수의학석사 학위논문

Intravenous catheter: can it be an alternative vascular access device for intraosseous catheterization?

정맥 카테터: 골 내 카테터 삽입을 위한 대체 혈관 접근 장치가 될 수 있는가?

2021년 02월

서울대학교 대학원
수의학과 임상수의학 전공
김 장 환

Intravenous catheter: can it be an alternative vascular access device for intraosseous catheterization?

지도 교수 김 민 수

이 논문을 수의학석사 학위논문으로 제출함

2020년 10월

서울대학교 대학원
수의학과 임상수의학 전공
김 장 환

김장환의 석사학위논문을 인준함
2021년 01월

위 원 장 ______ 윤 정 희 ______ (인)

부위원장 ______ 김 민 수 ______ (인)

위 원 ______ 이 인 형 ______ (인)

Abstract

Intravenous catheter: can it be an alternative vascular access device for intraosseous catheterization?

Janghwan Kim
Major in Veterinary Clinical Sciences
Department of Veterinary Medicine
The Graduate School
Seoul National University

Objective – To evaluate clinical relevance of commercial intravenous catheter for intraosseous cannula by an electric drill and compare feasibility with an automatic bone injection gun (EZIO®) by pressure.

Methods – After inhalation anesthesia with isoflurane, intraosseous catheterization was performed on both trochanteric fossa of the femurs using commercial 16-gauge intravenous catheter (BD Angiocath Plus™, USA) and 15-gauge intraosseous vascular access needle (EZIO®, Teleflex, USA) in six beagle dogs. Three methods were used to measure each pressure. 5 mL of normal saline (0.9% NS) was infused by hands in 5 seconds for 5 times; normal saline was infused in gravity for 5 minutes and measured the average pressure; normal saline was infused at 60 mL/kg by a mechanical infusion for 5 minutes and measured the average pressure. Each insertion site was confirmed by radiography and fluoroscopy. Insertion time and success rate were recorded.

Results – Results were analyzed by the Kruskal Wallis test and the Bonferroni post-hoc test. The mean pressure during injection in intraosseous catheterization with intravenous catheter (11.70 psi) had statistically lower than that with EZIO® intraosseous catheterization (13.90 psi) in hand infusion ($p<0.01$). There was no significant difference in pressure during injection between EZIO® intraosseous catheterization (0.98 psi) and intraosseous catheterization with intravenous catheter (1.01 psi) in gravity infusion. In addition, mean pressure of injection with EZIO® intraosseous catheterization (2.48 psi) was lower than that of intraosseous catheterization with intravenous catheter (2.95 psi) in using mechanical infusion. Median insertion time of EZIO® intraosseous catheterization was 11.65 seconds (±1.70 seconds) and intraosseous catheterization with intravenous catheter was 16.79 seconds (±0.92 seconds). The success rate of the insertion was equal (83.33%) between two groups. No remarkable complications were found in the study.

Conclusions – Intraosseous catheterization with commercial intravenous catheter can be an alternative method of intraosseous catheterization in emergency, especially in need of rapid vascular access.

Keywords: intraosseous catherization, intravenous catheter, vascular access, emergency, automatic bone injection gun

Student Number: 2018-25165

Table of Contents

List of Figures

List of Tables

Introduction

Securing vascular access is very important to save animals from emergency. Most emergency situations require rapid procedures such as injecting drugs or supplying fluids. However, it may be challenging for practitioners to place peripheral vessels especially in states of shock or any other emergency circumstances. In human medicine, several intraosseous catheters have been developed and widely used to provide rapid access when intravenous catheters are not accessible. It has been demonstrated that it takes 10 to 15 seconds to insert intraosseous catheter with a 90-100% success rate for pediatric patients by using four different intraosseous devices (Bielski et al., 2017). For adults in need of resuscitation, the intraosseous catheter on the first attempt was 2.0 minutes average with 85% success rate. With central venous catheter, 8.0 minutes average with 60% success rate on the first attempt (Leidel et al., 2012). In a pilot study of adults requiring cardiopulmonary resuscitation, intraosseous catheter success rates are significantly faster in average procedure times for intraosseous catheter placement (2.3 ± 0.8 minutes) with 90% success rate compared to central venous catheter placement (9.9 ± 3.7 minutes) (Leidel et al., 2009). Regarding the time spent and success rate, the American Heart Association supports the use of intraosseous catheters a reasonable alternative method if they are not able to access with intravenous catheterization (Frascone et al., 2015). Due to the urgent situation, and given the limited time, intraosseous catheterization is recommended as an alternative procedure for fluid and medication administration in human medicine (Blumberg et al., 2008).

Intraosseous vascular access has its advantages as it is non-collapsible, safe to administer fluids and drugs, along with safe and rapid access (Lange et al., 2019). To date, there are many studies of the use of intraosseous catheters in veterinary medicine. One study has reported that dogs can access blood vessels by placing intraosseous catheters with automatic bone injection guns (EZIO, Teleflex, USA), while another has reported that automatic bone injection guns can be used to facilitate the placement of intraosseous catheters on cat cadavers (Olsen et al., 2002; Bukoski et al., 2010). Both studies suggest that intraosseous catheterization in animals suffering from cardiovascular collapse could be an alternative method to intravenous catheterization. However, the financial burden of using intraosseous catheters by applying automatic injection guns in veterinary medicine may be greater than expected, and there are limited studies to replace them. In one study, a hypodermic needle was used in intraosseous catheterization in cadaver rabbits by inexperienced clinicians with moderate success (Kennedy et al., 2020). We hypothesized and compared the pressure through the EZIO® and normal intravenous catheter by applying them to intraosseous catheterization. Therefore, the purpose of this study is to compare whether intraosseous catheterization can be fitted and performed by intravenous catheters in general clinical practices, in addition to the method of placing intraosseous catheters by applying automatic bone injection guns.

Materials and Method

This study was approved and received ethic clearance from Institutional Animal Care and Use Committee at Seoul National University (SNU-200226-6). The study was proceeded by 6 healthy beagle dogs, within age of 12–18 months. All dogs were premedicated with intravenous antibiotic (Cefazolin, Cefazoline Injection®, Chongkundang, Korea) 25 mg/kg, intravenous analgesic (Tramadol, Trodon Injection®, Aju Pharm Co., Ltd, Korea) 3mg/kg, and intravenous sedation (Medetomidine, Domitor®, Orion Pharm, Finland) 0.01mg/kg, respectively. Anesthesia was maintained with 2-3% isoflurane (Ifran Liq®., Hana Pharm Co., Ltd, Korea) after intravenous induction with alfaxalone (Alfaxan®, Jurox Inc., Australia) 2 mg/kg, respectively. Trochanteric fossa of the femur was chosen for the insertion site. The insert sites were clipped and aseptically prepared. Local anesthesia was injected 1 mg/kg at the sites with 2% lidocaine (Daihan Lidocaine HCl Hydrate Inj. 2%®, Dai Han Pharm Co., Ltd, Korea), respectively.

For femoral intraosseous insertion, 15-gauge intraosseous vascular access needle (45mm×1.8mm)(The Arrow® EZIO® Needle Set, Teleflex, PA, USA) and 16-gauge intravenous catheter (45mm×1.7mm)(BD Angiocath Plus®, BD, NJ, USA) were used as cannulas. As the sizes of intravenous catheters mostly used in small animal practices are 16, 18, 20, 22 and 24 gauges, 16-gauge intravenous catheter was decided due to its rigidity and durability. Comparing between 15-

gauge EZIO® intraosseous vascular access needle and 16-gauge intravenous catheter, the length was equal and the diameter was 0.1mm smaller in 16-gauge intravenous catheter. For the insertion, intraosseous needle was positioned within the trochanteric fossa, just medial to the greater trochanter. Each needle was directed parallel to the long axis of the femur. Intraosseous catheters were placed in the trochanteric fossa of the both femurs. After identifying the greater trochanter of the femur, the catheters were placed direct medial to the trochanter into the trochanteric fossa, respectively (**Figure 1**). Intraosseous vascular needle was inserted by the power driver (The Arrow® EZIO® Power driver, Teleflex, PA, USA), and normal intravenous catheter was inserted by a commercial electrical drill (Robert Bosch GmbH, Gerlingen-Schillerhöhe, Germany). Radiography and fluoroscopy were used to confirm the insertion (**Figure 2**). After the insertion, 3-way stop cock was placed and pressure gauge was installed. Normal saline was used to flush catheter by possibility of blocking bone segments in the catheter.

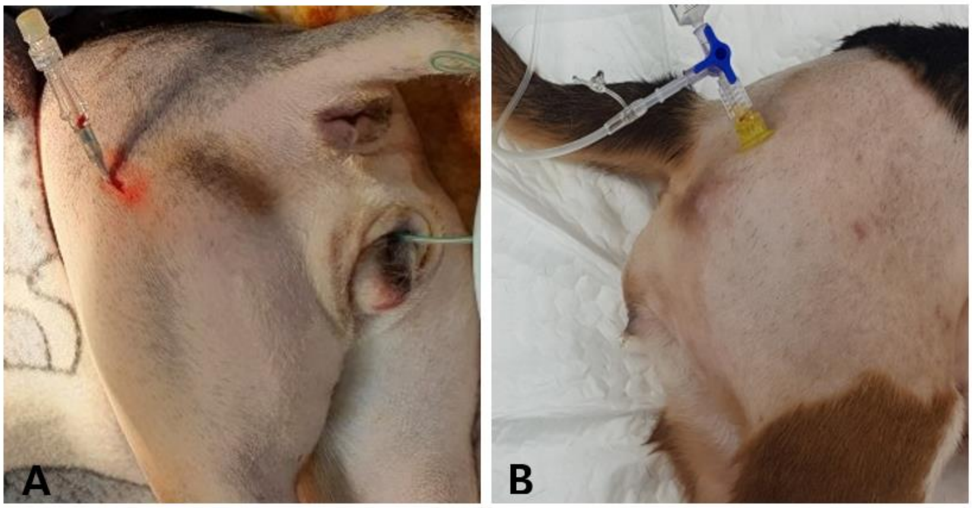

Figure 1. Femoral intraosseous catheterization. IO catheter was placed in the trochanter fossa. Intravenous catheter (A), EZIO catheter (B), respectively.

Figure 2 Radiographs and fluoroscopy of the placement. Radiography of intravenous catheter IO insertion, ventral-dorsal view (A), lateral view (B). Radiography of EZIO IO insertion, ventral-dorsal view (C), lateral view (D). Fluoroscopy of intravenous catheter IO insertion (E), and EZIO IO insertion (F).

1. Measuring Pressure during Injection

Three different methods were used to measure each pressure during injection. 1) 5 mL of normal saline (0.9% NS) was infused by hands in 5 seconds for 5 times and maximum pressure was measured; 2) normal saline was infused in gravity for 5 minutes and the average pressure was measured; 3) normal saline was infused at 60 mL/kg by a mechanical infusion pump for 5 minutes and the average pressure was measured. Pressure of intraosseous catheterization with EZIO® and intravenous catheter were compared along with pressure of cephalic vein catheterization. Pressure gauge (Fieldlab, Ralston Instruments, Ohio, USA) was used to measure the pressure during injection, and data was collected by Fieldlab software (Fieldlab Desktop, Ralston Instruments, Ohio, USA). Pressure was measured in units of pound per square inch (psi). Pressure transducer was connected to the middle of 3-way stop cock and the needle hub to the proximal intraosseous cannula. 5 mL of normal saline (0.9% NaCl) was injected in 5 seconds by hands for 5 times each. For cephalic vein catheterization, same procedures were undertaken at proximal intravenous cannula.

In addition to each location, normal saline was infused in gravity for 5 minutes and measured the average pressure. With mechanical infusion pump (Medifusion DI-2000, Daiwha Corp., Ltd, Korea), each site was infused 60 mL/kg of normal saline for 5 minutes to measure the average pressure.

2. Statistical Analysis

Kruskal-Wallis test was used to determine the difference in each measurement of 5 mL normal saline injection by hands in 5 seconds according to the group. Bonferroni was used for post-hoc test. With gravity drop and mechanical infusion, a descriptive statistical analysis was used to find out technical statistic of the variables.

Results

Before the study, pressure during 5mL normal saline injection in 5 seconds of each intravenous catheters and 15-gauge EZIO® intraosseous vascular needle were measured in normal state (**Table 1**). The differences among the pressures in variety of intravenous catheter gauges showed 3.91 psi per two gauges, in which 1.96 psi per one gauge. As compare to 15-gauge EZIO® intraosseous vascular needle and 16-gauge intravenous catheter, the pressure was very close to the data.

Table 1. Pressure during 5 mL normal saline injection in 5 seconds of each catheters

	Items	Pressure (psi)
5mL normal saline injection in 5 seconds by hands	15-gauge EZIO® intraosseous vascular needle	0.27
	16-guage intravenous catheter	1.68
	18-gauge intravenous catheter	5.34
	20-gauge intravenous catheter	9.65
	22-gauge intravenous catheter	12.91
	24-gauge intravenous catheter	17.31

1. Pressure during 5mL normal saline injection in 5 seconds

Pressure during 5 mL normal saline injection in 5 seconds are including; the average pressure of EZIO® intraosseous catheterization was 13.90 psi; IV intravenous catheterization was 9.67 psi; IV intraosseous catheterization was 11.70 psi; and the total was 11.76 psi. Looking at the test statistic, the F value is 7.879 and the significance probability is 0.019, thus there is a statistically significant difference depending on the method (**Table 2**). These differences suggest that the pressure of intraosseous catheterization by using intravenous catheter was lower than that of using EZIO®. In addition to this method, other studies were undertaken to support the pressures of intraosseous catheterization by using intravenous catheter by two other methods.

Table 2. Mean pressure of 5 mL normal saline injection in 5 seconds.

	Items	Mean	SD	t/F	p
Method	**EZIO IO**	13.90	1.806	7.879	0.019*
	IV catheter IV	9.67	2.293		
	IV catheter IO	11.70	.953		
	Total	11.76	2.437		

SD = Standard Deviation, p = p-value, *p<0.05

2. Pressure of gravity drop and mechanical infusion

Two different methods were performed once in each dog. With gravity drop method: the mean pressure of gravity drop for 5 minutes in EZIO® intraosseous catheterization was 0.98 psi, and the standard deviation was 0.23; the mean pressure of gravity drop for 5 minutes in IV intravenous catheterization was 1.01 psi and a standard deviation of 0.27; the mean pressure of gravity drop for 5 minutes in intravenous catheter intraosseous catheterization was 1.01 psi and a standard deviation of 0.28. The mean pressure of 60 mL/kg using mechanical infusion pump for 5 minutes was 2.48 psi in EZIO® intraosseous catheterization, and the standard deviation was 0.98; the mean pressure of 60 mL/kg using mechanical infusion pump for 5 minutes was 1.90 psi in IV intravenous catheterization and the standard deviation of 0.78; the mean pressure of 60 mL/kg using mechanical infusion pump for 5 minutes was 2.95 psi in intravenous catheter intraosseous catheterization and the standard deviation of 1.31 (**Table 3**).

Table 3. Pressure of gravity drop and mechanical infusion.

	Mean	SD
EZIO gravity drop for 5 minutes	0.98	.231
IV catheter IV gravity drop for 5 minutes	1.01	.267
IV catheter IO gravity drop for 5 minutes	1.01	.278
EZIO IO 60 ml/kg using mechanical infusion for 5 minutes	2.48	.978
IV catheter IV 60 ml/kg using mechanical infusion for 5 minutes	1.90	.782
IV catheter IO 60 ml/kg using mechanical infusion for 5 minutes	2.95	1.309

SD = Standard Deviation

3. Procedure time and success rate

The difference between the procedure time in EZIO® intraosseous catheterization and intravenous catheter intraosseous catheterization was 4.91 seconds. The success rate was equally 83.33% (**Table 4, 5**).

Table 4. Procedure time in both EZIO and intravenous catheter intraosseous catherization.

	No. of individual	Time (s)	Average (s)
EZIO IO	1	13.28	11.835
	2	12.31	
	3	11.65	
	4	11.82	
	5	11.54	
	6	10.41	

	No. of individual	Time (s)	Average (s)
IV IO	1	17.32	16.746
	2	16.82	
	3	16.49	
	4	17.05	
	5	16.27	
	6	16.53	

s = seconds

Table 5. Number of failures in both EZIO and intravenous catheter intraosseous catherization.

	No. of individual	EZIO IO	IV IO
No. of Failure	1	0	0
	2	0	1
	3	0	0
	4	0	0
	5	1	0
	6	0	0

Discussion

In human medicine, intraosseous catheterization is suggested as an alternative vascular access technique under resuscitation of both pediatric and adult patients (Orlowski et al., 1990; Weiser et al., 2012). Likewise, veterinary medicine is prompt to use intraosseous catheterization as patients' peripheral veins are smaller especially in shock or in small breeds. Although intraosseous vascular access can be manipulated manually by hands in infants, it is almost impossible to access intraosseous vascular access by hands in matures, especially when after bone maturation is done. Due to emergent situations, intraosseous catheterization also needs to be proceeded rapidly and use of intraosseous vascular access system, such as EZIO®, is widely used and studied by its safeness and rapidness (Hafner et al., 2013; Lange et al., 2019). However, the cost of EZIO® vascular access needle sets (approximately $100) is rather expensive, so as the power driver that is supplied with the EZIO® vascular access system (approximately $600). Therefore, the study was plan to seek for alternative way other than using EZIO®.

According to Poiseuille's law, the fluid flowing through the tube or blood vessel is subjected to resistance, part of which is caused by the frictional force acting between the fluid and the tube wall (Pasley et al., 2015). In addition, since friction in the liquid itself can cause resistance, the pressure can increase. Therefore, the study was designed to compare the pressure through the EZIO® and normal intravenous catheter by applying them to intraosseous catheterization.

The result of this study indicates that comparison between use of EZIO® and commercial intravenous catheter in intraosseous catheterization shows no significant difference in perfusion via pressure. In this study, intraosseous catheterization by using an intravenous catheter and an electrical drill can be substitute to automatic bone injection guns and intraosseous catheters in clinical practices. With less than an hour education and trials of using intravenous catheter to intraosseous catheterization, success rate was equal to EZIO® by this study, and the procedure time was within 17 seconds. On the other hand, the time in this study by using EZIO® to intraosseous catheterization was within 12 seconds. From this study, it is worth considerable to use an intravenous catheter as an alternative tool of intravenous catheter in the absence of automatic bone injection gun.

There were limitations while doing the study. First of all, the insert site was decided at the trochanteric fossa of the femur due to the length of intravenous catheter (45mm×1.7mm). Intraosseous catheter placement sites can be chosen among tibia, humerus, and femur. The length of the catheter used in this study must be inserted into medullary cavity of the bone. However, the catheter was longer than the diameter of the cross section of the bone. The site was decided to avoid extravasation and failure of intraosseous catheterization since the vertical direction of the bone was shorter than the length of the catheter. The location works especially well for small breeds and pediatric patients. In medium to large breeds, it may be difficult to palpate the great trochanter owing to fats and muscles. Furthermore, a larger EZIO® needle was used by presence of significant fats or muscles in the area. As the site is anatomically adjacent to the sciatic nerve and femoral artery, clinicians should be aware and well understood when approaching. During the study, some shortcomings were concerned. As an intravascular catheter is mostly made of plastic and is rather flexible, its durability was concerned. Moreover, since its length is longer than that of EZIO® catheter, the catheter was rather difficult to support the force during the insertion. With couple of trainings and education through an imitation bone model, the approach was relatively successful during the study. However, due to the small number of studies, more trials and research is needed, and additional research is also needed for retention and durability.

An important consideration of using an intravenous catheter as an intraosseous catheter is the risk of drilling the cortex out of inner bone tissues. As the catheter's length is longer than EZIO® catheter, practitioners must estimate the depth of the insertion. A potential complication of extravasation, such as leaking from the penetrating hole or fracture, can cause compartment syndrome (Paxton, 2012). Although the complications after intraosseous catheterization are rare with less than one percent, clinicians should be aware of the complications and contraindication of intraosseous catheterization (Drobatz et al., 2018). There were no complications found in this study.

There are differences in social, economic, and political backgrounds around the countries, but unfortunately, place where lacking medical supplements are not being used due to cost issues even when a situation arises that requires proper intraosseous catheter equipment. This study may suggest as an alternative medical device for intraosseous catheter device. Not all hospitals that have patients who need immediate fluid treatment, i.e., patients who need intraosseous catheterization, have dedicated devices. Clinicians often need to face challenge creative and innovative medical solution with their knowledge although there is lack of adequate medical devices. This method can be applied in both veterinary and human medicine and could suggest one of the options to it. This approach may be a means of saving lives in places where insufficient medical infrastructure, or in disaster where equipment is not ready.

Rapid vascular access is essential and life-threatening dilemma in severe emergency cases. Intraosseous route for vascular access has been vigorously used during modern wars in human medicine. As time passed, the procedure has been applying to pediatric and emergency resuscitation. However, in veterinary medicine, the use of intraosseous catheter is sometimes overlooked. A single way to approach vascular access is not always better than another, particularly when it is in emergency and even without the fitting equipment.

Conclusion

Through this study, it was able to consider the potential possibility of intraosseous catheterization by replacing to commercial intravenous catheter that requires rapid vascular access. Intraosseous catheterization by using commercial intravenous catheter can be an alternative method of intraosseous catheterization in emergency, especially in need of rapid vascular access.

References

Allukian, A. R., Abelson, A. L., Babyak, J., & Rozanski, E. A. (2017). Comparison of time to obtain intraosseous versus jugular venous catheterization on canine cadavers. *Journal of veterinary emergency and critical care*, *27*(5), 506–511.

Bielski, K., Szarpak, L., Smereka, J., Ladny, J. R., Leung, S., & Ruetzler, K. (2017). Comparison of four different intraosseous access devices during simulated pediatric resuscitation. A randomized crossover manikin trial. *European journal of pediatrics*, 176(7), 865–871.

Blumberg, S. M., Gorn, M., & Crain, E. F. (2008). Intraosseous infusion: a review of methods and novel devices. *Pediatric emergency care*, *24*(1), 50–58.

Bukoski, A., Winter, M., Bandt, C., Wilson, M., & Shih, A. (2010). Comparison of three intraosseous access techniques in cats. *Journal of veterinary emergency and critical care, 20*(4), 393–397.

Drobatz, K. J., Hopper, K., Rozanski, E., & Silverstein, D. C. (Eds.). (2018). *Textbook of Small Animal Emergency Medicine* (1st ed., pp. 1170-1171). Wiley Blackwell

Frascone, R. J., Salzman, J. G., Adams, A. B., Bliss, P., Wewerka, S. S., & Dries, D. J. (2015). Evaluation of intraosseous pressure in a hypovolemic animal model. *The Journal of surgical research*, *193*(1), 383–390.

Hafner, J. W., Bryant, A., Huang, F., & Swisher, K. (2013). Effectiveness of a Drill-assisted Intraosseous Catheter versus Manual Intraosseous Catheter by Resident Physicians in a Swine Model. *The western journal of emergency medicine*, *14*(6), 629–632.

Kennedy, C. R., Gladden, J. N., & Rozanski, E. A. (2020). Comparison of 3 intraosseous catheter sites and methods of determining placement success in cadaver rabbits. *Canadian journal of veterinary research*, 84(1), 33–36.

Lange, J., Boysen, S. R., Bentley, A., & Atilla, A. (2019). Intraosseous Catheter Flow Rates and Ease of Placement at Various Sites in Canine Cadavers. *Frontiers in veterinary science*, *6*, 312

Leidel, B. A., Kirchhoff, C., Bogner, V., Braunstein, V., Biberthaler, P., & Kanz, K. G. (2012). Comparison of intraosseous versus central venous vascular access in adults under resuscitation in the emergency department with inaccessible peripheral veins. *Resuscitation*, *83*(1), 40–45

Olsen, D., Packer, B. E., Perrett, J., Balentine, H., & Andrews, G. A. (2002). Evaluation of the bone injection gun as a method for intraosseous cannula placement for fluid therapy in adult dogs. *Veterinary surgery*: VS, 31(6), 533–540.

Orlowski, J. P., Porembka, D. T., Gallagher, J. M., Lockrem, J. D., & VanLente, F. (1990). Comparison study of intraosseous, central intravenous, and peripheral intravenous infusions of emergency drugs. *American journal of diseases of children (1960)*, *144*(1), 112–117.

Pasley, J., Miller, C. H., DuBose, J. J., Shackelford, S. A., Fang, R., Boswell, K., Halcome, C., Casey, J., Cotter, M., Matsuura, M., Relph, N., Tarmey, N. T., & Stein, D. M. (2015). Intraosseous infusion rates under high pressure: a cadaveric comparison of anatomic sites. *The journal of trauma and acute care surgery*, *78*(2), 295–299.

Paxton, J. H. (2012). Intraosseous vascular access: A review. *Trauma*, *14*(3), 195–232.

Weiser, G., Hoffmann, Y., Galbraith, R., & Shavit, I. (2012). Current advances in intraosseous infusion - a systematic review. *Resuscitation*, *83*(1), 20–26.

국문초록

정맥 카테터: 골 내 카테터 삽입을 위한 대체 혈관 접근 장치가 될 수 있는가?

서울대학교 대학원
수의학과 임상수의학 전공
김 장 환

응급상황에서 신속한 혈관확보를 할 수 있는 능력은 응급약물 및 수액의 공급을 하기 위해 가장 중요하다. 특히 심혈관 붕괴가 있는 환자에서의 신속한 정맥 확보는 어려울 수 있다. 환자의 크기, 일반적으로 사용되는 혈관부위의 외상, 비만, 또는 말초 부종과 같은 다른 문제들도 혈관확보의 신속한 접근을 방해할 수 있다. 혈관확보를 하기 위해 여러 번 시도를 할 때 치료의 시간이 지연될 경우, 이로 인해 질병과 사망률을 증가시킬 수 있다.

심혈관 붕괴로 고통받는 동물에서 골 내 카테터를 사용하는 것이 말초정맥 카테터의 대한 대안이 될 수 있다고 제안하고 있다. 그러나 수의학에서의 자동 골격주입장치를 적용하여 골 내 카테터를 장착하는 부담은 생각보다 클 수 있으며 이를 대체할 수 있는 연구가 제한되어 있다. 따라서 본 연구는 자동 골격주입장치를 적용하여 골 내 카테터를 장착하는 방법 이외에 일반 시중에서 판매되는 카테터를 이용하여 골 내 카테터를 장착 및 적용할 수 있는지를 비교하기 위함이다.

실험 방법으로는 여섯 마리의 개에서 흡입 마취 후 16 게이지 정맥 카테터와 15 게이지 EZIO® 골 내 카테터를 사용하여 대퇴골의 돌기오목(trochanteric fossa)에 골 내 카테터 삽입을 실시하여 세 가지 방법으로 각 압력을 측정하였다. 5초 동안 일반 식염수(0.9% NS) 5 mL

를 손으로 5회 주입하였고, 일반 식염수를 5분간 중력에 의해 주입하여 평균 압력을 측정하였으며, 인퓨전 펌프를 사용하여 60 mL/kg의 일반 식염수를 5분간 주입하여 평균 압력을 측정하였다. 각각의 삽입 부위는 방사선 촬영과 투시 진단으로 확인하였으며 삽입 시간과 성공률을 기록하였다.

결과는 Kruskal-Wallis 검정법과 Bonferroni 사후 검정을 사용하여 분석하였다. 5초 동안 일반 식염수 5 mL를 손으로 주입하였을 시 정맥 카테터를 사용한 골 내 카테터 평균 압력(11.70 psi)은 EZIO®를 사용한 것보다(13.90 psi) 통계적으로 낮았다($p<0.01$). 중력 주입 시 정맥 카테터를 사용한 골 내 카테터 평균 압력(1.01psi)은 EZIO®를 이용한 골 내 카테터 평균 압력(0.98 psi) 과 큰 차이가 없었으며 인퓨전 펌프를 사용하여 60 mL/kg의 일반 식염수를 5분간 주입하여 평균 압력을 측정하였을 때 정맥 카테터를 사용한 골 내 카테터 평균 압력(2.95 psi)은 EZIO®를 사용한 평균 압력(2.48 psi) 과도 큰 차이가 없었다. EZIO®를 이용한 골 내 카테터 삽입 소요 시간은 11.65초(±1.70초)가 나왔으며, 정맥 카테터를 사용한 골 내 카테터 삽입 소요 시간은 16.79초(±0.92초)였다. 삽입 성공률은 두 그룹 간 동일(83.33%)하였다. 본 연구에서 발견된 합병증은 없었다.

결론적으로, 본 연구를 통해 빠른 혈관 확보가 필요한 상황에서 일반 정맥 카테터를 골 내 카테터로 대체할 수 있는 잠재적 가능성을 고려할 수 있다.

주요어: 골내카테터, 정맥카테터, 혈관확보, 응급상황, 자동골격주입장치

학 번: 2018-25165