

Comparison of Catheter Tip Style, Placement, Locking Solutions and their Influence on Catheter Patency in Sprague Dawley (SD) Rats

A. Evans, S. Gledhill, P. Sparks, T. Gleason. Charles River, Ashland, OH, United States; V. Karicheti. Charles River, Wilmington, MA, United States

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1 ABSTRACT

Transcutaneous buttons are a proven refinement for intravenous (IV) infusion and blood sampling compared to traditional vascular access ports by reducing pain and distress from repeat needle punctures; however, there are still issues with patency. To further explore patency issues, an 8-week study on patency was conducted in SD rats comparing catheter tip styles, placement, and locking solutions with and without anticoagulant. Surgeries were conducted at the animal vendor and animals were transported to the study site. Twenty animals/sex were surgically implanted with a femoral vein catheter (FVC) with a round-tip placed at the approximate level of the renal veins (FVC-RV); 20 animals/sex received a FVC with the tip placed in the vena cava (FVC-VC) (10/sex with round-tip (RT), 10/sex with blunt-tip (BT)) (Fig 1); 20 animals/sex received a jugular vein catheter (JVC) with tip placed close to the atrium (10/sex RT, 10/sex BT). Patency was checked weekly, and catheters were locked with 20 IU/mL heparinized saline except for 10 animals/sex (FVC-RV) which were locked with 0.9% sterile saline. Animals were socially housed (Fig. 2); body weights and clinical observations were collected weekly. When comparing catheter tip styles regardless of placement, 79% of animals with RT style catheters maintained bidirectional patency for the duration of the study compared to 35% with BT. Seventy percent of FVC-RV and FVC-VC animals combined remained bidirectionally patent, while JVC animals had a 53% patency rate. Animals with FVC-RV placement were 87% bidirectionally patent compared to 70% of FVC-VC animals. Eighty-five percent of FVC-RV animals locked with saline remained bidirectionally patent compared to 89% of FVC-RV animals locked with heparinized saline. All animals were patent for infusion. FVC-RV with RT style catheters provided the best outcome for blood sampling and IV infusion indicating tip style and position are important for long term patency.

2 METHODS

Sixty male and 60 female rats were used to compare different catheter tip styles, placement and locking solutions to assess differences on catheter patency. The animals were surgically implanted at the vendor with catheters attached to Vascular Access Buttons (VAB). Forty per sex were implanted with a femoral vein catheter, twenty with the catheter tip (round tip style) advanced in the inferior vena cava to the approximate level of the renal veins and twenty with tip placement in the inferior vena cava just cranial to the bifurcation of the right and left iliac veins, (10 round tip style and 10 blunt tip style). Twenty per sex were implanted with a jugular vein catheter, half with a blunt tip and half with a round tip. Body weights and detailed physicals were collected weekly, and cage side observations were collected daily (Monday – Friday). Patency was checked once weekly for 8 weeks by removing the protective caps and swabbing the pinport with alcohol prior to accessing with a syringe of sterile saline attached to a needleless injection cap and a pinport injector. An attempt was made to withdraw the previous solution from the internal catheter and the catheter was flushed with sterile saline. The systems were then flushed with heparinized saline at a concentration of 20 IU/mL administered using a positive pressure push except for ten males and ten females (Group 2) with round tip catheters advanced to the level of the renal veins that were flushed with only sterile saline. Animals were noted as “patent” or “unidirectionally patent” at the time of weekly access. A catheter was considered patent if blood was able to be withdrawn from and fluid administered into the system. It was considered unidirectionally patent if fluid could be administered into the system, but blood could not be withdrawn. At the completion of study necropsy was conducted and catheter tip sites and gross lesions were collected. The study was approved by the IACUC prior to start.

3 RESULTS

Body weights and body weight gains were similar across groups. The majority of clinical signs noted across groups were attributed to the surgical procedure and included scabbing and swelling at the dorsal implantation site. Most resolved within a few days following receipt. Eye opacities noted in Groups 1-5 animals are thought to be a result of using injectable ketamine anesthesia during surgery. There were seven total animals that did not survive to the end of the study. Two animals (one Group 2 male, and one Group 6 female) had undetermined causes of death. One male in Group 4 was euthanized due to injuries resulting from fighting with a cage-mate. The other four (three females in Group 5 and one male in Group 6) showed signs of thrombi upon histopathology examination. When comparing overall patency data between the round tip groups (Groups 1, 2, 3, and 6) to the blunt tip groups (Groups 4 and 5) regardless of catheter placement or gender, 79% of round tip animals had bidirectional patency until the end of the study compared to 35% of blunt tip animals. When comparing overall patency for the 0.9% saline lock group (Group 2) compared to the round tip groups that used an anticoagulant lock groups (Groups 1, 3, and 6), 85% of the 0.9% saline lock animals had bidirectional patency until the end of study compared to 76% of the anticoagulant lock animals. When comparing patency of the femoral vein groups with round tip placed at the approximate level of the renal veins (FVC-RV) (Groups 1 and 2) to the femoral vein group with round tip placed just cranial to the bifurcation of the iliac veins (FVC-VC) (Group 3) regardless of locking solution, 87% of the FVC-RV animals had bidirectional patency until the end of the study compared to 70% of the FVC-VC animals

Group	Placement	Catheter Tip Location	Tip Style	Heparinized Saline/Saline	Number of Animals	
					M	F
1	Femoral	RV	Round	Hep-20 IU/mL	10	10
2	Femoral	RV	Round	Saline	10	10
3	Femoral	VC	Round	Hep-20 IU/mL	10	10
4	Femoral	VC	Blunt	Hep-20 IU/mL	10	10
5	Jugular	Jug	Blunt	Hep-20 IU/mL	10	10
6	Jugular	Jug	Round	Hep-20 IU/mL	10	10



Fig. 1-blunt tip (top) and round tip (bottom) catheters

RV = placement in the inferior vena cava to the approximate level of the renal veins
 VC = placement in the inferior vena cava just cranial to the bifurcation of the right and left iliac veins
 Jug = placement in the superior vena cava with the tip placed at the atrial entrance

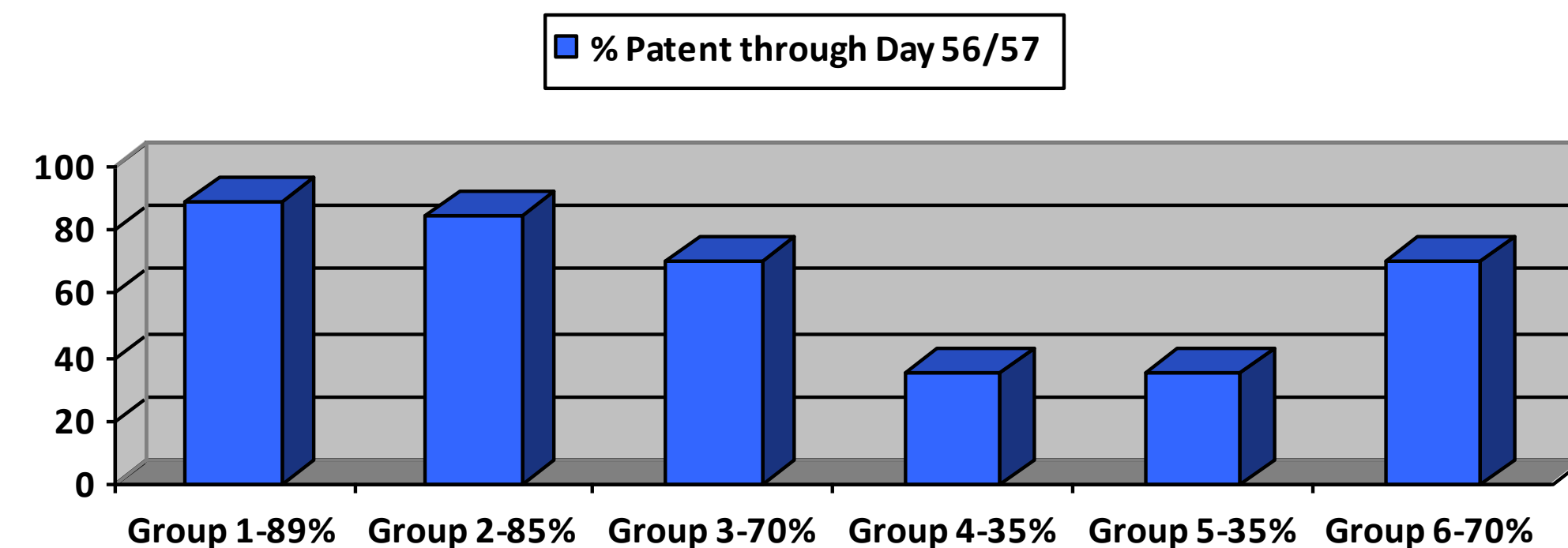


Fig. 2-VAB rats socially housed with protective metal caps

4 CONCLUSION

- All surviving animals were patent for infusion at the end of the study
- Round tip catheters (Groups 1, 2, 3, and 6) had improved patency over blunt tip catheters (Groups 4 and 5) regardless of femoral or jugular placement
- Saline only lock (Group 2) compared to the same catheter type and tip location, FVC-RV with a round tip, locked with Heparinized saline (20 IU/mL) (group 1) showed little difference in patency rates [85% vs. 89%]
- Catheters with round tips placed in the vena cava at the approximate level of the renal veins (Groups 1 and 2) compared to traditional tip placement in the vena cava (Groups 3) had a better percentage patency at the end of the study [89% and 85% vs. 70%]
- Round tip femoral vein catheters with the tip located near the level of the renal veins provided the best outcome for blood sampling and IV infusion indicating tip style and position are important for long term patency