triplet), 45.5% (15 out of 33) of the gestational sacs were detected in the upper region, 51.5% (17 out of 33) in the middle region, and 3.0% (1 out of 33) in the lower region. The results demonstrated that when embryos are transferred to the central area of the uterine cavity there is an increase in implantation rate in the middle region compared with the rate expected in naturally conceived pregnancies (9% to 15%) (17). This study amply restresses the importance of ultrasound guidance for directed ETs.

Recent evidence has shown that ultrasound-guided ET significantly increases successful implantation compared with the clinical touch method (22, 28). It has been postulated that new echodense catheters, which are more readily detectable by ultrasound, may refine transfer techniques even more,
thus improving IVF outcome. Hence, Coroleu et al. (30) performed a prospective, randomized, controlled trial that compared IVF outcomes for women undergoing ET under ultrasound guidance by a single health-care provider with random assignment according to a computer-generated randomization table to either standard soft Wallace catheter (standard catheter group, n = 95) or the new echogenic soft Wallace catheter (echogenic catheter group, n = 98) (30). The use of the echogenic catheter facilitated catheter identification under ultrasound, and thus shortened the duration of the ET procedure; the loaded catheter was handed to the physician, and the time thereafter to embryo discharge was significantly shorter with the echogenic catheter group as compared with the standard catheter group. There were 39 and 53 clinical pregnancies in the standard catheter (41%) and echogenic catheter (54.1%) groups, respectively. This was not statistically significant (P = 0.08) according to the odds ratio (0.6) and confidence interval (0.33–1.04); however, the twin pregnancy rate was statistically significantly increased (P < 0.01) with the use of the new catheter, which was the underlying source for obtaining the statistically significant increase in the implantation rate in this group (37.1%) as compared with the standard catheter group (23.2%) (30). This study suggests that the use of the echogenic Wallace catheter simplifies ultrasound-guided ET although no definite benefit in terms of pregnancy rates was obtained (30). In contrast, the use of the new catheter was associated with a significant increase in the number of twin pregnancies (30).

The evaluation of customer satisfaction is elementary for any quality management system (31). In our IVF unit (which has been certified according to DIN EN ISO 9001:2000 criteria), repeated evaluations of patient satisfaction conducted over the course of 3 consecutive years on structures and processes in the scope of the quality management system found an increase in targeted interventions such as 2 hours bedrest after ET. This led to a measurable increase in satisfaction with postprocedure communication despite evidence in recent literature indicating no difference in pregnancy rates after prolonged rest after ET (32, 33).

CONCLUSION

Studies evaluating the role of ultrasound-assisted ET have had mixed results, and although meta-analysis of prospective trials has suggested an improvement in outcome, limitations in the study designs may overstate the effect of ultrasonography (34, 35). Other ET techniques may eliminate the advantages provided by ultrasonography, limiting its benefits to specific clinical scenarios (36). However, because no trial has demonstrated an adverse effect and because cases that may benefit from its use often cannot be predicted reliably, the routine application of ultrasonography can be justified.

The use of the echogenic SureView catheter simplifies ultrasound-guided ET as compared with the widely used, standard, soft Wallace catheter. Limiting the time of embryo manipulation during the transfer technique may increase pregnancy rates after ART. The shorter duration of the ET procedure for the patients in the echogenic catheter group would be the expected outcome, and it could be explained by the use of the echodense catheter that facilitates catheter identification under ultrasound. The routine use of the SureView catheter can add to the refinement of the technique for all ultrasonography guided ET; in the years to come, this may become the gold standard for ET techniques.

The SureView ET catheter combines all of the benefits of the classic Wallace catheter with the unique opportunity to view the entire length of the catheter under ultrasound. The SureView catheter with its ultrasonic contrast properties simplifies ultrasound-guided ET, but the pregnancy success rates remain similar to those obtained when a Wallace catheter is used.

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