YEDİTEPE ÜNİVERSİTESİ HASTANESİ

Determinants of Successful Embryo Transfer

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23 April National Sovereignty and Children ’s Day

The only special day’s dedicated to children by our Great Leader

MUSTAFA KEMAL ATATURK

Every year on this date, children from all around the world come together in Turkey to enjoy Children's Day celebrations and festivities in a hope that these memories of friendly atmosphere will contribute to a future of enhanced brotherhood and peace among nations.

THE MAIN DETERMINANTS OF IVF SUCCESS

- **Woman age**
- **Ovearian reserve**
- **Embryo quality**
- **Uterine receptivity**
- ***Embryo transfer technique***

Strandel A, Hum Reprod 2000
Hoozemans DA, RBM online 2004
Schoolcraft WB, Fert Steril 2001

INTRODUCTION

An ideal embryo transfer method can be defined as one in which the embryos are deposited in the endometrial cavity without the catheter disturbing the endometrium and avoiding contact with the uterine fundus

INTRODUCTION

- **Despite the numerous advances in the field of IVF and ICSI, the maximum implantation rate per embryo transferred is still approximately 30%.**
- **Nearly 85% of all embryos transferred in the uterine cavity fail to implant***
- **Up to 30% of failed implantations are due to poor transfer techniques**

** Edwards RG. Hum Reprod 1995; 10: 60-6*
*** Li et al. J Assist Reprod Genet 2005; 22: 3-8*

POSSIBLE CAUSES OF FAILURE

- Disturbing the endometrium with the catheter
- Stimulation of uterine contractions
- Placing a suboptimal location of the embryo
- Injury of embryo during the process

DETERMINANTS OF SUCCESSFUL ET

- USG guidance
- Embryo transfer depth
- Movement and localization of air bubbles
- Blood or mucus effects
- Transfer catheter type
- Catheter loading technique
- Trial transfer
- Retained embryos
- Uterine contractions
- Ease of the procedure

ROUTINE USG GUIDANCE

- **Use of USG for proper catheter placement was first described over 20 years ago***
- **Routine USG guidance increases ET success****

* Strickler et al. Fertil Steril 1985; 43: 54-61

** NICE guidelines 2004. RCOG press, p. 112

ROUTINE USG GUIDANCE

Embryo transfer: techniques and variables affecting success

The embryo transfer catheter may be inserted in one of two ways: blindly by “clinical touch” or with ultrasonographic guidance. Blind catheter insertion has been shown to result in the inadvertent abutment of the catheter tip with the fundal endometrium in 17.4% of patients

Outcome of embryo transfer with and without ultrasonographic guidance.

	Without ultrasonography			With ultrasonography			
Study (reference)	No. of patients	Implantation rate (%)	Clinical pregnancy rate (%)	No. of patients	Implantation rate (%)	Clinical pregnancy rate (%)	*P* value[a]
Wood et al. (6)	260	14.1	25.4	258	19.9	38.4	<.022, .001
Corcleu et al. (52)	180	18.1	33.7	182	25.3	50	<.01, .002
Kan et al. (53)	97	16.2	28.9	98	20.4	37.8	NS, NS[b]
Prapas et al. (51)	71	—	22.6	61	—	36.1	<.05
Lindheim et al. (54)	35	17.5	35	67	27	61	<.05, .05

[a] Significance of implantation rate and pregnancy rate, respectively.
[b] NS = not significant.

Schoolcraft. Embryo transfer. Fertil Steril 2001

Schoolcraft WB, Fertil steril 2001

ROUTINE USG GUIDANCE

Implantation, clinical pregnancy and miscarriage rates after introduction of ultrasound-guided embryo transfer

Parameter	Clinical touch embryo transfer		USG embryo transfer		P-value	
	Fresh	Frozen	Fresh	Frozen	Fresh	Frozen
No. of embryos transferred	652	703	683	658	–	–
No. of gestational sacs[a]	62	51	136	86	NS	NS
Implantation rate %	9.5	7.3	19.9	13.1	<0.0001	<0.0004

NS = not statistically significant; USG = ultrasound-guided.
[a]With visible fetal heart on ultrasound.

Parameter	Clinical touch embryo transfer		USG embryo transfer		P-value	
	Fresh	Frozen	Fresh	Frozen	Fresh	Frozen
No. of embryos transferred	385	496	394	448	–	–
Positive pregnancy test (%)	65 (16.9)	66 (13.3)	127 (32.2)	108 (24.1)	<0.0001	<0.0001
Clinical pregnancy (%)	48 (12.5)	44 (8.9)	106 (26.9)	70 (15.6)	<0.0001	0.0015
Miscarriage before fetal heart (%)	15 (3.9)	21 (4.2)	19 (4.8)	36 (8.0)	NS	0.015
Miscarriage after fetal heart (%)	4 (1.0)	7 (1.4)	4 (1.0)	4 (0.9)	NS	NS
Total miscarriage (%)	19 (4.9)	28 (5.6)	23 (5.8)	40 (8.9)	NS	0.027
Ectopic pregnancy (%)	2 (0.5)	1 (0.2)	2 (0.5)	2 (0.4)	NS	NS

NS = not statistically significant; USG = ultrasound-guided.

A total of 1723 embryo transfers were included in the analysis.

The practice of USG embryo transfer is associated with statistically higher implantation and clinical pregnancy rates in IVF.

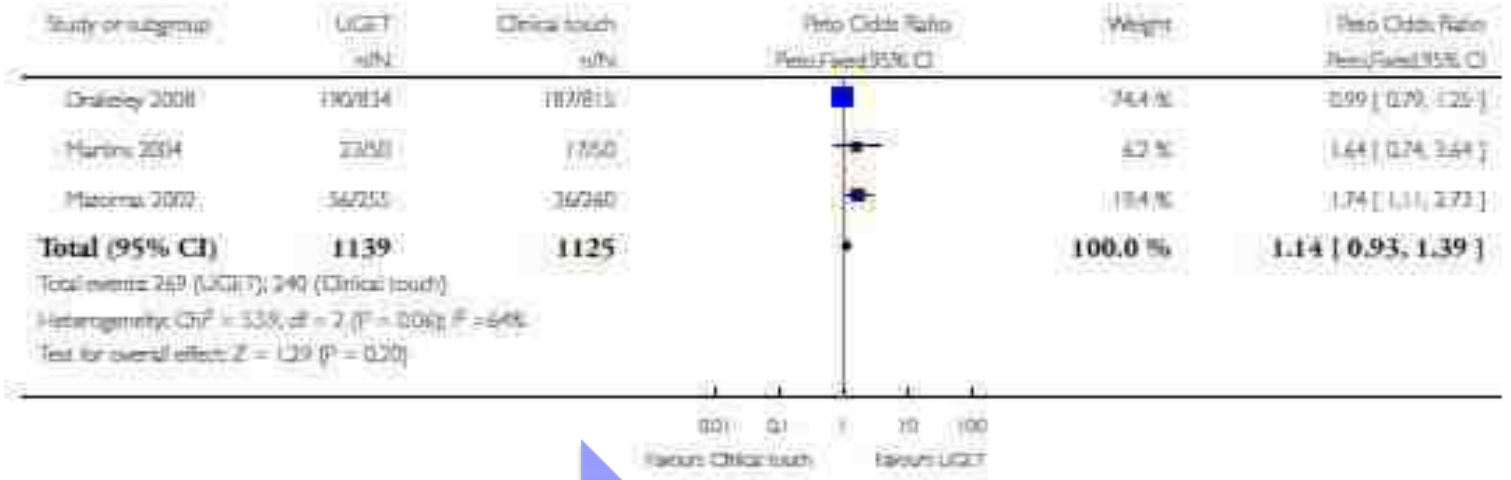
Ali RC, RBM Online, 2008

ROUTINE USG GUIDANCE

The ongoing pregnancies per woman randomised associated with UGET (441/1254) was significantly higher than for clinical touch (350/1218) OR 1.38, 95%CI 1.16 to 1.64, P<0.0003

There is no evidence of a significant difference in the outcome of live birth

Analysis 1.1. Comparison 1 Pregnancy, Outcome 1 Live birth (per woman randomised).

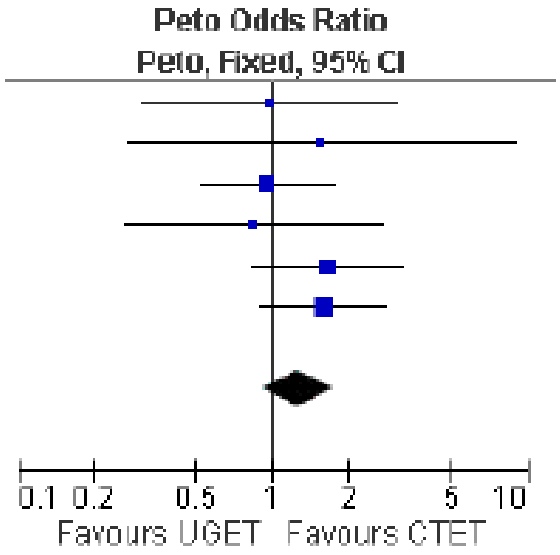


The primary outcome measure of future studies should be the reporting of live births per woman randomised

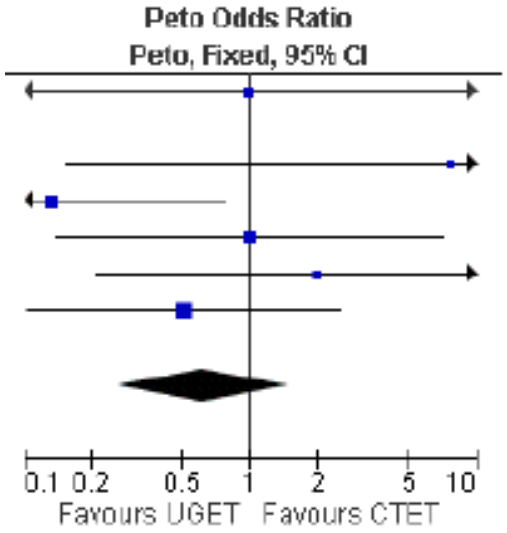
Brown J, *Cochrane Database of Systematic Reviews* 2010

USG Guided vs Clinical Touch ET

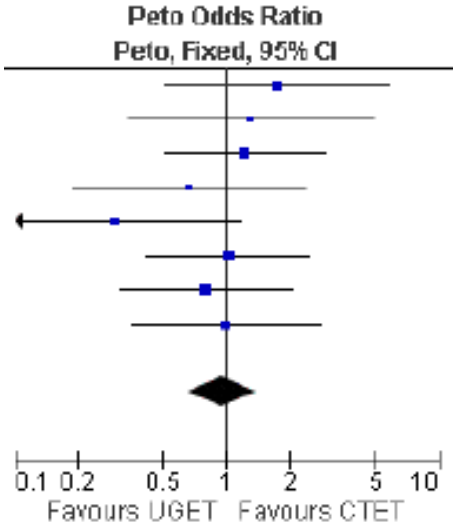
Multiple pregnancies



Ectopic pregnancy



Spontaneous miscarriage



No statistically significant differences in the incidence of adverse events were identified between the comparison groups

Brown J, *Cochrane Database of Systematic Reviews* 2010.

ROUTINE USG GUIDANCE

Ultrasound guidance during embryo transfer: a systematic review and meta-analysis of randomized controlled trials

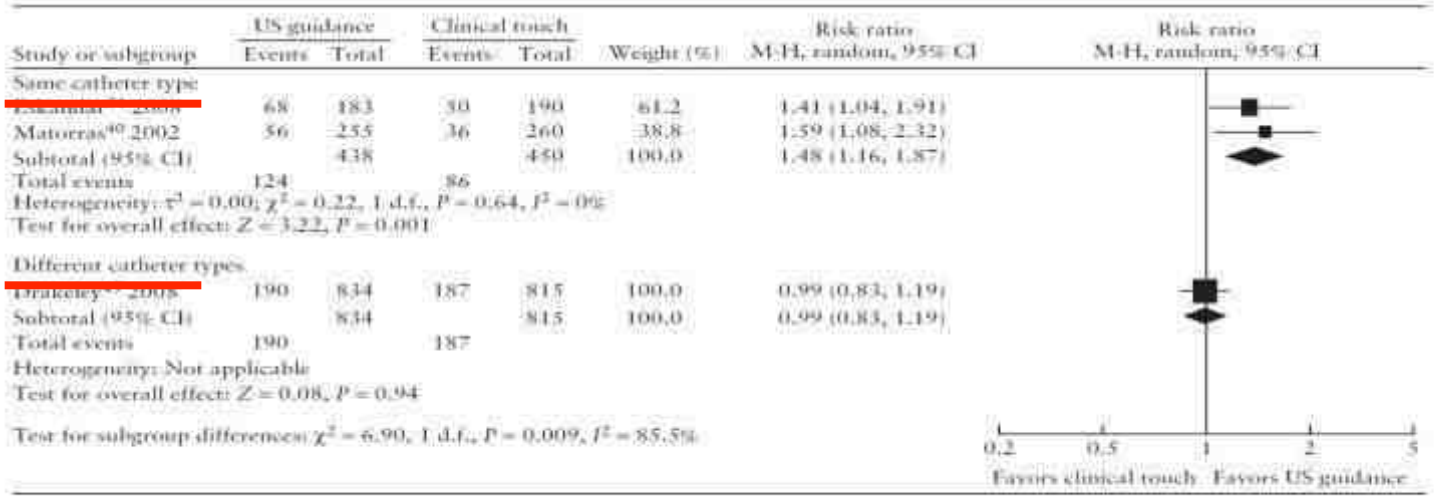


Figure 2 Forest plots of relative risk for live-birth results, comparing ultrasound (US) guidance with clinical touch, using the same and different types of catheter during embryo transfer. M-H, Mantel–Haenszel.

The available evidence suggests that there is a benefit of using US guidance during ET. However, both US-guided transfer and clinical touch should be considered acceptable, as the benefit of US is not large and should be balanced against the increased cost and need to change the catheter type.

TEIXEIRA DM, Ultrasound Obstet Gynecol 2015

ROUTINE USG GUIDANCE
Potential Advantages

- To facilitate placement of soft catheters
- To avoid touching the fundus
- To confirm that the catheter is beyond the internal os
- To avoide disruption of the endometrium
- To assess the ovaries and presence of excessive peritoneal fluid volume
- To rule out fluid in the endometrial cavity

EMBRYO TRANSFER DEPTH

Best site for embryo transfer: the upper or lower half of endometrial cavity?

Table III. Upper half × lower half: rates of implantation, clinical pregnancy, spontaneous abortion (≤ 12 weeks), ectopic pregnancy and ongoing pregnancy in the two groups studied

	Group I: upper half	Group II: lower half	*P*
Implantation rate	16.0% (89/555)	16.4% (87/530)	0.86
Pregnancy rate/transfer	35.0% (70/200)	29.5% (59/200)	0.28
Miscarriage rate	15.7% (11/70)	15.2% (9/59)	1.00
Ectopic pregnancy rate	1.4% (1/70)	— (0/59)	1.00
Ongoing pregnancy rate	29% (58/200)	25% (50/200)	0.43

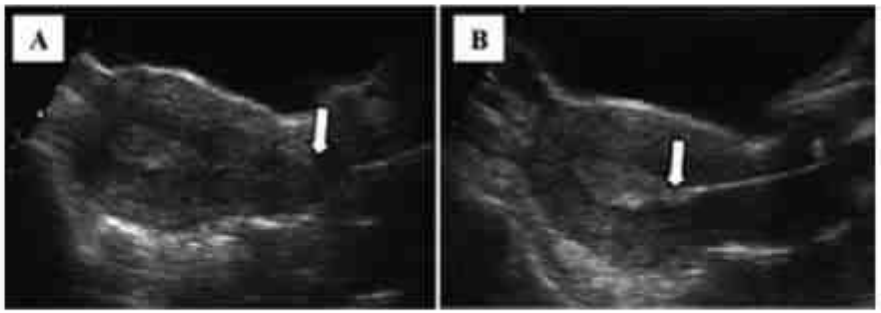
Implantation rates and pregnancy rates were similar for transfers to the upper <50% ecl or lower half >50% ecl of uterine cavity

Franco JG Hum Reprod 2004

Location of the embryo-transfer catheter guide before the internal uterine os improves the outcome of in vitro fertilization

FIGURE 1

Transvaginal ultrasound monitored embryo transfer with the catheter guide before (A) and after the internal os (B). Arrows indicate the tip of the catheter.



Abdelmassih. Transfer cather location and IVF-ICSI outcomes. Fertil Steril 2007.

TABLE 1

Features analyzed in patients submitted to ET before and after the internal os.

Variable	Before internal OS (group 1)	After internal OS (group 2)	*P* value
Number of transfers	218	190	
Mean age ± SD (y)	34.8 ± 5.4	35.5 ± 6.4	.2
Injected oocytes	8.1 ± 3.5	8.0 ± 4.2	.7
Fertilized oocytes	6.8 ± 3.37	6.7 ± 3.55	.7
Embryos transferred	3.59 ± 1.10	3.30 ± 1.12	.1
Embryos transferred "A"	1.0 ± 1.4	0.8 ± 1.2	.1
Embryos transferred "B"	0.5 ± 0.9	0.5 ± 1.0	.8
Pregnancy rate	57.3% (125/218)	43.1% (82/190)	.0054
Clinical PR	51.8% (113/218)	39.4% (75/190)	.01
Clinical abortion rate	15.9% (18/113)	18.6% (14/75)	.69
Implantation rate	14.8% (113/763)	11.8% (75/631)	.11

Note: Type A (cleavage rate in 48 hours: 2–4 cells; 72 hours: 6–8 cells and fragmentation ≤10%); Type B (cleavage rate in 48 hours: 2–5 cells; 72 hours: 5–12 cells and fragmentation ≤11 to 20%).

Abdelmassih. Transfer cather location and IVF-ICSI outcomes. Fertil Steril 2007.

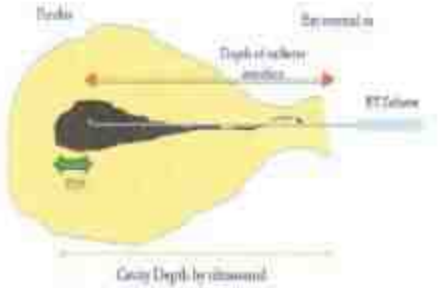
Abdelmassih VG. Fertil Steril 2007

Influence of embryo transfer depth on in vitro fertilization and embryo transfer outcomes

for every additional millimeter embryos are deposited away from the fundus,
the odds of clinical pregnancy increased by 11%.

FIGURE 1

Explanation of terms.



Transfer Distance from Fundus (TDF) =

cavity depth by ultrasound − depth of catheter insertion

FIGURE 2

IVF-ET outcome by embryo transfer distance from fundus using ultrasound guidance.

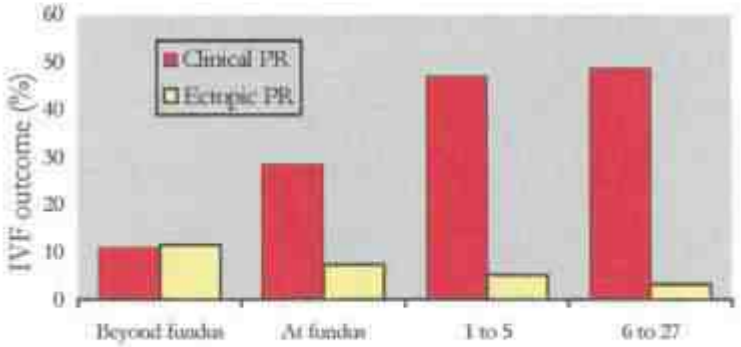


TABLE 1

Crude pregnancy rates per transfer by depth of embryo transfer.

TDF US	Total transfers no.[a]	Total pregnancies no. (% of transfers)	Clinical pregnancies no. (% of transfers)	Ectopic pregnancies no. (% of total pregnancies)	Implantation rate (%)
TDF US <0	125	26 (20.8)	14 (11.2)[b]	3 (11.5)[b]	5.4[b]
TDF US = 0	147	54 (36.7)	42 (28.6)[c]	4 (7.4)[b]	15.4[c]
TDF US between 1–5 mm	241	134 (55.6)	117 (47.0)[d]	7 (5.2)[b]	25.5[d]
TDF US >5 mm	166	93 (56.0)	78 (48.6)[d]	3 (3.2)[b]	26.2[d]

Pope JC. Fertil Steril 2004;81:51– 8.

Impact of embryo replacement depth on in vitro fertilization and embryo transfer outcomes

Bulent Tiras, M.D.,[a,b] *Mehtap Polat, M.D.,*[a] *Umit Korucuoglu, M.D.,*[b] *Hulusi Bulent Zeyneloglu, M.D.,*[c] *and Hakan Yarali, M.D.*[d]

Pregnancy rates and ongoing PRs are higher if the embryos are replaced at a distance >10mm from the fundal endometrial surface.

In addition because significantly more embryos were replaced in cycles where the transfers occurred at a distance of >20 mm, a distance >10 mm to <20 mm seems to be the best site for embryo transfer to achieve higher PRs.

Group 1: Distance from fundal cavity <10 mm
Gorup 2: Distance from fundal cavity 10 -15mm
Gorup 3: Distance from fundal cavity 15-20 mm
Group 4: Distance from fundal cavity 20-25 mm
Group 5: Distance from fundal cavity >25 mm

TABLE 3

Pregnancy rates and outcome of gestation in the five groups studied.

Variable	Group 1 (n = 31; 0.6%)	Group 2 (n = 676; 13.4%)	Group 3 (n = 2,690; 53.2%)	Group 4 (n = 1,296; 25.6%)	Group 5 (n = 362; 7.2%)
Pregnancy rate/transfer (%; n)	32.3% (10/31)	44.9% (304/676)	44.2% (1,189/2,690)	44.2% (566/1,281)	43.3% (156/360)
Ongoing pregnancy rate (%; n)	29.0% (9/31)	40.2% (272/676)	40.0% (1,076/2,690)	40.0% (512/1,281)	39.2% (141/360)
Miscarriage rate (%; n)	[illegible]	9.5% (29/304)	9.2% (109/1,189)	9.2% (52/566)	9.6% (15/156)
Ectopic pregnancy rate (%; n)	–	1.0% (3/304)	0.3% (4/1,189)	0.4% (2/566)	–

Tiras. What is the best site for embryo transfer? Fertil Steril 2010.

Tıraş B. Fertil Steril 2010

AIR BUBBLE LOCALIZATION AND MOVEMENT

- **Air bubble loading to transfer catheters has no negative impact on pregnancy rates ***
- **81% of embryos implant to the localization where they have been first transferred ****
- **Thus, air bubble loading to transfer catheters has become a routine process**

* Moreno et al. Fertil Steril 2004; 81(5): 1366-70

** Baba et al. Fertil Steril 2000; 73(1): 123-5

The effect of air bubble position after blastocyst transfer on pregnancy rates in IVF cycles

This study is the first to suggest that BT closer to the fundus is associated with higher PR. Although no ectopic pregnancies occurred in the <10-mm group, this outcome should be monitored closely in larger studies

TABLE 2

Clinical pregnancy rate.

Distance from fundus (mm)	No. of transfers	Pregnancy rate (%)	OR	*P* value	95% CI
<10	24	62.5	–	–	–
10–20	176	42.0	0.38[a]	0.03[b]	0.153–0.917
>20	115	38.3	0.35[a]	0.03[b]	0.135–0.899

[a] ORs calculated using logistic regression analysis, adjusting for age, parity, FSH, and frozen transfers.
[b] Compared with <10mm.

Friedman. Air bubble position and pregnancy rate. Fertil Steril 2011.

Friedman BE. Fertil Steril 2011

The importance of the length of uterine cavity, the position of the tip of the inner catheter and the distance between the fundal endometrial surface and the air bubbles as determinants of the pregnancy rate in IVF cycles

Pınar Ozcan Cenksoy, Cem Fıcıcıoglu, Mert Yesiladali , Oya Alagoz Akcin, Cigdem Kaspar

E J Obst&Gyn Repr Bio 2014

Table 2
The ratio of A/B and B/C for pregnant and non-pregnant groups.

Variable	Pregnant group (n=115)	Non-pregnant group (n=116)	p
A/B	1.97±1.36	1.83±0.38	0.208
B/C	3.07±1.33	3.05±1.21	0.193
B	2.41±0.62	2.44±0.54	0.658
The depth of uterine cavity	4.359±0.7577	4.34±0.7194	0.854

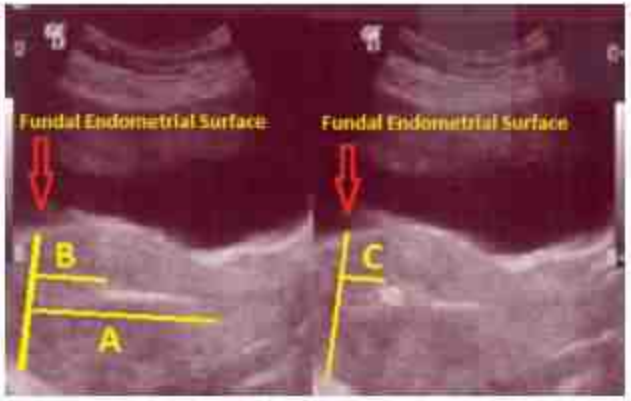


Fig. 1. (A) The length of uterine cavity, (B) the distance between the end of the fundal endometrial surface and the tip of inner catheter, and (C) the distance between fundal endometrial surface and air bubbles.

Table 3
The relation between PR and the depth of air bubble (C).

Depth of air bubble	Pregnancy rates	OR	p value	95% CI
<10mm (n=181)	65.2%	0.708	0.677	0.139–3.602
10–20 mm (n=94)	32.2%	0.649	0.608	0.124–3.390
>20mm (n=6)	2.6%	-	-	-

the clinical intrauterine pregnancy rates were 65.2%, 32.2% and 2.6% in the <10 mm, 10–20 mm, and 20 mm distance groups, respectively

Fig. 2. The location of the tip of inner and outer catheter.

The position of transferred air bubbles after embryo transfer is related to pregnancy rate

The position of the air bubbles after embryo transfer is related to pregnancy rate; the highest pregnancy rates are found when the air bubbles end up closer to the fundus

FIGURE 1

View of the transfer catheter and the air bubble at embryo transfer. (A) Transvaginal ultrasonographic view. (B) Schematic diagram.

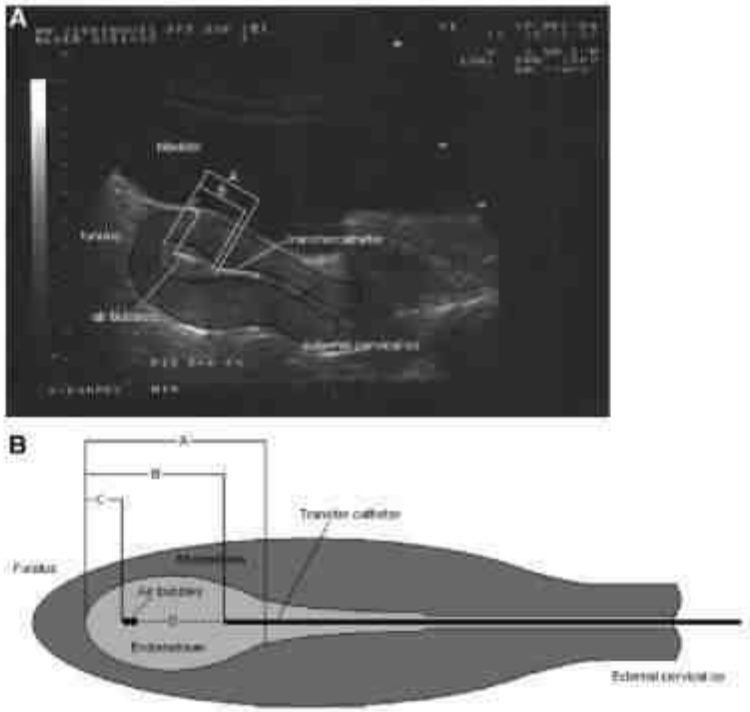
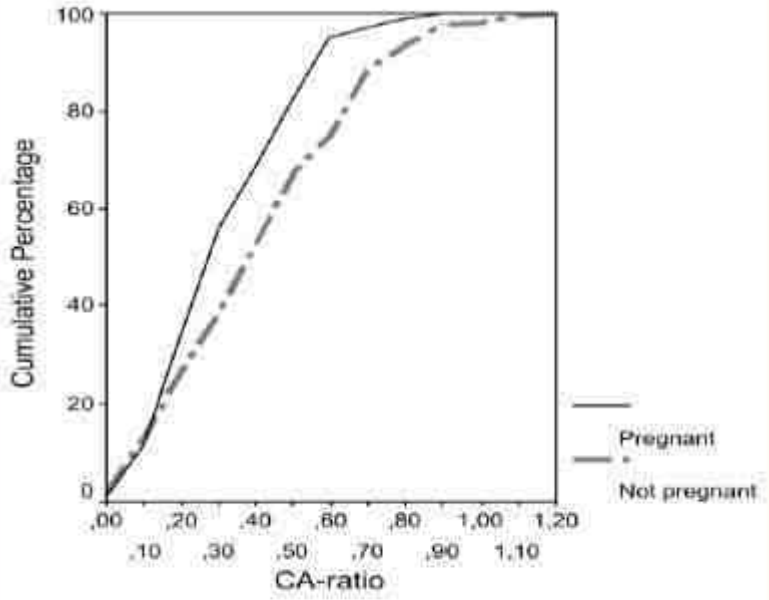


FIGURE 2

Cumulative percentages of pregnant and nonpregnant cycles related to the relative position of the air bubbles (CA ratio).



Lambers. Air bubble position is related to pregnancy rate. Fertil Steril 2007.

unfortunately, it is at present not possible to predict and/or control the position of the air bubbles; after positioning of the transfer catheter the final position of the air bubbles is dependent on the syringe, the resistance of the plunger, the pressure used to press the plunger, and patient-related determinants as a possible intrauterine resistance.

Lambers MJ. Fertil Steril 2007;88:68 –73.c

Effect of air bubble localization after transfer on embryo transfer outcomes

Bulent Tiras[a], Umit Korucuoglu[c,*], Mehtap Polat[b], Ayse Saltik[b], Hulusi Bulent Zeyneloglu[d], Hakan Yarali[e]

An initial finding of this study was significantly decreased positive pregnancy test rates and clinical pregnancy rates with air bubbles moving towards the cervical canal after transfer. Although air bubbles moving towards the uterine fundus with ejection were associated with higher pregnancy rates, higher miscarriage rates and similar live birth rates were observed compared to air bubbles remaining stable after transfer

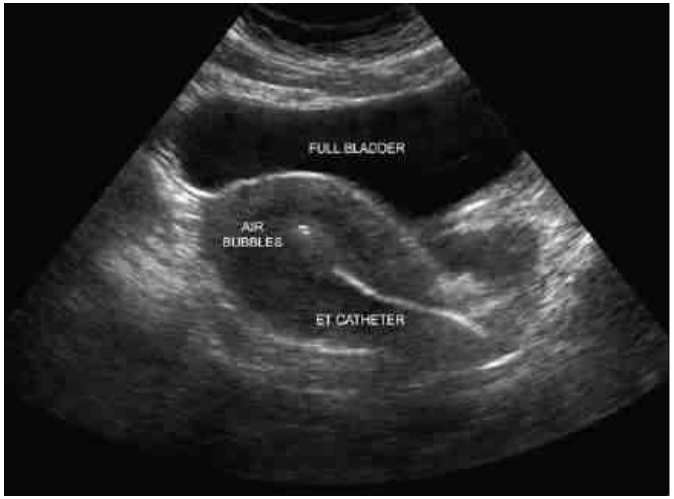


Table 2
Comparison of pregnancy rates and outcomes in groups 1–4.

	Group 1	Group 2	Group 3	Group 4	p
hCG ≥ 45 mIU/ml/ET	3236/6631 (48.8%)	189/407 (46.4%)	195/370 (52.7%)	18/81 (22.2%)	0.000
Clinical pregnancy/ET	2991/6631 (45.1%)	169/407 (41.5%)	179/370 (48.3%)	15/81 (18.5%)	0.001
Biochemical pregnancy/ET	245/6631 (3.7%)	20/407 (4.9%)	16/370 (4.3%)	3/81 (3.7%)	>0.05
Miscarriage/ET	256/6631 (3.9%)	15/407 (3.7%)	16/370 (4.3%)	-	>0.05
Live birth/ET	2735/6631 (41.2%)	154/407 (37.8%)	163/370 (44.1%)	15/81 (18.5%)	>0.05

Tiras B, E J Obs & Gyn Rep Bio 2012

AIR BUBBLE LOCALIZATION AND MOVEMENT

Assessment of the embryo flash position and migration with 3D ultrasound within 60 min of embryo transfer

Table II Pregnancy and implantation rates according to the position of the embryo flash relative to the fundus at 1, 5 and 60 min after embryo transfer.

Embryo flash	<15 mm group		>15 mm group	
	Implantation rate	Pregnancy rate	Implantation rate	Pregnancy rate
1 min	31.7% (99/312)	43.2% (73/169)	30.1% (59/196)	43.4% (46/106)
5 min	30.8% (119/386)	43.5% (91/209)	32.8% (39/119)	43.8% (28/64)
60 min	32.8% (139/424)[a]	46.5% (106/228)[b]	18.2% (10/55)[a]	25.8% (8/31)[b]

[a,b]P < 0.05 in comparison between the <15 mm group and the >15 mm group.

Table III Pregnancy and implantation rates according to embryo flash movement within 60 min of embryo transfer.

Embryo flash movement	Implantation rate	Pregnancy rate
Fundal migration group	32.8% (120/366)	45.5% (90/198)
Static group	37.7% (20/53)	55.2% (16/29)
Cervical migration group	15.0% (9/60)[a]	25.0% (8/32)[b]

[a]P < 0.01; [b]P < 0.05 for cervical migration group in comparison with the static group and the fundal migration group.

Within 60 min of embryo transfer, 76.4% (198/259) of the embryo flashes migrated towards the fundus, 12.4% (32/259) migrated towards the cervix and 11.2% (29/259) remained static. At 60 min, however, the pregnancy and implantation rates among subjects with embryo flashes located <15 mm from the fundus was significantly higher than those with embryo flashes located >15 mm from the fundus (46.5 and 32.8% versus 25.8 and 18.2%, respectively; P , 0.05). The pregnancy and implantation rates when the embryo flash was seen moving towards the cervix (25.0 and 15.0%) was significantly lower (P , 0.05 and P , 0.01, respectively)

There was no significant association between the embryo position or movement and the pregnancy rate at 1 and 5 min. These findings may challenge the traditional notion that the exact position of the embryo flash immediately following embryo transfer is related to clinical outcome

Saravelos HS, Hum Reprod 2016

BLOOD OR MUCUS EFFECTS

- **The presence of blood on the outside of the catheter tip may indicate a difficult embryo transfer and has been found to be associated with lower pregnancy rates***
- **Blood or mucus on the catheter tip has been found to be associated with a higher incidence of retained embryos****
- **Mucus plugging of the catheter tip can cause embryo retention and damage**

* Goudas et al. Fertil Steril 1998; 70: 878-82

** Visser et al. J Assist Reprod Genet 1993; 10: 37-43

BLOOD OR MUCUS EFFECTS

Effect of macroscopic or microscopic blood and mucus on the success rates of embryo transfers

In general, IR and CPR appear to be unaffected by ET catheter contamination, whether it is macroscopic or microscopic presence of blood or mucus. Contamination of the ET catheter has no statistically significant effect on IVFET success rates

TABLE 3

Clinical outcomes of embryo transfers with contamination.

			Microscopic blood				
	No contamination	Macroscopic blood	Outer catheter	Inner catheter	Blood anywhere	Mucus	Blood and mucus
No. of patients	306	49	52	69	63	101	49
Implantation rate (%)	183/779 (23.49)	30/125 (24.0)	29/137 (21.17)	45/181 (24.86)	42/159 (26.42)	71/266 (26.69)	30/131 (22.90)
Clinical pregnancy rate (%)	136/306 (44.44)	21/49 (42.86)	17/52 (32.69)	32/69 (46.38)	30/62 (48.39)	50/101 (49.5)	19/49 (38.78)

Note: All $P>.05$ (Fisher's exact test).

Moragianni. Blood and mucus effects on IVF success. Fertil Steril 2010.

BLOOD OR MUCUS EFFECTS

Effect of blood and mucus on the success rates of embryo transfers

Bulent Tiras[a], Umit Korucuoglu[b,*], Mehtap Polat[a], Ayse Saltik[a], Hulusi Bulent Zeyneloglu[c], Hakan Yarali[a]

This study showed decreased IR, CPR and live birth rates in ETs associated with blood on the catheter. Mucus on the catheter appeared to be a simple contamination in this study and pregnancy rates remained unaffected.

Table 2
Effect of different degrees of blood on pregnancy rates and outcomes.

	No blood	Mild blood	Moderate blood	Severe blood	p
hCG ≥ 45/ET	3103/6897 (45.0%)	476/1168 (40.8%)	13/33 (39.4%)	70/213 (32.8%)	<0.001
Clinical pregnancy/ET	2909/6897 (42.1%)	455/1168 (38.9%)	12/33 (36.3%)	62/213 (29.1%)	<0.001
Biochemical pregnancy/(+) hCG	194/3103 (6.2%)	21/476 (4.4%)	1/13 (7.6%)	8/70 (11.4%)	ns
Miscarriage	146/1093 (13.4%)	26/183 (14.2%)	1/10 (10.0%)	3/23 (13.0%)	ns
Live birth/pregnancy	686/1093 (62.8%)	109/183 (59.6%)	5/10 (50.0%)	12/23 (52.0%)	ns
Live birth/ET	686/6897 (9.9%)	109/1168 (9.3%)	5/33 (15.0%)	12/213 (5.6%)	0.023

Table 3
Effect of mucus on pregnancy rates and outcomes.

	No mucus	Mucus (+)	p
hCG ≥ 45/ET	2702/6162 (43.8%)	933/2081 (44.8%)	0.4492
Clinical pregnancy/ET	2526/6162 (41.0%)	882/2081 (42.4%)	0.2767
Biochemical pregnancy/(+) hCG	176/2702 (6.5%)	51/933 (5.5%)	0.2884
Miscarriage	138/975 (14.2%)	36/319 (11.3%)	0.2266
Live birth/pregnancy	604/975 (61.9%)	199/319 (62.4%)	0.9425

The implantation rate (IR) and The clinical pregnancy rate (CPR) were lowest in the group with severe blood on the catheter. The presence of mucus on the catheter was found to have no effect on IR, CPR,.

Difficult embryo transfers or blood on catheter and assisted reproductive outcomes: a systematic review and meta-analysis

Phillips JAS, Eurp j obst gynec and repr B, 2013

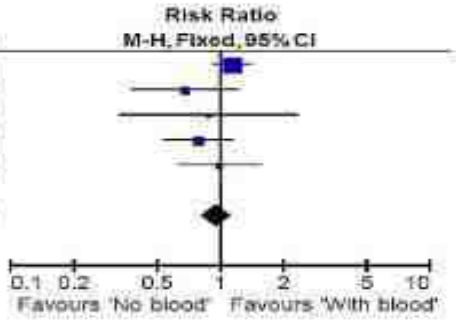
The current evidence also suggests that the presence of blood at embryo transfer does not affect the chance of achieving a clinical pregnancy

Presence of blood on the transfer catheter

Clinical pregnancy

Study or Subgroup	With blood Events	With blood Total	No blood Events	No blood Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Bodri 2011	65	119	101	211	48.0%	1.14 [0.92, 1.42]
Eskandar 2008	9	37	120	336	15.7%	0.68 [0.38, 1.22]
Karande 2002	2	4	140	247	2.9%	0.86 [0.33, 2.36]
Rhodes 2005	17	38	95	167	23.2%	0.79 [0.54, 1.15]
Rhodes 2007	9	15	51	84	10.2%	0.99 [0.63, 1.55]
Total (95% CI)		**213**		**1045**	**100.0%**	**0.96 [0.82, 1.14]**
Total events	102		507			

Heterogeneity: Chi² = 4.86, df = 4 (P = 0.30); I² = 18%
Test for overall effect: Z = 0.44 (P = 0.66)



Miscarriage

Study or Subgroup	With blood Events	With blood Total	No blood Events	No blood Total	Risk Ratio M-H, Fixed, 95% CI
Bodri 2011	11	65	13	101	1.31 [0.63, 2.76]

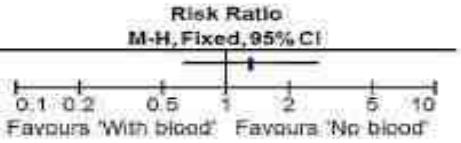


Fig. 3. Forest plots for clinical pregnancy and miscarriage: comparison between 'With blood' versus 'No blood'.

Table 3
Summary of findings for the effect of blood on or in the transfer catheter on clinical pregnancy and miscarriage.

	Illustrative comparative risks[a] (95% CI)			Relative effect (95% CI)	No. of participants (studies)	Quality of the evidence (GRADE)
	Assumed risk Control	Corresponding risk Blood on catheter	Risk difference			
Clinical pregnancy (per allocated woman)	48.5%	46.6% (39.8–55.3%)	−1.9% (−8.7% to 6.8%)	RR 0.96 (0.82–1.14)	1258 (5 studies)	⊕⊕⊖⊖ low[b]
Miscarriage (per clinical pregnancy)	12.9%	16.9% (8.1–35.5%)	4.0% (−4.8% to 22.6%)	RR 1.31 (0.63–2.76)	166 (1 study)	⊕⊖⊖⊖ very low[c]

TRANSFER CATHETER TYPE

- **Many large retrospective studies* have reported higher clinical PRS with "soft" embryo transfer catheters compared with "hard" embryo catheters**

- **Soft embryo catheters :**

  - Cook catheter (Cook Ob/Gyn,Inc., Bloomington, IN)

  - Wallace catheter (Marlow Technologies, Willoughby, OH)

* Burke et al. AJOG 2000. 182; 1001-4

Wood et al. Hum Reprod 2002; 15: 107-12

De Placido et al. J Assist Reprod Genet 2002; 19: 14-18

Sallam et al. J Assist Reprod Genet 2003; 20: 135-42

TRANSFER CATHETER TYPE

A prospective randomized comparison of the Wallace catheter and the Cook Echo-Tip® catheter for ultrasound-guided embryo transfer

Pregnancy rate (CPR), ongoing pregnancy rate (OPR), and implantation rate (IR) in the two catheter groups.

	Wallace (%)	Cook Echo-Tip® (%)
All transfers		
No. of transfers	141	110
CPR	81 (57)	61 (55)
OPR	69 (49)	52 (47)
IR	106/348 (30)	83/238 (35)
IVF transfers		
No. of transfers	105	77
CPR	59 (56)	41 (53)
OPR	51 (49)	34 (44)
IR	78/270 (29)	58/177 (33)
Frozen embryo transfers		
No. of transfers	22	25
CPR	15 (68)	14 (56)
OPR	10 (45)	13 (52)
IR	18/47 (38)	16/44 (36)
Donor oocyte transfers		
No. of transfers	14	8
CPR	7 (50)	6 (75)
OPR	7 (50)	5 (63)
IR	10/31 (32)	9/17 (53)

Note: *P* was not significant for all data.

Karande. Ultrasound-guided ET catheter comparison. Fertil Steril 2002.

The Cook Echo-Tip catheter with its echogenic tip simplifies ultrasound-guided ET, but pregnancy success rates are similar to those obtained when a Wallace catheter is used

Karande V. Fertil Steril 2002;77:826 –30.

TRANSFER CATHETER TYPE

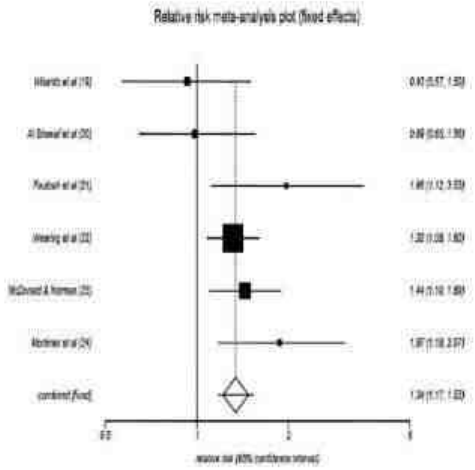
A review and meta-analysis of prospective trials comparing different catheters used for embryo transfer

William M. Buckett, M.D.

An increased chance of clinical pregnancy is achieved when soft ET catheters are used. There appears to be little difference between the Cook and Wallace soft catheters . The TDT catheter was compared against both soft catheters and other hard catheters, showing decreased chance of clinical pregnacy when the TDT catheter was used

FIGURE 2

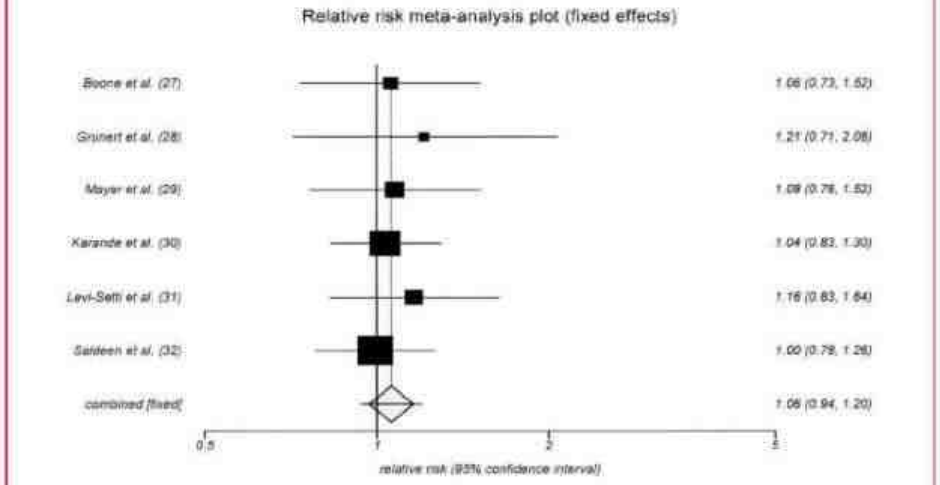
Relative risk for clinical pregnancy per embryo transfer in trials comparing soft with hard embryo transfer catheters (over unity in favor of soft catheters).



Buckett. Meta-analysis of ET catheters. Fertil Steril 2006.

FIGURE 5

Relative risk for clinical pregnancy per embryo transfer in trials comparing Cook with Wallace soft embryo transfer catheters (over unity in favor of Wallace catheters).



Buckett. Meta-analysis of ET catheters. Fertil Steril 2006.

TRANSFER CATHETER TYPE

Modern embryo transfer catheters and pregnancy outcome: a prospective randomized trial

There was no significant difference in the clinical PR between the Wallace and the Cook catheters .There is no significant difference in the PRs achieved by modern, soft, double-lumen ET catheters.

The results of this study have further confirmed that modern ET catheters are embryo friendly and impact little on the pregnancy outcome .. Therefore, the choice of ET catheter may be decided by economics and operator preference. Some catheters may be easier to use for training purposes and this also should be taken into account so that the patients may not suffer as a result of training.

TABLE 2

Comparison of embryo transfer and pregnancy results between the two catheters.

	Wallace, n = 75 (%)	Cook, n = 75 (%)	*P* value
Pregnancy rate	22/75 (29)	23/75 (31)	.99
Change of catheter			
Obturator	13/75 (17)	NA	
Different catheter	3/75 (4)	2/75 (3)	
Total	16/75 (21)	2/75	.001
Tenaculum	1/75 (1)	1/75 (1)	1.0
Blood or mucous catheter tip	16/75 (21)	28/75 (37)	.03
Time embryos loaded before transfer	2:52	2:16	.2
Number of easy transfers	60/75 (80)	66/75 (88)	
Moderate transfers	10/75 (13)	7/75 (9)	
Difficult transfers	4/75 (5)	2/75 (3)	.4[a]

Note: NA = not applicable.

[a] Easy vs. difficult.

McIlveen. Modern ET catheters and pregnancy outcomes. Fertil Steril 2005.

CATHETER LOADING TECHNIQUE

- **A large volume (60 µL) of transfer media and a large air interface may result in expulsion of embryos into the cervix or on the speculum or cause adherance to the outside of the catheter***

- **Studies reported an increase in pregnancy and implantation rates after reducing the amount of air and the total transfer volume****

* Poindexter et al. Fertil Steril 1986; 46: 262-7

** Meldrum et al. Fertil Steril 1987; 48: 86-93

Embryo afterloading: a refinement in embryo transfer technique that may increase clinical pregnancy

The clinical pregnancy rate in the group with ET using the afterloading technique was higher than in the direct ET group (52.4% vs. 34.9%).

TABLE 2

Features of the ET.

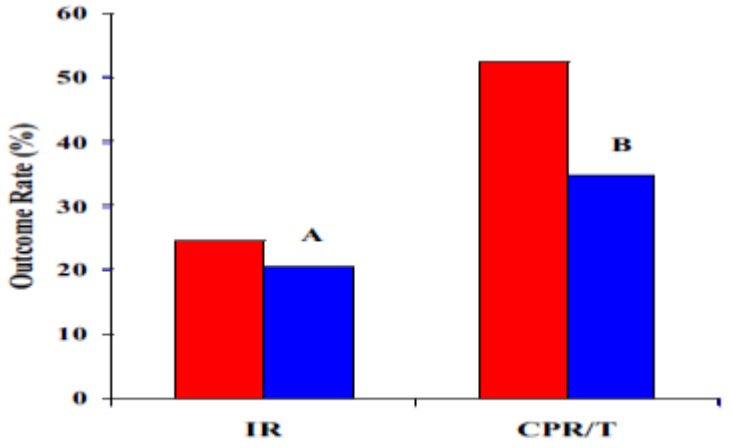
	Afterload (n = 84)	Direct (n = 43)	*P*
Difficulty, hard	0	0	1.00[a]
Difficulty, moderate	6 (7.10)	4 (9.30)	.73[a]
Presence of blood	8 (9.5)	4 (9.30)	1.00[a]
Presence of mucus	5 (5.95)	11 (25.58)	.002[b]

Note: Data in parentheses are percents.
[a]By a two-tailed Fischer's exact test.
[b]By χ^2 analysis.

Neithardt. Embryo afterloading. Fertil Steril 2005.

FIGURE 1

Comparison of pregnancy outcomes with direct vs. afterloaded ET methods. IR = implantation rate, defined as the number of embryos transferred divided by number of gestational sacs on ultrasound. CPT/T = clinical pregnancy per ET cycle based on ultrasound evidence of fetal cardiac activity at 6–8 weeks of gestation. A, *P* = NS; B, *P*=.06 by χ^2 analysis. *Red*, afterloaded ET; *blue*, direct ET.



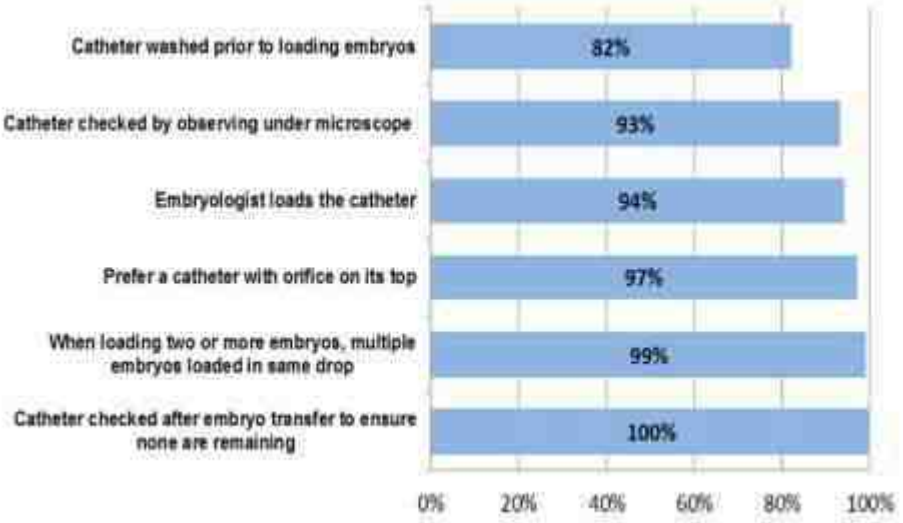
Neithardt. Embryo afterloading. Fertil Steril 2005.

This method may be especially useful in centers that are training physicians to perform ET.

CATHETER LOADING TECHNIQUE
'Medical Intelligence'

Embryo catheter loading and embryo culture techniques: results of a worldwide web-based survey

Christianson SM J Assist Reprod Genet (2014)



Most centers (97 %) prefered a catheter with its orifice on top, with only 3 % preferring a catheter with the orifice on its side; 41 % preferred a catheter marked for clear ultrasound view. The most commonly-reported methods of embryo loading were medium-air-embryoairmedium (42 %), medium in catheter with embryo at end (20 %) and medium-air-embryo (15 %). In 68 % of centers the final volume of the catheter was up to 0.3 ml, with only 19 % using 0.3-0.5 ml and 1 % using 0.5- 0.7 ml

TRIAL TRANSFER

- A trial transfer in a cycle preceding IVF allows the physician to measure the uterine cavity depth and direction due to the great variability in cervical and uterine anatomy
- The direction of the cervix and uterus can be mapped and the depth of the cavity recorded
- In addition, any degree of cervical stenosis can be dealt with in advance

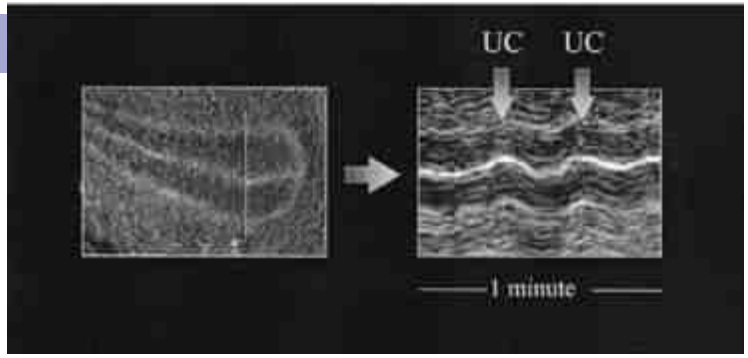
RETAINED EMBRYOS

- **The effect of retained embryos on IVF-ET outcome is controversial**
- **Some authors found no significant difference in pregnancy rates when retained embryos were identified and retransferred***
- **In contrast, some others found a lower pregnancy rate when retained embryos were present (3% vs. 20.3%)****

* Goudas et al. Fertil Steril 1998; 70: 878-82

** Visser et al. J Assist Reprod Genet 1993; 10: 37-43

Uterine contractions



- Uterine contractions frequency 4.3 /min.
- The higher freguency the less preggnacy rate .

- P4 effects to decrease the frequency of contrations.

Fanchin R, Hum Reprod 1998;13:1968–74.

- The directions of Uterine contractions during Luteal phase is usually cerviko-fundal. (it explains the increased rate of ectopic pregnancies at IVF/ICSI procedure).

Lesny P, Hum Reprod Update 1998;4:440–5.

- The directions of Uterine contractions change to fundo- cervial directions when the the transfer is difficullt one and frequency increases.

Lesny P, Hum Reprod Update 1998;4:440–5.

Uterus position / transfer speed

Summary of the contribution of injection speed of the transferred volume to the potential of embryo implantation at the fundus region.

Parameter	Anatomical posture: Retroversion (Horizontal model)		Anatomical posture: Anteversion (Tilted model)	
Catheter tip–fundus distance (cm)	2	0.5–1	2	0.5–1
Slow speed (25 s)	↓	↓	↑↑	↓ (Ectopic)
Fast speed (1 s)	↑	↓	↑	↓ (Ectopic)

Note: ↑, increased potential for implantation; ↑↑, great potential for implantation; ↓, decreased potential to reach fundal area.

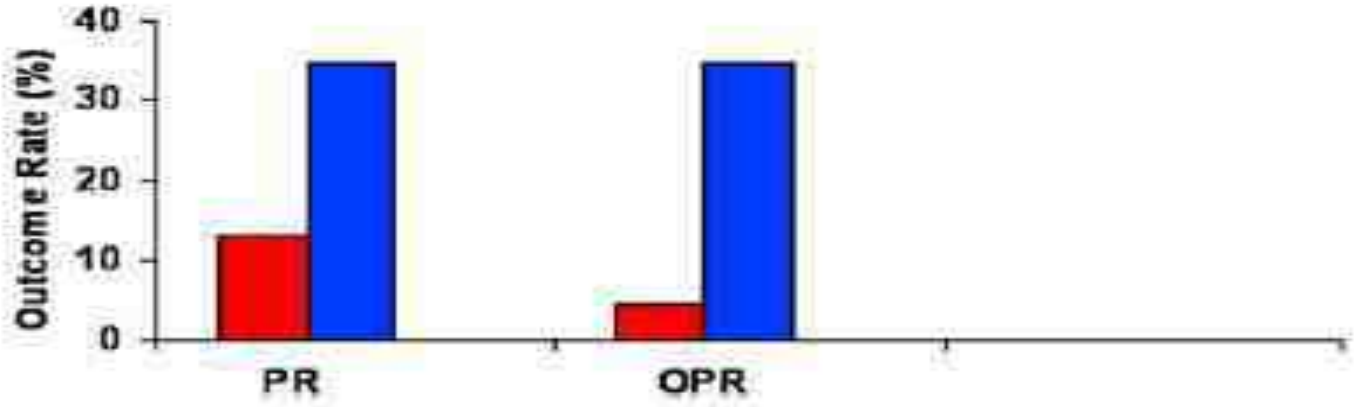
Eytan. Physical features of ET protocol. Fertil Steril 2007.

Effect of delayed versus immediate embryo transfer catheter removal on pregnancy outcomes during fresh cycles

there were no differences in terms of clinical pregnancy rates ongoing pregnancy rates and spontaneous abortion rate

FIGURE 1

Comparison of pregnancy in outcomes in two subsequent cycles with intermediate technique (red) versus delayed technique (blue). PR=clinical pregnancy rate; OPR=ongoing pregnancy rate/ delivery rate. OPR, *P= .039 by McNemar's analysis.



Sroga. Correspondence. Fertil Steril 2010.

Results do suggest that timing of catheter removal may alter pregnancy rates in patients with a previously failed ET. Patients that have failed an initial embryo transfer may be more sensitive to contractions, and leaving the catheter in place 60 seconds may help stabilize the uterus during ET.

Difficult embryo transfers or blood on catheter and assisted reproductive outcomes: a systematic review and meta-analysis

Phillips JAS, Eurp j obst gynec and repr B, 2013

A difficult embryo transfer (defined subjectively or by the need for additional instrumentation) was associated with a reduced chance of achieving pregnancy, The results of the review are limited by the different definitions used to define a difficult embryo transfer.

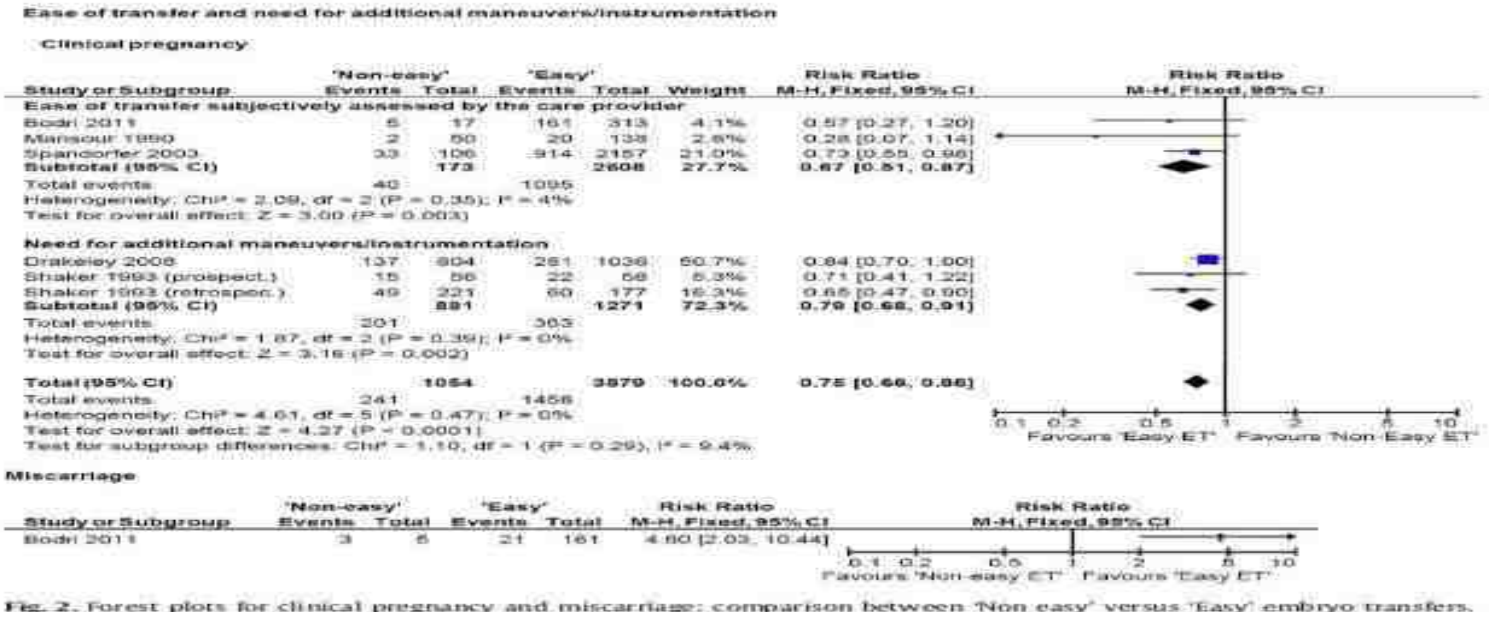


Fig. 2. Forest plots for clinical pregnancy and miscarriage: comparison between 'Non easy' versus 'Easy' embryo transfers.

Table 2
Summary of findings for the effect of difficult embryo transfer on clinical pregnancy and miscarriage.

	Illustrative comparative risks[a] (95% CI)			Relative effect (95% CI)	No. of participants (studies)	Quality of the evidence (GRADE)
	Assumed risk Control	Corresponding risk Difficult embryo transfer[b]	Risk difference			
Clinical pregnancy (per allocated woman)	37.6%	28.2% (24.8–32.3%)	−9.4% (−12.8% to −5.3%)	RR 0.75 (0.66–0.86)	4933 (6 studies)	⊕⊕⊕⊖ low[c]
Miscarriage (per clinical pregnancy)	13.0%	60.0% (26.5–100%)	47.0% (13.5–87.0%)	RR 4.60 (2.03–10.44)	166 (1 study)	⊕⊖⊖⊖ very low[d]

The difficulties encountered with embryo transfer and the role of catheter choice in clinical pregnancy success rates in an IVF cycle

Cem Fiçicioglu, M.D., Ph.D., et all, Middle East Fertility Society Journal. 2005

- **Table 1.** The distribution and results of groups
- Easy Transfer
- GROUP 1 (n: 826)
- Moderately Difficult Transfer
- GROUP 2 (n: 284)
- Difficult Transfer
- GROUP 3 (n: 47)
- Clinical pregnancy rate 41.4% 36.2% 17%, respectively

Easy Transfer' describes the transfer, which is performed only with the use of Wallace soft transfer catheter without any resistance.

'Moderately Difficult Transfer' describes the resistance to the soft transfer catheter and the use of Malleable transfer catheter and requiring some soft manipulation.

'Difficult Transfer' describes the requirement of Tenaculum using, need of cervical dilatation,

EASE OF THE PROCEDURE

- **The transfer could be considered difficult:**

- ✓ **if time spent on ET was long,**
- ✓ **if a firmer catheter, additional maneuvers and/or instrumentation, sounding or cervical dilatation were needed**
- ✓ **if the resistance to the catheter advancement was encountered,**
- ✓ **the presence of blood on the transfer catheter was noted**

- ❖ **But there is no universally accepted definitions !**
- *Difficult ET is more common in cases with severe anteflexion, retroflexion or anteversion and retroversion of the uterus and cervical stenosis. The presence of blood on the transfer catheter results from traumatic cervical passage of the catheter, subclinical infection, or endometrial bleeding due to traumatic contact with the catheter*

Immediate ambulation after embryo transfer: a prospective study

Itai Bar-Hava, M.D., Ram Kerner, M.D., Rakefet Yoeli, M.D., Jacob Ashkenazi, M.D., Yosef Shalev, M.D., and Raoul Orvieto, M.D., M.Sc.

Immediate ambulation following the ET procedure has no adverse influence on the ability to conceive.

	Study group (immediate mobilization) n = 167	Control group (bed rest) n = 239
Age (y)	34.2 ± 0.46	34.2 ± 0.39
No. of previous IVF cycles	3.2 ± 0.3	4.0 ± 0.3
No. of gonadotropin ampules used	33.6 ± 1.4	31.7 ± 1.2
E_2 level on day of hCG administration (pmol/L)	4,338 ± 327	4,411 ± 285
Progesterone level on day of hCG administration (nmol/L)	4.8 ± 0.3	4.3 ± 0.25
No. of oocytes retrieved	8.7 ± 0.49	9.5 ± 0.44
Fertilization rate (%)	57 ± 2	59 ± 2
No. of embryos transferred	2.7 ± 0.12	2.9 ± 0.11
% of day 2 transfer	52	48
No. of grade A embryos transferred	1.7 ± 0.11	1.9 ± 0.11
% of patients undergoing ICSI	55	50
Pregnancy rate	41/167 (24.55%)	51/239 (21.34%)

Bar-Hava I. Fertil Steril 2005.

conclusions

- Evidenced based
  - To avoid difficult transfer
  - Recommend usg guided transfer
  - Soft catheter

Mains L, Fertil Steril 94,2010

- Recommendations
  - Mock transfer or after load technique
  - Cleaning cervikal mucus
  - Embryo should be deposited “midportion”
  - Withdraw transfer catheter slowly
  - Minimaze time interval between embryo loading and transfer

Semin Reprod Med 2014 taraş B, Özcan P. 2013

Thank you

Practice of Embryo Transfer: Recommendations During and After

Bulent Tıras, MD[1] Pinar Ozcan Cenksoy, MD[2]

Expectations

- To avoid disruption of the endometrium by the catheter
- To minimize induction of the uterine contractions
- To protect the embryo(s)
- To deposit the embryo(s) in an optimal position within the uterine cavity

Semin Reprod Med 2014

Practice points

- Use ultrasound guidance with full bladder and trial (mock) transfer to avoid "difficult" transfers, touching the fundus, using additional maneuvers and/or instrumentation, and the presence of blood on the transfer catheter
- Gentle manipulation, use of a soft catheter to avoid inducing uterine contractions and to avoid trauma to the cervix and endometrium
- Routine removal of cervical mucus to decrease the incidence of retained embryos and cervical and endometrial contamination
- Do not use vaginal antiseptics to avoid potential toxicity to the embryos
- Do not recommend the administration of antibiotics during embryo transfer
- Use the "three-drop technique" for loading the embryo(s)
- Use minimum ejection speed to prevent embryo expulsion
- Withdraw transfer catheter slowly after the deposition of embryo
- Minimize the time interval between loading the embryo and embryo transfer
- Routinely check the catheter, cervix, and speculum following transfer to detect retained embryos
- Perform fundal transfer
- The optimal distance between the most distal fundal endometrial surface and the tip of inner catheter should be 1.5–2 cm

Pressure changes during embryo transfer

ET can cause rapid pressure fluctuations in the transferred liquid. Therefore, it is advisable to transfer the embryo gently with minimum ejection speed, to avoid exposing the embryo to the steep pressure gradient

TABLE 1

Pressure changes, time and speed of injection of transferred volume recorded during 30 mock embryo transfers.

	Mean	SD	Minimum	Maximum
Peak pressure during transfer (mm Hg)	76	37	14	155
Pressure increase slope (mm Hg/s)	26,682	16,595	2,656	72,437
Pressure decrease slope (mm Hg/s)	61,742	34,209	8,375	144,250
Time of injection of transferred volume (s)	0.021	0.006	0.011	0.032
Speed of injection of transferred volume (m/s)	12.1	3.5	7.5	21.8

Grygoruk. Embryo transfer: part I. Fertil Steril 2011.

TABLE 2

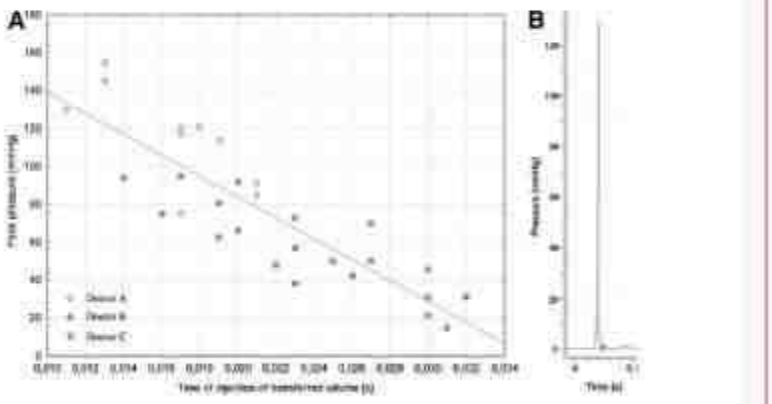
Pressure changes (in mm Hg) recorded during ejection of transferred volume for doctor A (10 transfers), doctor B (10 transfers), and doctor C (10 transfers).

	Doctor A	Doctor B	Doctor C	Together
Mean peak pressure (SD)	116 (25)[a]	66 (25)	47 (20)	76 (37)
Minimum	76	31	14	14
Maximum	155	95	73	155

[a] $P < 0.05$.

Grygoruk. Embryo transfer: part I. Fertil Steril 2011.

FIGURE 1



UTERINE CONTRACTIONS

- **A tenaculum applied to the cervix during mock ET increased uterine contractions***

- **Uterine junctional zone contractions decrease with progesterone into the luteal phase, and this may be a contributing factor in the success of day 5 blastocyst-stage ET****

* Lesny et al. Hum Reprod 1999; 14; 2367-70

** Lesny et al. Fertil Steril 1999; 72: 305-9

UTERINE CONTRACTIONS

- Capillary action or a negative pressure created by withdrawing the catheter could draw embryos into the cervix
- Embryos may stick to the outside of the catheter and could then be wiped onto the cervical mucus during catheter withdrawal
- Unwanted uterine contractions may also be a cause of embryo expulsion

CONCLUSION

The relative importance of factors important for successful embryo transfer.[a]

Priority	Mean score[b]
Removal of hydrosalpinges	6.8
Absence of blood or mucus	6.6
Type of catheter	6.1
Not touching fundus	5.8
Avoiding tenaculum	5.7
Removal of all mucus	5.2
Ultrasonography of cavity before procedure	4.3
Leaving catheter in place for 1 minute	4.2
30 minutes of bed rest	3.8
Trial transfer	3.1
Ultrasonographic monitoring	2.6
Antiprostaglandins to prevent uterine contractions	1.9

[a] Data from reference 11. **Kovacs GT. Hum Reprod 1999; 14: 590-2**

[b] The possible score for each factor was on a scale of 1 to 10.

Schoolcraft. Embryo transfer. Fertil Steril 2001.

CONCLUSION

Variables affecting the success of embryo transfer.

Effect	Degree of impact
Positive	
Cervical lavage	+
Catheter type (soft)	+
Loading catheter by limiting volume and air	++
Presence of a trial transfer	+++
Precycle cervical dilatation (if necessary)	++
Ultrasonographic guidance	++
Late luteal transfer (day 5)	+
Negative	
Blood on catheter	+++
Mucus on catheter tip	+
Retained embryos	+
Bacterial contamination of catheter	+++
Excessive uterine contractions	++
Subjective assessment of difficulty of transfer	+

Schoolcraft. Embryo transfer. Fertil Steril 2001.

CONCLUSION

Protocol for embryo transfer, based on key factors associated with success.

Precycle trial transfer
Transabdominal ultrasonographic guidance with full bladder
Cervical lavage with culture media to remove excess mucus
Practice transfer just through internal os
Wallace catheter, 30 μL volume, embryos in last 10 μL of fluid, continuous fluid column to syringe
Gentle insertion: manipulate cervix with speculum, ring forceps as necessary to negotiate internal os
Use ultrasonography to avoid catheter tip disrupting endometrium; avoid touching fundus
Inject embryos slowly 1.5 cm from fundus as confirmed by ultrasonography withdraw catheter slowly
Inspection of catheter by embryologist for blood, mucus, or retained embryos

Schoolcraft. Embryo transfer. Fertil Steril 2001.

FUTURE PERSPECTIVES

Improvement of pregnancy rate by modification of embryo transfer technique: a randomized clinical trial

In this randomized trial study, two groups of infertile women (n = 55) aged ≤40 years underwent in vitro fertilization or intracytoplasmic sperm injection treatment cycles with or without 0.2 mL of air pushed into the catheter after embryo transfer. The implantation and clinical pregnancy rates were statistically significantly higher in the study group than in the controls. This improvement on standard ET technique may advance clinical pregnancy rates. (Fertil Steril® 2010;■:■–■. ©2010 by American Society for Reproductive Medicine.)

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The presence of blood in the transfer catheter negatively influences outcome at embryo transfer*

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BACKGROUND: Embryo transfer (ET) influences pregnancy rates in patients undergoing assisted reproduction. Data are conflicting as to which variables affect ET success. This study examines variables that may affect outcome after ET in assisted reproductive technology patients who had high-quality embryos transferred. METHODS: Over a 23 month period, 669 consecutive cycles were examined. Only patients having grade I and grade II embryos, or blastocyst transfers, were included in this retrospective analysis. A total of 584 consecutive cycles met study criteria. At the time of ET, the following variables were recorded: aborted first attempt at ET; presence of blood and/or mucus in or on the transfer catheter after ET; ease of ET as judged by provider; need for mock embryo transfer immediately before the actual transfer and retention of embryos in the transfer catheter. These variables were retrospectively analysed for their impact on implantation rate (IR) and clinical pregnancy rate (CPR). RESULTS: There were 290 gestations (49.7% CPR). Multiple attempts at ET, subjective difficulty of ET, performance of a sham pass immediately prior to embryo transfer, and presence of mucus on or in the catheter did not affect the CPR or IR. No difference was noted in the mean age of patients having or lacking any of these factors. There was a significant association between the presence of blood on or in the catheter and decreased IR ($P = 0.015$) and CPR ($P = 0.004$). Retained embryos also decreased IR ($P = 0.03$). Multivariable analysis confirmed that the presence of blood on the transfer catheter was the most important of these transfer characteristics in predicting IR ($P = 0.042$) and CPR ($P = 0.018$). CONCLUSIONS: These results suggest that when only high-grade embryos or blastocysts are transferred, the presence of blood on the catheter is associated with decreased IR and CPR in assisted reproduction.

BLOOD OR MUCUS EFFECTS

Table III. Strength of the association between implantation rate (dependent variable) and blood on or in transfer catheter, retained embryos at transfer, difficulty of transfer, mucus on or in transfer catheter, need for a sham transfer prior to actual procedure or aborted initial attempt at transfer, using analysis of covariance

Parameter	*F*	*P*
Blood on/in catheter	3.7	0.04
Retained embryo at transfer	3.2	0.07 (NS)
Difficulty of transfer	0.3	0.56 (NS)
Mucus in catheter	0.7	0.38 (NS)
Sham at transfer	0.3	0.62 (NS)
Aborted transfer	0.01	0.89 (NS)

NS = not significant.

BLOOD OR MUCUS EFFECTS

Table IV. Strength of the association between CPR (dependent variable) and blood on or in transfer catheter, retained embryos at transfer, difficulty of transfer, mucus on or in transfer catheter, need for a sham transfer prior to actual procedure or aborted initial attempt at transfer, using logistic regression

Parameter	*P*
Blood on/in catheter	0.01
Retained embryo at transfer	0.49 (NS)
Difficulty of transfer	0.80 (NS)
Mucus in catheter	0.18 (NS)
Sham at transfer	0.32 (NS)
Aborted transfer	0.94 (NS)

NS = not significant.

TRANSFER CATHETER TYPE

- **However, in technically difficult ET, particularly where difficulties are encountered negotiating the internal cervical os, there is often a need for the stiffer hard catheters**

- **Hard embryo catheters:**
  - **TDT (Laboratoire CCD, Paris, France)**
  - **Frydman (Laboratoire CCD)**
  - **Tomcat (Kendell Health Care, Hampshire, MA)**
  - **Tefcat (Kendell Health Care)**
  - **Rocket ET catheters (Rocket Medical,Watford, UK)**