Ease of intravenous catheterisation in dogs and cats: a comparative study of two peripheral catheters

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Abstract

Objectives: To evaluate animal comfort and ease of placement of a veterinary specific intravenous catheter compared to a catheter manufactured for human use.

Methods: Fifty-nine veterinary undergraduates were recruited to perform intravenous catheterisations with two brands of over-the-needle catheter (Smiths Medical Jelco® (human use) and Abbott Animal Health catheter® (veterinary use)) in 69 healthy cats (n = 28) and dogs (n = 41) requiring general anaesthesia. After a standardised pre-anaesthetic medication, each animal was randomly allocated to have one of the two brands of catheter placed. Each student was allowed a maximum of three attempts to achieve cephalic vein catheterisation. The student and a single experienced observer evaluated each attempt. Observations related to ease of placement and to the animal's reaction were recorded.

Results: Human use catheters were placed in 34 and veterinary use in 35 animals. There was no difference in weight, sex, or sedation score between the two groups. The number of failed attempts was similar between the two groups. There was no difference between groups for the number of animals reacting to catheter insertion.

Clinical significance: The two types of catheters evaluated are equally suitable for intravenous catheterisation of sedated animals by veterinary undergraduate students.

Keywords

Anaesthesia, Fluid therapy, Canine, Feline, Catheter placement

Introduction

Placement of short-term peripheral intravenous catheters is common practice in veterinary medicine. It is well recognised that catheterisation is an unpleasant procedure for both humans and animals, and therefore can be stressful for the staff involved (Dutt-Gupta *et al.* 2007; Van Cleve *et al.* 1996; Flecknell *et al.* 1990; Hellyer *et al.* 2007; Jacobson 1999). Despite being a routine procedure, there is limited published research on methods to decrease the discomfort and stress associated with intravenous catheter placement.

Multiple failed attempts at intravenous catheterisation have been reported to increase complication rates in human patients including infection, haematoma formation, thrombosis or extravasation of fluids or drugs (Johnson *et al.* 1998; Karapinar & Cura 2007; Mansfield & Hohn 1994). It is reasonable to assume that any catheter design feature that reduces the number of failed attempts would decrease morbidity associated with catheterisation.

A new catheter for peripheral intravenous access has recently been introduced to the veterinary market. It has a sharp needle (Abbott Animal Health 2010), which is claimed to reduce tissue trauma and pain (Suzuki & Tanaka 2004). As the Smiths Medical Jelco® catheter it is an over-the-needle non-winged catheter. But shape and length of the plastic handling and connection parts are different. It is also fitted with additional features such as a transparent hub and an asymmetric stylet handgrip to aid awareness of the bevel's orientation.

The aim of the present study was to determine if the design of the catheter makes it easier to place for undergraduate veterinary students and whether is associated with less insertional discomfort in cats and dogs, compared to a commonly used brand designed for human use.

Materials and Methods

This study was designed as a prospective, randomised, clinical trial and received approval of the University of Cambridge Department of Veterinary Medicine Ethics and Welfare Committee (CR34).

Students

Veterinary undergraduate students were recruited on a voluntary basis from the fourth and final years. Clinical training starts in the fourth year at the University of Cambridge and so the fourth year students were considered to have no or minimal experience in catheterisation as compared to final year students who are in their third year of clinical training. Students were asked if they had already attempted venous catheterisation or not. All fourth year students taking part in the study watched a video demonstrating a percutaneous technique as described elsewhere (Beal & Hughes 2000). The video was also made available for final year students requesting a teaching supplement.

Each student was allowed a maximum of three attempts to place the catheter in an allocated animal. The first and second attempts were made on the right cephalic vein if the students were right-handed and on the left cephalic vein if they were left-handed. The third attempt was made on the opposite side. The second attempt was also performed on the opposite side if the initial site was rendered unsuitable after unsuccessful attempt (e.g. haematoma formation).

Animals

Animals enrolled in the study were cats and dogs admitted for elective surgery between October 2011 and April 2012 at the Queen's Veterinary School Hospital Cambridge and classified as ASA I or II (American Society of Anesthesiologists' classification) after clinical examination. These animals required the placement of an intravenous catheter prior to anaesthesia. Owners or animal caretakers were asked for written consent prior to enrolment.

Animals were included in the study only if the single study investigator (AC) was available to assess the attempt.

Sex, weight, body condition score (BCS) (LaFlamme 1997) and baseline demeanor using a descriptive scale (Table 1) were recorded before pre-anaesthetic medication by AC throughout the study.

Pre-anaesthetic medication was administered intramuscularly in the epaxial cervical or lumbar muscles. Dogs received methadone (0.2 mg/kg - Comfortan; Eurovet Animal Health), medetomidine (0.01 mg/kg - Sedator, Eurovet Animal Health) and acepromazine (0.02 mg/kg - ACP Injection 2 mg/ml; Novartis Animal Health). Cats received buprenorphine (0.02 mg/kg - Vetergesic; Alstoe), medetomidine (0.01 mg/kg - Sedator; Eurovet Animal Health) and acepromazine (0.02 mg/kg - ACP Injection 2 mg/ml; Novartis Animal Health).

Following pre-anaesthetic medication, the degree of sedation was scored every 10 to 15 minutes for 30 minutes by the assessor (Table 1). The highest score obtained was recorded for the study. If profound sedation (sedation score of five) was achieved before the end of the thirty-minute period, catheterisation was attempted at this time. Cats and dogs that did not reach a sufficient level of sedation to allow catheterisation with minimal restraint (sedation score equivalent to three or less) within 30 minutes were excluded from the study.

Animals were excluded if their temperament did not allow a complete clinical examination or an intramuscular injection without simple restraint. They were also excluded if their cephalic veins were not suitable for catheterisation (such as presence of phlebitis or dermatitis).

Catheters

A block randomisation process was designed with four blocks to ensure homogenous distribution of catheters between species (cats or dogs) and students' year (4^{th} year or final year).

Within each block and using the randomisation function of the Excel software (Microsoft, Redmond, USA) animals were assigned to one of two groups: the Jelco group (receiving the Jelco catheter - Smiths Medical Company, Ashford, UK) and the Abbott group (receiving the Abbott catheter - Abbott Animal Health, Illinois, USA). Both catheters have the same general design and could be handled in the same manner.

Only 20 and 22 gauge catheters were used in this study. In dogs, the size of the catheter was determined for each attempt by the size of the animal based on the investigator's experience. In cats only 22 gauge catheters were used.

Catheterisation attempt

The hair was clipped over the antebrachial cephalic vein area. The insertion site was then disinfected using a routine standardised protocol.

A single investigator (AC) assessed each attempt throughout the study. This person had experience in teaching intravenous percutaneous catheterisation to students but had limited experience with either catheters.

Each attempt was timed using a stopwatch from the insertion of the catheter through the skin until the catheter was removed in case of unsuccessful catheterisation or after successful placement confirmation. Successful intravenous placement was confirmed after fixation of the catheter with medical tape by palpating the intravenous flow of an injected isotonic crystalloid solution (Vetivex 1, Dechra Veterinary Products).

Conditions of insertion site (quality of clipped area, visibility of vein, palpability of vein, stability of vein) were described by the student and the assessor in a binary fashion ("good" or "bad"). Ease of the different steps of placement (skin introduction, vein puncture, catheter threading, fixation, overall difficulty) were assessed using "easy" or "difficult" as subjective modalities. The reaction of the animals to catheterisation was scored by the assessor using a descriptive scale for each attempt (Table 2).

Students had the opportunity to express any comments during the self-evaluation following each attempt.

Statistical analysis

Data were analysed using SPSS 20 (IBM, Armonk, USA). Recorded variables were summarized as frequencies (percentage) for categorical variables; means and standard deviations (± sd) for continuous normally distributed variables, or medians (inter-quartile range) for skewed data. Univariable analysis were undertaken to evaluate the association of catheter factors with outcome variables (e.g. ease parameters, success, time, animals' reaction) using Chi-squared or Fisher's Exact tests for categorical data and Student's T-tests or Mann-Whitney U-tests for quantitative data as appropriate. A p-value below 0.05 was considered significant.

Results

Demographic results

Fifty-nine students took part in the study. Thirty-two were fourth year students; the remaining 27 were final year students. Six fourth-year students and two final-year students participated in the study twice. One final-year student participated in the study three times. Fourteen (44%) of the fourth year students already had previous experience in catheterisation. All final

year students had previously attempted intravenous catheterisation before taking part in the study. Eighteen (31%) students had no experience with catheterisation prior to the study.

Thirty-four cats and 42 dogs were originally recruited for the study. Five cats (one from the Jelco group and four from the Abbott group) and one dog from the Jelco group were excluded due to insufficient sedation. One cat from the Jelco group was excluded for a skin condition present on the forelimbs (dermatitis and phlebitis from previous blood sampling). In total 28 cats (14 in each group) and 41 dogs (20 in the Jelco group and 21 dogs in the Abbott group) were included in the study.

No differences were found between treatment groups regarding cat weight ($p=0.73$), dog weight ($p=0.53$), body condition score ($p=0.1$), sedation score before premedication ($p=0.23$) or sedation score after premedication ($p=0.87$). There was no statistical difference in the number of females and males between groups ($p=0.54$). The use of different catheter sizes in dogs (20 or 22 gauge) was similar between the two groups ($p=1$).

Success rates

In total 111 catheterisation attempts were recorded during the study, including all successful and failed ones. Students managed to successfully place a catheter within the three allowed attempts in 65 (94%) animals. A catheter could not be inserted after three attempts in one (3%) of 34 animals in the Jelco group, and three (9%) of 35 animals in the Abbott group (Figure 1). There was no difference in success rate between groups ($p = 0.61$).

Catheter placement was successful at first attempt in 23 (68%) animals in the Jelco group and 18 (51%) in the Abbott group. The second attempt was successful for six (18%) cases in the Jelco group and eight (23%) cases in the Abbott group. A third attempt was required for four (12%) animals in the Jelco group and six (17%) in the Abbott group (Figure 1). There was no

difference in the number of attempts required for successful catheterisation between the two groups (p=0.53).

There was no difference in success rate between groups when considering only students with no experience at all (p=0.22) or students with previous experience (p=0.46).

Timing

The median duration for successful attempts in the Jelco group was 169 (142-190) seconds and it was 177 (144-215) seconds in the Abbott group (p=0.48). The median duration of failed attempts for the Jelco and the Abbott groups respectively were 95 (69-145) and 100 (72-139) seconds (p=0.94).

Ease of placement

The parameters assessing insertion site quality (quality of clipping area, vein visibility, vein palpability, vein stability) were similar between groups, as evaluated by the students and the assessor (Table 3).

The Jelco catheter was easier to slide off the stylet according to the students (p=0.02). The difference was not statistically significant (p=0.08) in the assessor's evaluation (Table 3). There was no statistical difference between the two groups for all other parameters used for ease of placement assessment.

Reaction of the animals

Ten (29%) animals in the Jelco group and seven (20%) in the Abbott group reacted to the first attempt at catheterisation (p=0.41). Animals reacted slightly to catheterisation in 19 (17%) attempts (eight (7%) in the Jelco group and 11 (10%) in the Abbott group). Moderate reaction was detected in two (2%) and five (5%) attempts, for the Jelco and the Abbott groups

191 respectively. Only one (1%) dog reacted strongly during a successful catheterisation in the
192 Jelco group. There was no difference in the occurrence and intensity of animal reaction
193 between groups (p=0.60). There was no difference in the intensity of animal reaction between
194 the first and the second attempt (p=0.30 for the Jelco group, p=0.43 for the Abbott group).

195 Students' comments

196 Twenty-two comments were recorded during the study. One student with previous
197 catheterisation experience stated comfort with the Abbott catheter. Fourteen comments
198 offered an explanation for a failed attempt, with five attributed to difficulties to puncture the
199 vein (one in the Jelco group and four in the Abbott group). A student stated that 'threading
200 (was) not possible' in one failed attempt using the Abbott catheter. Six comments highlighted
201 difficulties after successful catheterisation to secure the catheter in place, four of those were
202 from the Abbott catheter group.

203 **Discussion**

204 Intravenous catheterisation performed by undergraduate veterinary students with a veterinary
205 specific catheter did not result in an improved successful placement rate and did not decrease
206 animals' discomfort when compared to a non-veterinary product.

207 Success rates at catheterisation can vary depending on the type of catheter used (Jacobson &
208 Winslow 2005). The authors hypothesised that experienced nurses accustomed to a certain
209 type of catheter were performing better with this brand of catheter than with another. In our
210 study undergraduate veterinary students with no or minimal experience were recruited to
211 minimise pre-existing bias for one or other catheter. In addition both catheters had a similar
212 design, being over-the-needle catheters without wings with a transparent hub and were both
213 made of fluorinated ethylene propylene (FEP-Teflon®).

The lack of students' experience in catheter insertion may have been a greater factor in determining success of placement, outweighing any positive difference in catheter design. However, the success rates at first attempt in this study were 68% in the Jelco group and 51% in the Abbott group. These are comparable to success rates obtained by medical interns or nurses with reported success rates ranging from 52% to 77% (Jacobson 1999; Jacobson & Winslow 2005; Chang *et al.* 2002; Kessler *et al.* 2013).

Subtle variations during the placement process would be more difficult to describe by non-experienced people. For example, problems in threading off the catheter may be difficult to describe for someone placing their first intravenous catheter. This lack of comparison points might explain the difference between assessor and student's evaluation in threading properties between catheters. This point can also be highlighted through the students' comments where a majority of the comments were reflecting on the student's technique more than the catheter used. Moreover the assessor was only evaluating a visual impression of the ease of catheter placement, which is different from the feeling people experience when physically placing a catheter.

Cats and dogs included in the study were sedated to decrease the impact of temperament on the difficulty of the attempt. Medetomidine could potentially increase the difficulty of intravenous catheter placement due to venous vasoconstriction (Civantos & de Artiñano 2001) as α_2-adrenergic receptors are widely encountered in venous systems such as large veins of canine limbs (Long & Kirby 2008). To the authors' knowledge clinical significance of this phenomenon has never been evaluated. The pre-anaesthetic medication protocol used in the present study is routinely used in the study facility to enable placement of intravenous catheters in healthy patients. In the authors' experience, the use of medetomidine at this dose range, associated with the use of acepromazine, does not reduce venous distension once occluded. This is supported by the fact that the vein was easily visible for the majority of

attempts, as evaluated by students and the assessor respectively. The combination of drugs used may reduce the animals reaction to catheter placement but also provides analgesia, which may reduce the degree of discomfort perceived (Murrell & Hellebrekers 2005; Samantaray 2014). The incidence of reactions in approximately 25% in either group and their intensities suggest that the premedication did not totally mask these signs.

Both catheters had backcut-grind inner needles which is the shape shown to generate less trauma (Suzuki & Tanaka 2004). Despite being the same gauge and same material, catheters used in our study have different diameters. The external diameter of the inner needle of the 22 gauge Jelco catheter is 0.56mm (Treuren & Galletly 1990) compared to 0.54mm for the Abbott catheter (Abbott Animal Health 2010). An increase in the needle or the catheter diameter has been shown to increase the force required to pass through experimental membrane models (Abbott Animal Health 2010; Suzuki & Tanaka 2004; Thacker *et al.* 1989). This difference in diameter did not appear to be clinically significant as the level of reaction was the same between the two catheter groups. Moreover skin penetration by the Abbott catheter was not perceived to be easier than the Jelco catheter. Treuren & Galletly (1990) reported that the 22 gauge Jelco catheter was favoured by experienced medical anaesthetists when compared to 11 other different catheter models. The Abbott catheter was not included in that study.

Catheters wider than 20 gauge were not available for the present study. Although the present study did not reflect the whole range of catheters and experience required in daily veterinary practise, 20 and 22 gauge catheters appear to be the most commonly used catheters in small animals. Students are usually taught to place intravenous catheters in cats and dogs using preferentially these two sizes.

One limitation of the study was that the students and assessor could not be blinded to the catheter used. Even if both catheters had the same general specifications the shape and the colour of the plastics were slightly different and could be identified by looking or handling them. Technical solutions to allow blinding, which would not have increased the difficulty of catheterisation or breached the catheter sterility were not found during the study design. However, the inexperienced students should have provided no bias towards a particular brand of catheter.

In conclusion, using the Abbott catheter or the Jelco catheter did not reduce the number of attempts required by relatively inexperienced undergraduate veterinary students for successful catheterisation. The intensity of animals' reactions to catheter placement was similar for both catheters. The present study supports the use of either 20-22 gauge catheter to teach catheterisation to undergraduate veterinary students. Further research is required to extend the findings of the present study to other populations such as experienced practitioners or non-healthy animals.

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