

TA/TV Uterine ultrasound phantom

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This phantom is based on the work by [Nattagh et al](#) at the University of California. Their phantom was designed for brachytherapy training using an endo-rectal US probe. This phantom is designed for trans-abdominal or tran-vaginal US scanning of the uterus – for IUD location or instrumentation for 2nd Trimester dilation and evacuation to effect abortion.



Figure 1 Making the plaster half mould

The case design was largely kept the same however the uterine model was created by making a plaster cast, rather than the 3D printing that Nattagh et al use in their model. If you do have access to or funds for a printer, the Nattagh group will provide the 3D printer instructions to you.

I created a simple plaster mould using a child's babushka doll as the positive. This created a half mould that could then be filled with agar. Other options could be a pear or trimmed potato.

I had initially made a larger two piece plaster mould however using a half mould is far quicker and easier and allows one to place iUD, raisins, bones, beads in between the two halves to create a uterus. Just remember to use a bit of warm agar or US gel between the two halves to remove air voids when joining.



Figure 2 The half mould and two agar halves together





Figure 3 case, plastic bag bladder and three uterine models - blue Plasti-dip, purple paper mache and white gladwrap. Several rectangular agar blocks were used for positioning of the uterus in relation to the vaginal canal positive

In the original article, the uterus in gelatine/agar was dipped in a paintable rubber product called Plasti-dip. This both creates a echogenic layer between the uterus and the surrounding agar and protects the uterus. Plasti-Dip is available in Australia from auto-barn parts shops. As my two agar halves were too large to dip, I did try painting with the Plasti-dip which although slow was effective. I also experimented with a paper mâché covering and a Gladwrap/Saran wrap covering. The plastic wrap needs to be done with narrow 3cm strips to avoid trapping air. The paper mâché created the most robust uterus.

The three coverings were similar in echogenicity. The Gladwrap technique was the fastest, the paper mâché the strongest and the Plasti-Dip gave the neatest final product.

The acrylic sheet was purchased from Bunnings Hardware, labelled SunTuf Handiguard, a 400x400x8mm sheet (\$AUD32) with the correct glue being Selleys Multifix small jobs 30mL (\$AUD8). The case dimensions were increased slightly to enable a larger uterine model than the original paper used, to represent a 2nd trimester uterus. Final dimensions were

- 2x sides 230x160mm
- 1x base 126x230mm
- 1xback 126x15.1mm

This gave enough left over from the 400x400mm original acrylic sheet to use as the removable front face. With this Selleys Multifix Small Jobs glue, this phantom has been robust – it has travelling in checked luggage, in boxes on trains and cars without breakage.

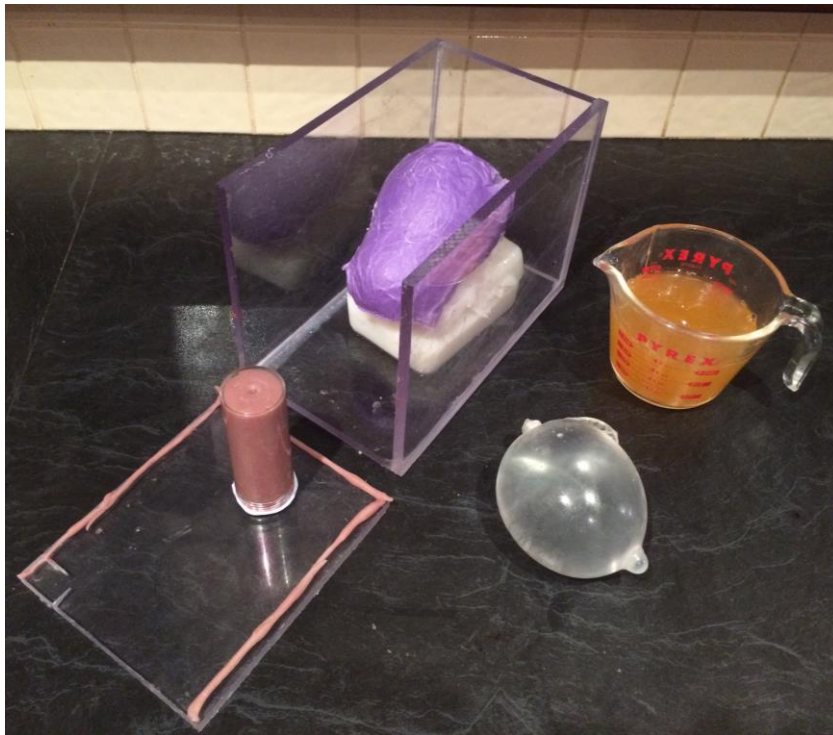


Figure 4 Case, removable faceplate with vaginal canal positive in place. condom 200mL bladder, uterus positioned on agar blocks and agar ready to pour

The case and model were then ready to be assembled. Playdough/plasticine was used to seal the removable front plate and the uterus was balanced on a cut to shape agar block. The vaginal canal positive was a craft store container, (filled with modelling clay so it wouldn't float in the agar) and held to the removable plate with Blue-Tac. The main filling Agar was made with agar flakes from an Asian Grocer, 20grams of agar threads to 1litre of water, boiled for three minutes. This creates a very stiff agar to ensure the front does not slump when the faceplates is removed.

Four scant tablespoons of Metamucil per litre was added to increase tissue density of the agar.

I have not found the ideal way to add the Metamucil to the agar as yet. Certainly, do not add it to cold water and then heat the agar and Metamucil together, this seems to potentiate the agar and create an incredibly thick mixture. Best was sprinkling Metamucil powder onto cooling agar after its 3minute boil, and let the powder settle on the surface and slowly be absorbed.

I tried Natural Metamucil which was more granular, the colour was a light brown. The sugar-free smooth Metamucil is orange flavour and gives a slight orange tint to the agar.



Figure 5 the filled, cooling phantom using natural Metamucil.

Don't put too much water in the bladder – 200-250mL, depending on the height of your agar block/uterus/vagina positive stack. The bladder top needs to be well below the final level of agar surface.

To fill this case required four litres of agar/Metamucil mixture. Once poured in, make sure it has plenty of time to cool before removing the face plate and withdrawing the vaginal canal positive. The vaginal canal positive needs a wooden skewer or similar slide down it to let some air in

between the positive and the agar to allow the positive to be withdrawn.



The condom created a much better bladder than the plastic bag. The crinkles in the plastic bag created some internal echoes in the bladder. The bladder needs to be held in place centred above the end of the vaginal canal and over the uterus. The bladder has a tendency to slide down and so a string to hold the bladder in place and stop this sliding down off the uterus is important. Staging the agar/gelatine pours so that some of the agar in the lower levels is

solid and supports the vaginal canal positive and uterus from the weight of the bladder.

This is an example of the TA view of this phantom



Figure 6 Bladder, uterus, IUD in transverse, this was with the paper mâché uterus covering. Machine is a Mindray 6600 with curvilinear probe



Figure 7 Bladder (tip of condom obvious) sagittal paper mâché covered uterus with IUD in endometrial cavity.. Machine is a Mindray 6600 with curvilinear probe



Figure 8 TV probe, sagittal through uterus. Orientation is more straight from vaginal canal than a true retroverted or anteverted appearance. Machine is Mindray 6600

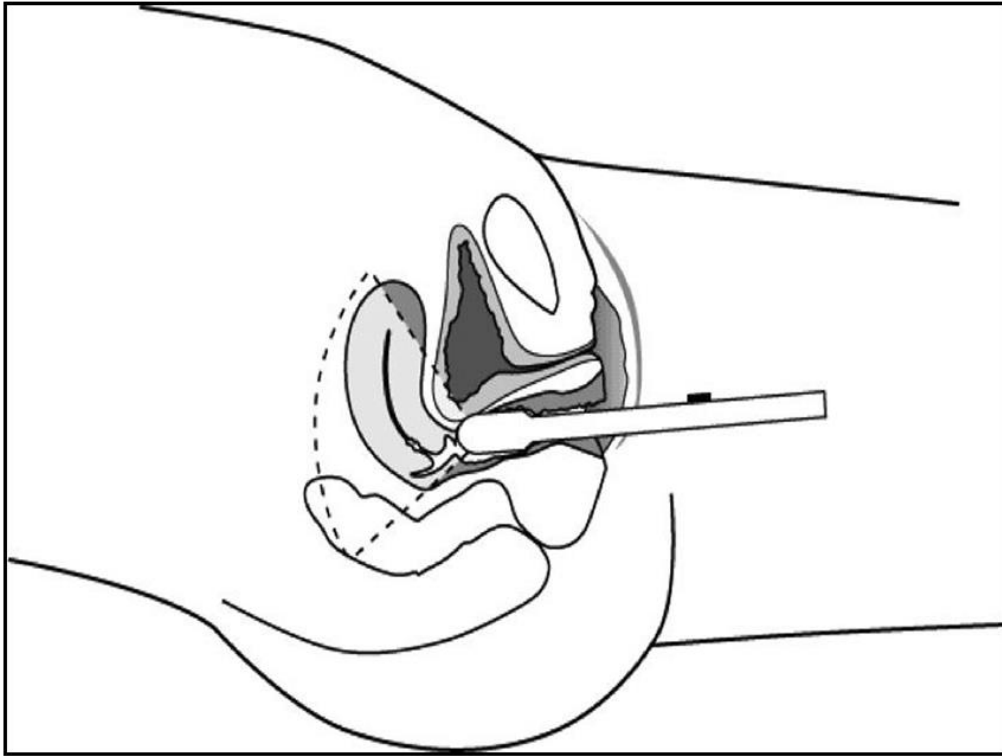


Figure 9 Future versions would better replicate anatomy for TV scanning by having the uterus more vertically in relation to the vaginal canal.



Figure 10 TV scanning with the phantom



Figure 11 scanning the phantom with the Signos RT handheld US. This workshop was at the 2017 Children by Choice conference. Dr Ea Mulligan's early pregnancy phantom is in the foreground.

This is the link to the original paper that this design was based on:

http://www.ultrasoundtraining.com.au/sb_cache/news/id/334/f/2014-Nattagh-phantom-for-us-needle-insertion-suturing.pdf