ASSESSING THE IMPACT OF CATHETER COATING COMPONENTS ON SPERM MOTILITY & SPERM MORPHOLOGY

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Background and Hypothesis

Hydrophilic intermittent urinary catheters with coatings containing **polyvinylpyrrolidone (PVP)** effectively manage chronic urinary retention, often resulting from neurogenic bladder conditions, most notably spinal cord injury (SCI)[1]. However, these coatings can delaminate during catheter withdrawal, leaving PVP residue in the urethra[1]. High frequency of catheter use and lack of natural flushing in SCI patients can exacerbate this, causing a build-up of PVP.

Interestingly, PVP is proven to reduce **spermatozoa motility** as it is exploited clinically for intracytoplasmic sperm injection and under long-term exposure can alter **spermatozoa morphology**[2]. Moreover, SCI patients are predisposed to infertility[3]. It is postulated that repeated urinary catheterisation may expose spermatozoa to PVP and further affect user **fertility**.

Study Aims

1. **Assess the extent of coating loss from four commercially available PVP-containing catheters following repeated insertions within an ex vivo porcine model.**
2. **Determine how PVP residue affects sperm morphology.**
3. **Determine how PVP residue affects sperm motility.**

Study design, materials and methods

Quantifying PVP-coating loss due to delamination

Four commercially available urinary catheters with PVP-based coatings were cut into 6 cm segments (including the tip) and inserted into an *ex vivo* urethral porcine model (360° model). Following catheterization, the coating was manually removed and weighed. The amount of coating was then compared to coating from 6cm catheter segments that had not been catheterised. The difference was calculated and the % w/w loss in coating was determined.

Solutions of PVP (molecular weight 360,000 (K90) dissolved in phosphate buffered saline (PBS)) based on loss of coating were prepared, representing the average frequency of catheter insertion: one insertion, five insertions (daily) and 35 insertions (weekly).

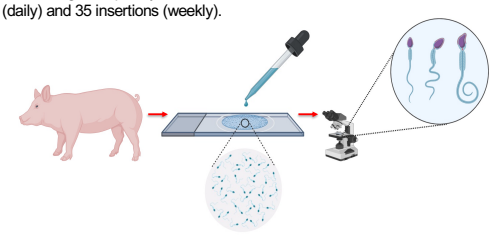

Figure 1. Diagram illustrating the evaluation of porcine spermatozoa morphology.

Spermatozoa Morphology & Sperm Motility

Porcine semen (Deer Park, Gloucester Old Spot) was enumerated using a haemocytometer and diluted in PBS to an average human sperm count of 23.5 million sperm per mL. Subsequently, 1.5 mL of diluted sperm (a volume representative of average human ejaculate) was heated to 34 °C and exposed to the prepared solutions of PVP for 5 minutes.

Immediately following exposure, the percentage of abnormal sperm morphology was assessed microscopically by identifying defects in the spermatozoa head, midpiece, and tail (**Figure 1**). Videos of spermatozoa were captured at random fields of view. Spermatozoa motility (µm/sec) was analysed by ImageJ software, measuring the distance travelled by spermatozoa in one second.

Results and interpretation

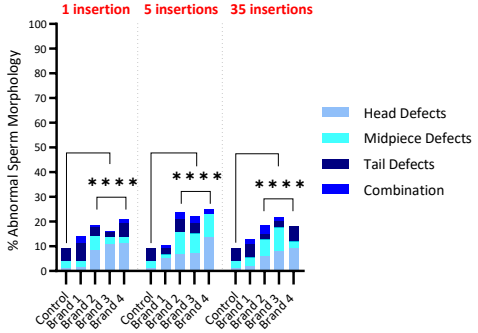

Figure 2. Percentage abnormal spermatozoa morphology following 5 min exposure to 360 K MW PVP concentrations representing 1, 5 and 35 insertions. A two-way ANOVA with Tukey's multiple comparisons test was performed (n=5). Asterisks denote statistically significant differences, with **** P ≤ 0.0001.

Spermatozoa Morphology

The percent of spermatozoa displaying abnormal morphology significantly increased relative to control for PVP containing brands 2,3 and 4 for all catheter insertions. No statistical significance in spermatozoa abnormalities were observed for each catheter between insertions, indicating that repeated insertions have no effect (**Figure 2**). For all brands and insertions, a range of abnormalities were observed, with head and midpiece abnormalities being the most predominant (**Figure 3**).

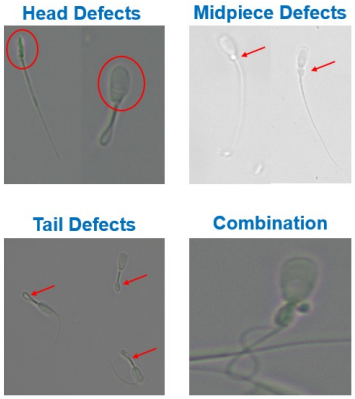

Figure 3. Spermatozoa abnormalities observed following exposure to 360 K MW PVP.

Spermatozoa Motility

A sequential reduction in spermatozoa motility was observed as insertions increased (**Figure 4**). Motility following exposure to PVP solution representing 1 insertion was < 9.51 ± 1.94. µm/s, decreasing to < 8.05 ± 1.76 µm/s for 5 insertions and to < 2.70 ± 2.10 µm/s for 35 insertions.

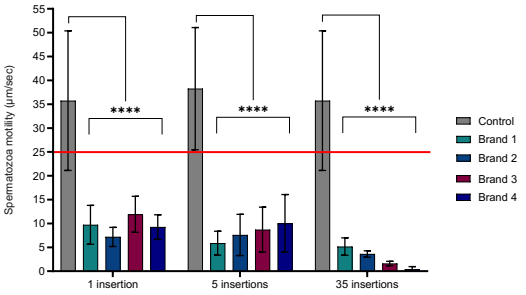

Figure 2. Spermatozoa motility (µm/sec) following 5 min exposure to 360 K MW PVP concentrations representing 1, 5 and 35 catheter insertions. A two-way ANOVA with Dunnett's multiple comparisons test was performed (n=5). Asterisks denote statistically significant differences, with **** P ≤ 0.0001.

Catheter coatings containing PVP, while beneficial for increasing lubricity and improving catheter insertion may have negative effects on sperm health. In this study, an amalgamation of tail, head and midpiece abnormalities were observed following 5 min exposure to PVP. These structural defects can disrupt flagellar movement and impair the sperm's ability to travel effectively through the reproductive tract. Additionally, motility across all catheter brands and insertions fell below 25 µm/s, a critical threshold for successful fertilisation.

Conclusions

Exposure to PVP was found to negatively affect spermatozoa morphology and motility. Findings from this work suggest that PVP accumulation within patients' urethras may have the potential to impact fertility.

Future work is necessary to investigate the relationship between this preliminary data and the effect of residual PVP in the urethra.

References

1. Pollard (et al.), Biotribology 2022; 32:100223.
2. Sabour (et al.), Andrologia 2022; 54: e14402.
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