Variable Intrauterine Pressure Catheter (IUPC) Tracings with Two Catheters

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ABSTRACT

OBJECTIVE: Accurate intrauterine pressure catheter (IUPC) readings are critical for the management of complicated labor. Two basic IUPC designs are currently available for assessment of intrauterine pressure in labor, one in which both the pressure sensor and transducer are at the catheter tip and intrauterine (Intran Plus IUP-400, Utah Medical Products, Utah) or one in which the transducer is extrauterine (Koala Balloon IPC 5000E, Clinical Innovations, Utah).

These two IUPC models were tested in a controlled artificial amniotic sac simulation under various unobstructed and obstructed conditions to assess their accuracy.

STUDY DESIGN: Both models were placed in duplicate in a liquid filled pressure vessel and subjected to no, partially, or fully obstructed scenarios utilizing direct or partial occlusion with pig uterus around the distal catheter tip while applying simulated contractions.

RESULTS: Unobstructed IUPC pressure readings were slightly, but not significantly different (within 5 mm Hg of reference baseline) for both catheters. However partial obstruction generated significant variability, with elevated baselines (up to 25 mm Hg), lower peak amplitudes (up to 30 mm Hg) and lower total contraction strengths (up to 45% reduction) for the external transducer device only.

Re-zeroing the external transducer catheter did not fully correct the false readings and resulted in a lowering of both the baseline and peak amplitude below reference values. The internal transducer did not develop any significant variations at any partial obstruction. However, total obstruction of the internal transducer tip created an elevated baseline.

CONCLUSION: The two IUPCs reacted differently in models of partial to total intrauterine obstruction with the internal transducer device recording pressure more consistently. External transducer tracings were more susceptible to variations (up to 60%) in simulated intrauterine compressions, and were not corrected by recommended "re-zero" maneuvers.

INTRODUCTION

Intrauterine pressure catheters have evolved from plastic, saline-filled tubes connected to an external pressure transducer dome to disposable units which offer greater convenience and sterility advantages. At no point in this evolution have intrauterine pressure catheters been trouble-free. Abnormal wave forms have long been understood to represent problems with catheter placement. Two types of catheters are in common usage. One of these (Koala, Clinical Innovations, Inc., Murray, UT) uses a column of air to connect a balloon in the amniotic cavity to an external pressure transducer. The other (Intran Plus, Utah Medical Products, Midvale, UT) places the transducer directly in the uterus. A previous study (Dowdle, J Reprod Med 2003;48:501-505) concluded that under conditions of active labor, the two catheter types recorded similar mean baseline uterine tone, peak pressures, contraction frequency and duration. Performance of these two catheter types under conditions where amniotic fluid communication with the sensing distal tip was impaired by tissue obstruction was not compared. The purpose of this study was to simulate conditions of partial obstruction of the catheter tip in an artificial environment to determine the performance characteristics of these two catheter types under adverse conditions of limited communication with amniotic fluid.

MATERIALS AND METHODS

No human or living animal subjects were used in any of these experiments. Contractions were simulated in a pressure vessel filled with saline and cycled at pressures which were consistent with contractions of the human uterus. The pressure vessel was fitted with a calibrated reference transducer and four ports for test catheters. Two Intran and two Koala catheters were used simultaneously in each test. Partial obstruction was induced using three methods; rubber stoppers, latex tubing, or pig uteri. The data from the catheters was recorded digitally, and presented in graphic form. The test equipment was provided by John Raynes Engineering, UT. The test chamber and the materials used for simulated obstruction are shown in the photographs on the right.

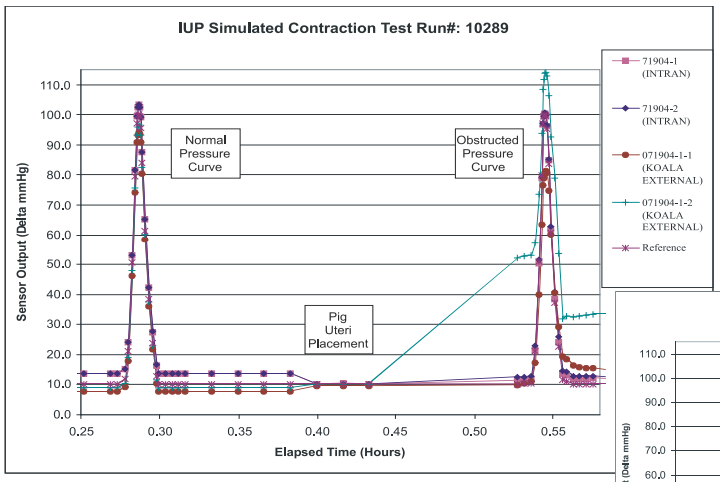
RESULTS

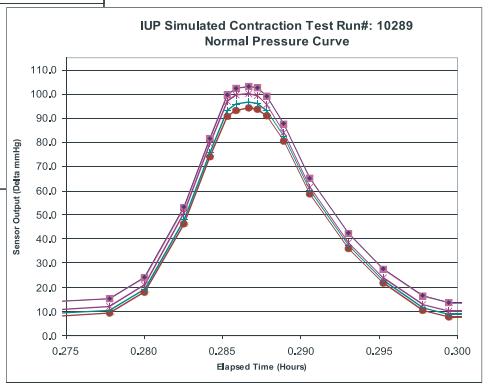
Both catheters produced similar curves under optimal test conditions in a full liquid environment. When obstructed, the air balloon catheters produced much more erratic pressure tracings than did the transducer tipped device. Some representative results are shown in graphic form on this poster (at right). Most typical of the performance of the balloon tip catheter is elevation of the baseline pressure and diminution of the contraction strength and ΔP (change in pressure [contraction intensity]) of the contraction.

Attempting to correct for the variation in balloon-tip catheter by re-zeroing according to the manufacturer's instructions did not correct the false readings. The internal transducer device was more consistent at all levels of obstruction until total obstruction occurred. In this respect, obstructive interference of the internal transducer device appeared to be an all or none phenomenon.

CONCLUSIONS

1. The two IUPC designs reacted differently under test conditions designed to simulate human uterine contractions when the catheters were subjected to partial obstruction. Such obstruction may occur clinically when the IUPC tip becomes lodged between the fetus and the uterine wall.
2. Under conditions of partial obstruction, the balloon tip catheter is more prone to be erratic. This errant behavior manifests as elevated baselines, decreased contraction maximum pressures and incorrectly decreased ΔP (contraction intensity).
3. Under certain clinical conditions, this errant behavior could result in diagnostic error that could affect an intervention decision. Examples include the use of increased resting tone to diagnose abruption of the placenta and the use of Montevideo Units to assess the adequacy of uterine contractions and govern the administration of oxytocin.
4. When the obstruction is removed from the transducer-tipped catheter, the baseline and contraction amplitude return to normal. This was not true for the balloon-tipped catheter.


IUP Simulated Contraction Test Run#: 10289
Normal Pressure Curve
Obstructed Pressure Curve
Pig Uteri Placement
Sensor Output (Delta mmHg)
Elapsed Time (Hours)
71904-1 (INTRAN)
71904-2 (INTRAN)
071904-1-1 (KOALA EXTERNAL)
071904-1-2 (KOALA EXTERNAL)
Reference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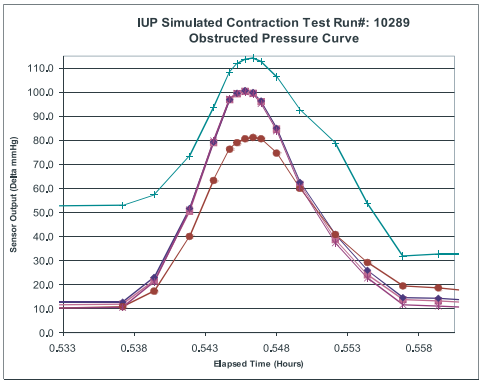
Normal Pressure Curve
Sensor Output (Delta mmHg)
Elapsed Time (Hours)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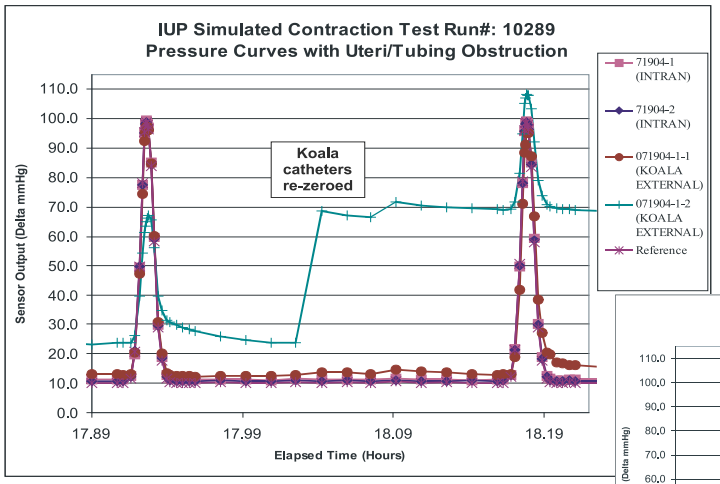
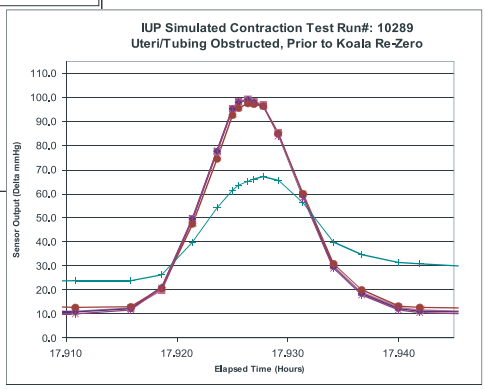
Obstructed Pressure Curve
Sensor Output (Delta mmHg)
Elapsed Time (Hours)


IUP Simulated Contraction Test Run#: 10289
Pressure Curves with Uteri/Tubing Obstruction
Koala catheters re-zeroed
Sensor Output (Delta mmHg)
Elapsed Time (Hours)
71904-1 (INTRAN)
71904-2 (INTRAN)
071904-1-1 (KOALA EXTERNAL)
071904-1-2 (KOALA EXTERNAL)
Reference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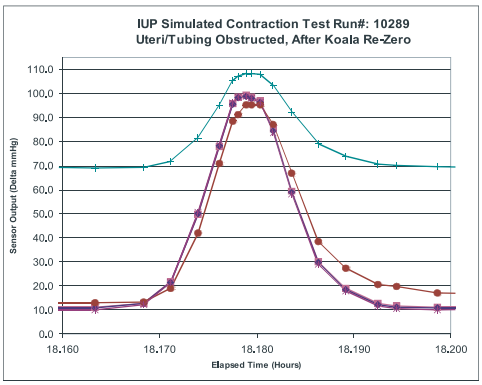
Uteri/Tubing Obstructed, Prior to Koala Re-Zero
Sensor Output (Delta mmHg)
Elapsed Time (Hours)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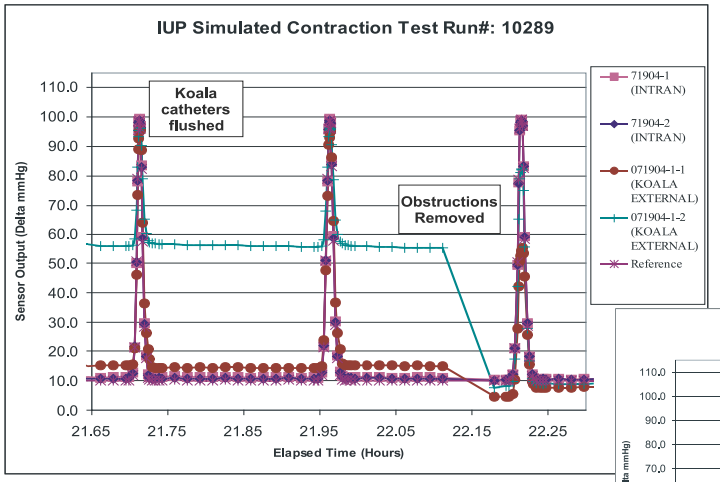
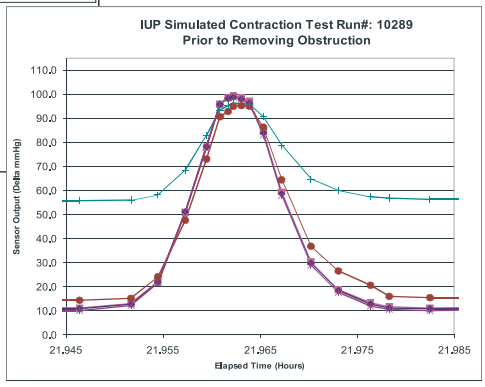
Uteri/Tubing Obstructed, After Koala Re-Zero
Sensor Output (Delta mmHg)
Elapsed Time (Hours)


IUP Simulated Contraction Test Run#: 10289
Koala catheters flushed
Obstructions Removed
Sensor Output (Delta mmHg)
Elapsed Time (Hours)
71904-1 (INTRAN)
71904-2 (INTRAN)
071904-1-1 (KOALA EXTERNAL)
071904-1-2 (KOALA EXTERNAL)
Reference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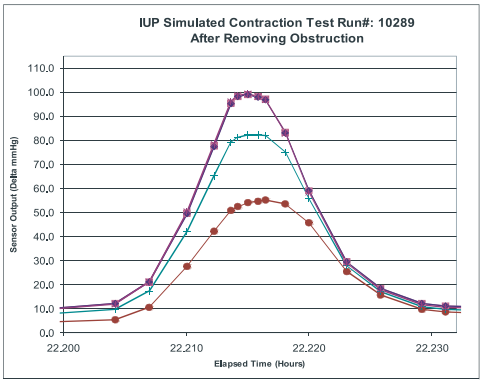
Prior to Removing Obstruction
Sensor Output (Delta mmHg)
Elapsed Time (Hours)


IUP Simulated Contraction Test Run#: 10289
After Removing Obstruction
Sensor Output (Delta mmHg)
Elapsed Time (Hours)

"The side effects of oxytocin use are principally dose related; uterine tachysystole and Category II or III FHR tracings are the most common side effects. Uterine tachysystole may result in abruptio placentae or uterine rupture."

"A numeric value for the maximum dose of oxytocin has not been established. The FHR and uterine contractions should be monitored closely"
- *ACOG Practice Bulletin No. 107, Aug. 2009 (reaffirmed in 2016)*

"Contraction frequency alone is a partial assessment of uterine activity. Other factors such as duration, intensity and relaxation time between contractions are equally important."
- *ACOG Practice Bulletin No. 106, July 2009 (reaffirmed in 2017)*

- Accurate titration of the oxytocin dose depends on knowledge of contraction intensities.
- If partial obstruction of the IUPC causes waveforms with baselines elevated and peak contraction pressures damped, calculated contraction intensities may be significantly lower than actual.

- Partial tissue obstruction of the IUPC is an inherent condition in utero.

For further information, please contact

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