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"Journal of Applied Animal Science" (JAAS)

Scope of the Journal

The philosophy of the Faculty of Veterinary Science, Mahidol University, is "*One Health*", i.e., to interweave the disciplines of veterinary sciences with medical sciences for extreme advantages to human, animals and environment. The *Journal of Applied Animal Science (JAAS)*, is a peered review journal which published 2 numbers (January-June, July-December) a year by Faculty of Veterinary Science, Mahidol University, accepts manuscripts presenting information for publication with this philosophy in mind. Articles published in *JAAS* include a broad range of research topics in veterinary science, animal science, animal husbandry, animal production and fundamental aspects of genetics, nutrition, physiology, and preparation and utilization of animal products. Articles typically report research with cattle, companion animals, goats, horses, pigs, and sheep; however, studies involving other farm animals, aquatic and wildlife species, and laboratory animal species that address fundamental questions related to livestock and companion animal biology will be considered for publication.

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“Journal of Applied Animal Science” (JAAS)

สารจากคณบดี

เรียน ท่านผู้อ่านและผู้สนใจทุกท่าน

ในวารสาร Journal of Applied Animal Science (JAAS) Vol.17 No.1 (2024): มกราคม-มิถุนายน นี้ ท่านจะได้พบกับเนื้อหาที่น่าสนใจและหลากหลายในแง่มุมของสัตวแพทย์ โดยเฉพาะอย่างยิ่งในส่วนของรายงานผู้ป่วย (Case report) ในสัตว์เลี้ยงเป็นเพื่อน และ exotic จำนวน 4 เรื่อง ที่จะช่วยเพิ่มพูนความรู้และแนวทางในการวินิจฉัยและรักษาโรคต่างๆ ได้แก่:

- A Feline Intestinal Adenocarcinoma in Domestic Shorthair Cat: A Case Report
- Successful Surgical and Medical Management of Liver Lobe Torsion and Severe Multiple Renal Cysts Concurrently in a Rabbit: A Case Report
- Canine Intrahepatic Portosystemic Shunt in a Poodle Toy: A Case Report
- Terbutaline Responsiveness in a Cat with Sinus Arrest

ดิฉันขอถือโอกาสนี้ขอบคุณผู้ประพันธ์ทุกท่านที่ได้กรุณานำเสนอผลงานที่มีคุณค่า รวมถึงกองบรรณาธิการ นำโดย รศ.ดร.น.สพ.ธนศักดิ์ ช่างบรรจง และทีมงานทุกท่านที่ได้ทุ่มเทเวลาในการจัดทำวารสารฉบับนี้ ให้มีคุณภาพตามมาตรฐานสากล และขอขอบคุณท่านผู้อ่านทุกท่านที่ให้ความสนใจติดตาม JAAS อย่างต่อเนื่อง

สำหรับท่านผู้ทรงคุณวุฒิและนักวิจัยทุกท่าน หากท่านมีผลงานวิจัยหรือบทความที่น่าสนใจในสาขาสัตวแพทย์ ขอเชิญชวนท่านส่งบทความเพื่อตีพิมพ์ในวารสาร JAAS เพื่อเผยแพร่ผลงานของท่านให้เป็นที่ประจักษ์ในวงกว้าง

พวกเราหวังเป็นอย่างยิ่งว่า JAAS จะเป็นแหล่งความรู้ที่เป็นประโยชน์สำหรับทุกท่าน และขอเชิญชวนให้ท่านติดตามผลงานในฉบับต่อๆ ไปค่ะ

รองศาสตราจารย์ ดร.สัตวแพทย์หญิงวลาสินี ศักดิ์คำดวง
คณบดีคณะสัตวแพทยศาสตร์
มหาวิทยาลัยมหิดล

"Journal of Applied Animal Science" (JAAS)

ปีที่ 17 ฉบับที่ 1 มกราคม-มิถุนายน 2567 Vol. 17 No. 1 January-June 2024

สารบัญ

Editor's Note

ธนศักดิ์ ช่างบรรจง 7

Case Report

A Feline Intestinal Adenocarcinoma in Domestic Shorthair Cat: A Case Report 9

Napat Kriengsakpichit Apisit Pornthummawat Somsak Wattananit Jeerawat Soonthornsit

Successful Surgical and Medical Management of Liver Lobe Torsion and Severe Multiple Renal Cysts Concurrently in a Rabbit: A Case Report 19

Chakchalat Yoopatthanawong Kriangkrai Pansomboon Chaowaphan Yinharnmingmongkol

Canine Intrahepatic Portosystemic Shunt in a Poodle Toy: A Case Report 29

Patarawit Kiathanomkul Alisa Saelee Duangthip Chatchaisak Phingphol Charoonrut

Terbutaline Responsiveness in a Cat with Sinus Arrest 41

Prapatsorn Chuenhiran Wachira Trakoolchaisri Paitoon Srimontri

คำแนะนำสำหรับผู้แต่ง

"Journal of Applied Animal Science" (JAAS)

วารสารสัตวศาสตร์ประยุกต์เป็นวารสารวิชาการราย 6 เดือน (2 ฉบับต่อปี เดือนมกราคม-มิถุนายน และเดือนกรกฎาคม-ธันวาคม) ของคณะสัตวแพทยศาสตร์ มหาวิทยาลัยมหิดล เผยแพร่ผลงานวิจัยครอบคลุมสหสาขาวิชาทั้งสัตวแพทยศาสตร์ และสัตวศาสตร์ ตั้งแต่พื้นฐานถึงระดับโมเลกุล รวมถึงรายงานทางคลินิก บทความที่ได้รับการตีพิมพ์ในวารสารต้องผ่านการประเมินโดยผู้ทรงคุณวุฒิอย่างน้อย 3 ท่าน ในรูปแบบ double-blind peer review

ผู้สนใจส่งบทความเพื่อตีพิมพ์ในวารสารสัตวศาสตร์ประยุกต์กรุณาปฏิบัติตามข้อแนะนำและส่งพร้อมจดหมายนำ

1. ประเภทบทความ ที่รับพิจารณาได้แก่ รายงานการวิจัย รายงานฉบับย่อ บทความปริทัศน์และรายงานทางคลินิกเขียนด้วยภาษาไทยหรือภาษาอังกฤษ แต่บทคัดย่อต้องมีทั้งภาษาไทยและภาษาอังกฤษ

2. การส่ง ส่งต้นฉบับพร้อมสำเนา 4 ชุด และไฟล์ดิจิตอลทางไปรษณีย์ ไฟล์ดิจิตอลต้องสร้างด้วยโปรแกรม MS-Word หรือซอฟต์แวร์ที่ใช้แทนกันได้ อาจส่งต้นฉบับผ่านอีเมลโดยไม่มีสำเนาได้

3. รูปแบบ ขนาดกระดาษเอ 4 พิมพ์หน้าเดียว เว้นระยะ 1 บรรทัด ขอบกระดาษ 2.54 ซม. (1 นิ้ว) ฟอนต์ Angsana New หรือ TH SarabunPSK 16 พอยต์

4. ส่วนประกอบ รายงานการวิจัยต้องประกอบด้วยหน้าแรก (ได้แก่ ชื่อเรื่อง ชื่อผู้แต่ง สถานที่ทำงานและที่อยู่ชื่อผู้แต่งหลักพร้อมที่อยู่ที่ติดต่อได้และอีเมล พิมพ์ทั้งภาษาไทยและภาษาอังกฤษ) บทคัดย่อ (สั้นกระชับได้ใจความและคำสำคัญ 3-4 คำ) บทนำ อุปกรณ์และวิธีการ ผลการวิจัย วิจารณ์ กิตติกรรมประกาศและเอกสารอ้างอิง

ก. รายงานฉบับย่อและรายงานทางคลินิก อาจเขียนโดยไม่แยกหัวข้อ หรืออาจรวมส่วนผลการวิจัยและวิจารณ์เป็นหัวข้อเดียว

ข. บทความปริทัศน์ ควรเริ่มด้วยบทนำ แล้วบรรยายโดยแยกตามหัวข้อที่ต้องการนำเสนอ พร้อมบทสรุป

5. ตาราง-รูปภาพ ตารางและรูปภาพให้แทรกไว้ท้ายสุดของบทความ คำบรรยายตารางพิมพ์ด้านบน คำบรรยายรูปภาพพิมพ์ใต้ภาพ และมีหมายเลขอาระบิกกำกับตามลำดับการอ้างถึง ตารางควรเข้าใจได้ง่าย ให้ส่งรูปภาพความละเอียดสูงแยกต่างหากมาพร้อมด้วย

6. การอ้างอิง ผู้แต่งต้องปฏิบัติตามรูปแบบการอ้างอิงของวารสาร การอ้างอิงในเนื้อหาใช้ระบบนาม-ปี เช่น (คัมภีร์ กอธีระกุล และคณะ 2530) หรือ คัมภีร์ กอธีระกุล และคณะ (2530) การเขียนรายการเอกสารอ้างอิงให้เขียนไว้หลังกิตติกรรมประกาศ โดยพิมพ์เอกสารภาษาไทยก่อนแล้วตามด้วยเอกสารภาษาอังกฤษ สำหรับการเขียนเอกสารอ้างอิงภาษาอังกฤษให้ดูจากส่วนแนะนำภาษาอังกฤษ

คัมภีร์ กอธีระกุล, เทิด เทศประทีป, วรา พานิชเกรียงไกร, โสมทัต วงศ์สว่าง, วราภรณ์ แซ่ลี้, สมศักดิ์ ภัคีศิริภรณ์. การสำรวจพบเชื้อ *อี.โคไล* ซีโรไทป์ K88 จากลูกสุกรวัยดูดนมและหลังหย่านม. เวชชสารสัตวแพทย์. 2530; 17(1): 21-7.

7. ชื่อวิทยาศาสตร์ ให้พิมพ์เป็นภาษาอังกฤษตามประมวลนามศัพท์สากลและทำให้เด่นแตกต่างจากเนื้อหา

8. การถอดคำไทยเป็นภาษาอังกฤษ ใช้หลักเกณฑ์การถอดอักษรไทยเป็นอักษรโรมันแบบถ่ายเสียงของราชบัณฑิตยสถาน

9. อักษรย่อและสัญลักษณ์ หากเป็นที่รับรู้โดยทั่วกันอนุโลมให้ใช้ได้โดยไม่ต้องพิมพ์ตัวเต็มก่อน

สำหรับรายละเอียดเพิ่มเติมและแม่แบบต้นฉบับ ให้ไปที่เว็บไซต์ของวารสาร https://he02.tci-thaijo.org/index.php/jaas_muvs

อีเมลบรรณาธิการวารสาร editor.jaas2020@gmail.com

ที่อยู่ คณะสัตวแพทยศาสตร์ มหาวิทยาลัยมหิดล 999 ถนนพุทธมณฑล สาย 4 ตำบลศาลายา อำเภอพุทธมณฑล จังหวัดนครปฐม 73170

Instructions to Authors

"Journal of Applied Animal Science" (JAAS)

Journal of Applied Animal Science is a peer-review journal (2 issues/year; January-June and July-December) which publishes papers that report on original research covering broadly interdisciplinary of veterinary and animal sciences with results of more than local regard. *JAAS* invite and welcome submissions on existing new research from basic to molecular. Articles published under our journal are double-blind peer reviewed by at least 3 reviewers.

The author should follow the instructions below for manuscript preparation and submit with covering letter.

1. Categories: *JAAS* accepts varieties of article, including research articles, short communications, reviews and also clinical reports.

2. Language: English articles are preferable; however, both Thai and English manuscripts are acceptable, with Thai and English abstracts.

3. Submission: Submission via email is our most preferable way. However, submission of the manuscript is acceptable by either paper (4 copies) or digital format (email). Finally, digital format must be submitted. The submission file is in MS-Word format or compatible software.

4. Format: The manuscript should be used A4 size with margin of 2.54 cm (1 in), double spacing and indentions by using tabs. Times New Roman font 12 points is favored for English and Angsana New or TH SarabunPSK 16 points is desirous for Thai.

5. Components: The research manuscripts should have sequential components as title page, abstract and 3-4 keywords, introduction, materials and methods, results, discussion, conclusion, acknowledgements and references. Title page, in both Thai and English, includes title, author(s) and affiliation(s) for each author. Corresponding author must provide full contact address and email.

a. Short communications or clinical reports: These could be written as no sections, combination of results and discussion or introduction and followed by several presentation sections.

b. Reviews: The manuscript should start with introduction and followed by demonstration sections and conclusion.

6. Tables-Figures: Tables and figures must be numbered by using Arabic numbers. The caption must be written on the top of table or the bottom of figure. Tables and figures should be put at the end of article. All tables should be understandable by itself. All figures with high quality should be prepared in black and white as separate files.

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Barker K. At the Bench: A laboratory navigator. New York: Cold Spring Harbor Laboratory Press; 1998.

Fairbrother JM, Gyles CL. Escherichiacoliinfections. In: Straw BE, Zimmerman JJ, D'Allaire S, Taylor DJ, editors. Diseases of swine. 9th ed. Iowa: Blackwell Publishing; 2006. p. 639-74.

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WHO media centre. African trypanosomiasis (sleeping sickness) [Internet]. WHO. 2010 [cited 2011 Oct 29]. Available from: http://www.who.int/mediacentre/factsheets/fs259/en/.

8. Scientific terms should use the update and follow the International Code of Nomenclature, written by emphasis.

9. Standard abbreviations and symbols are acceptable without definition.

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Editor Note

สวัสดีครับท่านผู้อ่านและสมาชิกวารสาร Journal of Applied Animal Science (JAAS) ทุกท่าน วารสารฉบับนี้เป็นฉบับแรกของปีพุทธศักราช 2567 ถือเป็นปีที่ 17 ของการจัดทำวารสารโดยคณะสัตวแพทยศาสตร์ มหาวิทยาลัยมหิดล ซึ่งเรายังคงมุ่งเน้นที่จะเป็นสื่อกลางเผยแพร่บทความวิจัยและรายงานสัตว์ป่วยที่เกี่ยวข้องกับทางสัตวแพทยศาสตร์อย่างต่อเนื่อง ถึงแม้ในปัจจุบันจะมีนักวิจัยส่งผลงานมาเผยแพร่ลดลงไปบ้าง แต่ทางวารสารยังคงมุ่งมั่นที่จะพัฒนาและรักษาไว้ซึ่งคุณภาพของงานวิจัยในทุก ๆ เรื่องที่ได้รับการตีพิมพ์ จึงอาจทำให้เกิดความล่าช้าในการเผยแพร่วารสาร ในนามของบรรณาธิการจึงต้องขออภัยมา ณ ที่นี้

สำหรับวารสารฉบับนี้ได้รับเกียรติจากนักวิจัยส่งผลงานประเภทรายงานสัตว์ป่วยมาตีพิมพ์รวม 4 เรื่อง ได้แก่ **“มะเร็งลำไส้ชนิดอะดิโนคาร์ซิโนมาในแมวไทยขนสั้น” “การจัดการภาวะตับบิดและโรคถุงน้ำในไตด้วยการผ่าตัดพร้อมกันในกระต่าย” “ภาวะความผิดปกติเส้นเลือดลัดข้ามตับในพุดเดิ้ล”** และ **“การตอบสนองต่อเทอร์บูทาลีนในแมวที่มีภาวะการหยุดเต้นของปุ่มไซนัสหัวใจห้องบน”** กองบรรณาธิการหวังเป็นอย่างยิ่งว่าทุกบทความจะเป็นประโยชน์ต่อการแลกเปลี่ยนเรียนรู้ของท่านผู้อ่าน

สุดท้ายนี้ ขอเชิญผู้สนใจทุกท่านร่วมส่งบทความเพื่อเผยแพร่ผลงานวิจัยและองค์ความรู้ต่าง ๆ ด้านสัตวแพทยศาสตร์และสัตวศาสตร์ โดยสามารถศึกษาคำแนะนำในการเตรียมต้นฉบับเพื่อจัดส่งได้ที่เว็บไซต์ https://he02.tci-thaijo.org/index.php/jaas_muvs/about/submissions หรือตาม QR Code ด้านล่างนี้หากต้องการสอบถามข้อมูลเพิ่มเติม กรุณาติดต่อที่โทรศัพท์ 0-2441-5242 ต่อ 1308 หรืออีเมล editor.jaas2020@gmail.com

รองศาสตราจารย์ ดร.นายสัตวแพทย์ธนศักดิ์ ช่างบรรจง

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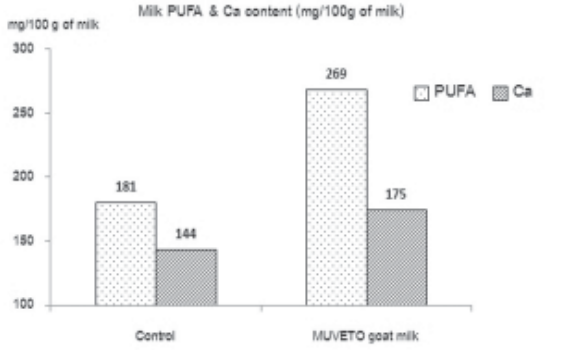
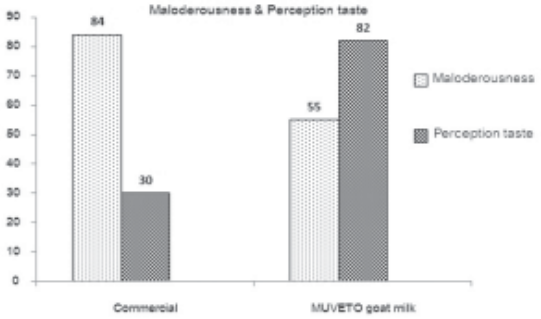
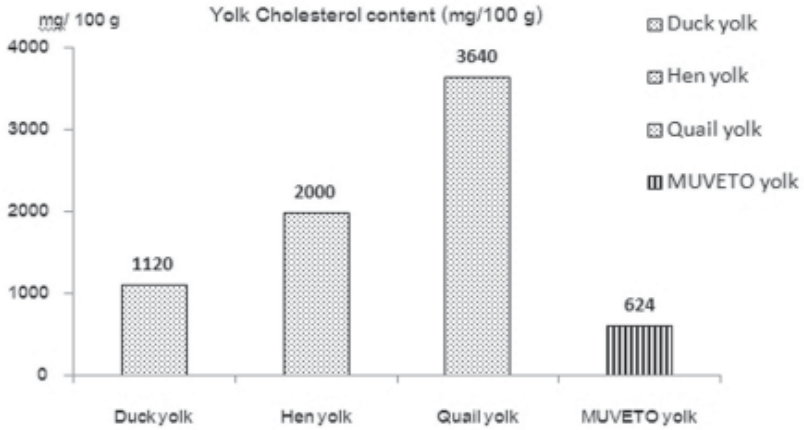
MUVETO





Functional goat milk: Naturally high PUFA,Ca and maloderousness



Functional egg: Low cholesterol

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Case Report

A Feline Intestinal Adenocarcinoma in Domestic Shorthair Cat: A Case Report

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Abstract

A 15-year-old, spayed female domestic shorthair cat was presented with clinical signs of weight loss, decreased appetite, and chronic vomiting persisting for more than 3 months. The cat had been given fenbendazole, probiotics, and a hydrolyzed diet; however, the symptoms, including vomiting and diarrhea, waxed and waned. The biochemical results revealed that feline pancreatic lipase, serum folate, and serum cobalamin were still within normal limits. Diagnostic imaging, including abdominal radiograph and ultrasonography, revealed a mass-like lesion cranially located in the urinary bladder and a significant thickening of the small intestinal wall. Due to the marked thickening and apparent obstruction of the jejunal wall, a jejunal resection and anastomosis were performed. The resected jejunal tissue was submitted for fungal culture and histopathologic examination. The microscopic diagnosis of the resected tissue was intestinal adenocarcinoma. Fungal culture on Sabouraud dextrose agar (SDA^+) was identified as *Aspergillus* sp. with a suspect of *A. fumigatus*. However, no fungal elements were detected by histopathology, and there was no positivity on Periodic Acid Schiff staining. Thus, a fungal infection is indefinite. Abdominal ultrasound conducted three days post-operation revealed a normal wall's thickness, normal peristalsis, and no dilation of the small intestine. There was no evidence of ascites or peritonitis. No signs of recurrence were detected during the 78 days post-operation. Nevertheless, the disease relapsed with neoplastic abdominal effusion, and a cat died four months after the operation.

Keywords: Feline intestinal adenocarcinoma; Intestinal tumor; Abdominal mass

รายงานสัตว์ป่วย: มะเร็งลำไส้ชนิดอะดิโนคาร์ซิโนมาในแมวไทยขนสั้น

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บทคัดย่อ

แมวพันธุ์ผสมขนสั้น เพศเมีย ทำหมัน อายุ 15 ปี มาเข้ารับการตรวจและรักษาที่โรงพยาบาลสัตว์ประศุอาทร ด้วยอาการน้ำหนักลด ความอยากอาหารลดลง และอาเจียนเรื้อรังมามากกว่า 3 เดือนแมวเคยได้รับการรักษาด้วยยาเฟนเบนดาโซล โปรไบโอติก และอาหารประเภทโปรตีนไฮโดรไลซ์ แต่ยังคงมีอาการอาเจียนและท้องเสียอยู่เป็นระยะ ผลการตรวจค่าชีวเคมีในเลือดแสดงระดับเอนไซม์ไลเพส ระดับโฟเลต และโคบาลามินในเลือดยังอยู่ในระดับปกติ ภาพถ่ายรังสีช่องท้องและการตรวจช่องท้องด้วยคลื่นเสียงความถี่สูงแสดงถึงลักษณะคล้ายก้อนเนื้ออยู่บริเวณหน้ากระเพาะปัสสาวะ และพบการหนาตัวของผนังลำไส้เล็กอย่างมีนัยสำคัญ แมวได้รับการผ่าตัดตัดต่อลำไส้เพื่อตัดลำไส้ส่วนที่หนาตัวออกแล้วส่งชิ้นเนื้อเพื่อส่งตรวจวินิจฉัยด้วยวิธีการเพาะเลี้ยงเชื้อราและการวินิจฉัยทางพยาธิวิทยา ผลวินิจฉัยชิ้นเนื้อทางจุลพยาธิวิทยา บ่งบอกว่าเป็นมะเร็งลำไส้ชนิดอะดิโนคาร์ซิโนมา ผลการตรวจด้วยวิธีการเพาะเชื้อราพบเชื้อราชนิดแอสเปอร์จิลลัส ฟูมิกาตัส แต่เนื่องจากไม่พบสายใยของเชื้อราจากการตรวจทางจุลพยาธิวิทยาจากตัวอย่างที่ย้อมด้วยสีฮีมาท็อกไซลินและอีโอซินและสีย้อมชนิด Periodic Acid Schiff จึงคาดว่าอาจมาจากการปนเปื้อน ผลการตรวจช่องท้องด้วยภาพสะท้อนคลื่นเสียงความถี่สูงสามวันหลังจากการผ่าตัดพบว่า ลำไส้เล็กมีความหนา และมีอัตราการบีบตัวเป็นปกติ ไม่พบการขยายตัวของลำไส้และ ไม่พบภาวะท้องมานหรือภาวะเยื่อบุช่องท้องอักเสบตลอด 78 วันหลังการผ่าตัด อย่างไรก็ตาม แมวกลับมาด้วยภาวะน้ำในช่องท้องที่มีเซลล์มะเร็งเป็นองค์ประกอบและเสียชีวิตที่ 4 เดือนหลังผ่าตัด

คำสำคัญ : มะเร็งชนิดอะดิโนคาร์ซิโนมาในแมว มะเร็งลำไส้ เนื้องอกในช่องท้อง

Introduction

Feline intestinal adenocarcinoma (FIA), a highly malignant form of non-hematopoietic gastrointestinal tumors, constitutes nearly one-third of all feline intestinal tumors (Rissetto et al., 2011). It ranks as the second most common alimentary neoplasm in cat, representing 7-27% of all alimentary tumors, following lymphoma, which range from 44-63% in the literature (Rissetto et al., 2011; Willard 2012; John et al., 2017; Czajkowski et al., 2022). The aggressive nature of this disease often leads to intestinal obstruction due to its annular stenosing growth pattern (Patnaik et al., 1976; Cribb 1988).

Most feline intestinal neoplasms are found in the small intestine, with 61-97% of all intestinal tumors. However, one report noted that 69% of intestinal adenocarcinoma (ACA) was diagnosed in the colon. Specifically, ACA is predominantly found in the small intestine, accounting for 82% of cases (Rissetto et al., 2011). Although some earlier studies reported approximately equal representation, intestinal ACA is typically more common in males (Patnaik et al., 1975, 1976; Turk 1981; Cribb 1988). In several studies on intestinal neoplasms, particularly those investigating intestinal ACA, the Siamese cat breed is often the most represented (Patnaik et al., 1976; Turk 1981; Cribb 1988; Kosovsky et al., 1988).

The age at which cats are diagnosed with feline intestinal ACA can vary. One study showed that the average age of diagnosis was 10.7 years (Cribb 1988), while a more recent study reported a median age of 12 years at the time of diagnosis, with an age range from 6-17 years (Czajkowski et al., 2022). The most common clinical signs associated with FIA include weight loss, vomiting, hyporexia, diarrhea, constipation or tenesmus, and hematochezia (Czajkowski et al., 2022). These symptoms are often associated with the tumor's rapid growth, which can lead to partial or complete blockage of the intestine (Patnaik et al., 1976; Cribb 1988). The factors that increase the risk of developing intestinal neoplasia include predisposing breeds such as Siamese and age greater than 7 years (Czajkowski et al., 2022).

Case description

A 15-year-old spayed female domestic shorthair cat weighing 2.7 kg was presented to Prasu-Arthorn Animal Hospital, Faculty of Veterinary Science, Mahidol University, with a history of weight loss, decreased appetite and chronic vomiting for more than 3 months. The cat was fed commercial and home-cooked diets. For the history of the health program, a cat only received the rabies vaccination. Physical examination showed that the cat had normal vital signs. No abdominal discomfort was perceived on abdominal palpation. Internal parasite was also not detected on direct fecal examination.

Hematological profiles revealed mild leukocytosis, neutrophilia with left shift and mild thrombocytopenia with adequate platelet numbers on the blood smear. Normal biochemical profiles were observed. Feline pancreatic lipase (fPL), serum folate, and serum cobalamin were still within normal limits. Abdominal radiograph indicated a mass-like lesion located cranially to the urinary bladder (Figure 1). Abdominal ultrasonography revealed diffuse thickening of the small intestinal wall. The jejunum was typically thickened with prominent muscularis layers (0.3-0.4 cm thickness). The most severe lesions showed segmental thickening (0.5 cm thickness) with loss of intestinal wall layers. The most thickened lesion was approximately 5 cm. in length. Duodenum and ileum were also mildly thickened to 0.35 cm. and 0.3-0.4 cm, respectively, with a prominent muscularis layer. Jejunal lymph nodes were enlarged with homogeneous

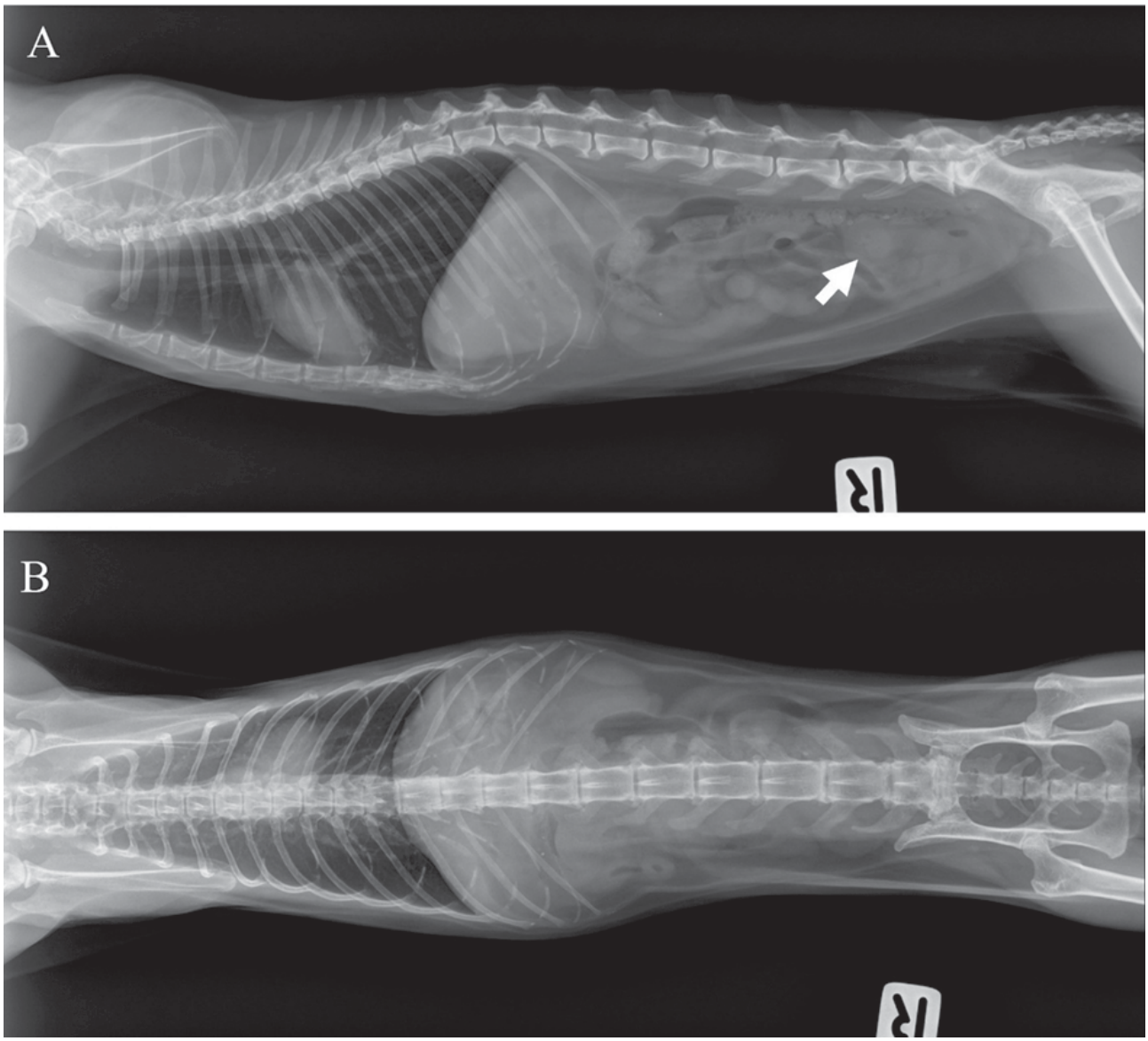

Figure 1. Radiographic imaging of thorax and abdomen. A) The right lateral view revealed a soft tissue opacity mass-like lesion cranially to the urinary bladder (arrow). B) Radiographic imaging of dorsoventral view.

hypoechoic parenchyma (Figure 2). A part of the jejunal wall was markedly thickened and obstructed, leading to a jejunal resection and anastomosis. Grossly, the resected section was obstructed by a hairball (Figure 3). The jejunal tissue was submitted for fungal culture and histopathologic examination.

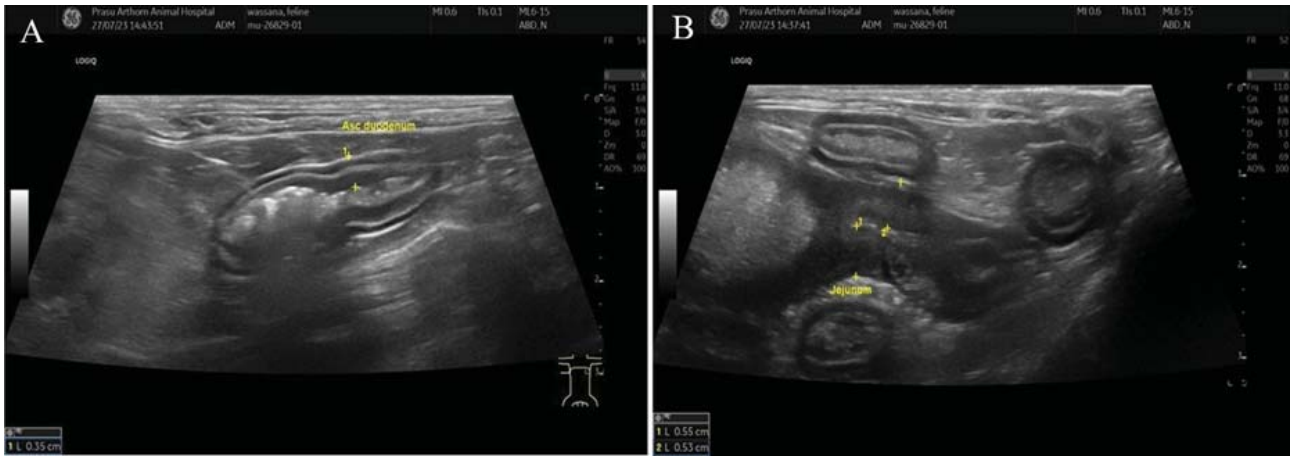

Figure 2. An abdominal ultrasonography (linear probe 11MHz). A) mild thickening of duodenal and jejunal wall. B) A marked thickening of the jejunal wall with a loss of the intestinal wall layer.

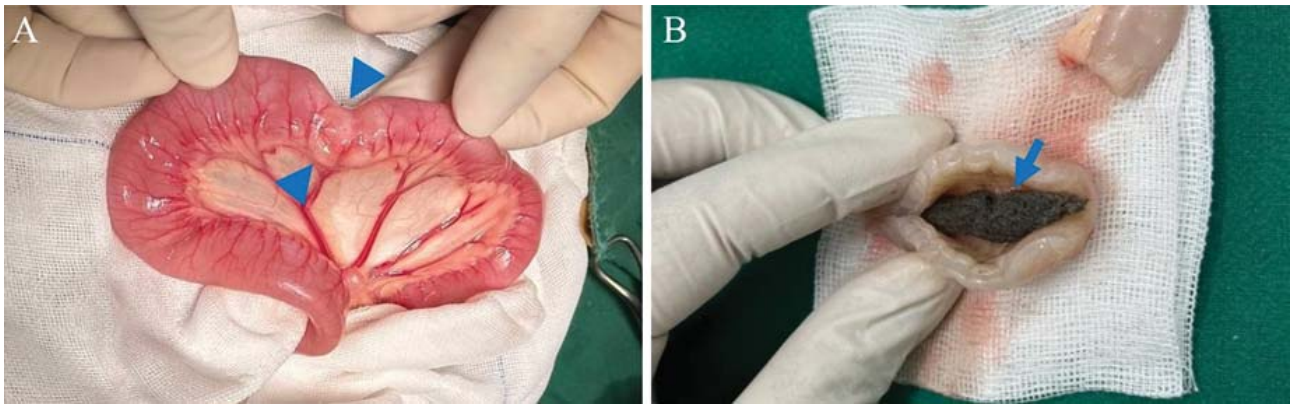

Figure 3. Exploratory laparotomy. A) The jejunal segment that is thickened and obstructed (arrowhead). B) The resected jejunal segment that appears to be obstruction by the hairball (arrow).

Microscopically, the tissue section exhibited an extensive growth of neoplastic cells mostly pronounced in the mucosal layer with multiple small numbers in submucosal and muscular layers. The lateral margin of the neoplasm was considered poor. There was a lake of mucin-like particles observed within the submucosal layer. The neoplastic cells were arranged in irregular glands to solid nests pattern on the dense fibrous tissue. Cell shapes were mainly cuboidal with conspicuous cell border in glandular area and polygonal in solid area. Small to moderate amount of eosinophilic cytoplasm was noted with round to oval shaped nuclei, finely granulated chromatin and often with single prominent nucleolus. Anisocytosis and anisokaryosis were marked. Mitotic figures were 10 cells/2.37 mm^2. The cells in the subjacent layers and in other sections were poorly differentiated; however, few granulated, plumped cells were seen. These cells were considered related to goblet cells that they

reacted with PAS staining similar to goblet cells in non-affected mucosal epithelium. Neutrophils and lymphocytes infiltration were spontaneously observed in the vicinity of neoplastic areas. Vascular invasion was not observed (Figure 4). The neoplasm was diagnosed as intestinal adenocarcinoma. Mold and yeast excluding dermatophytes conventional culture on Sabouraud dextrose agar (SDA^{+}) was identified as *Aspergillus* sp. Based on macroscopic and microscopic morphology, *A. fumigatus* was the most sus pected species. However, histopathology detected no fungal elements, and Periodic Acid Schiff (PAS) staining was negative. As a result, the fungal infection could be ruled out.

Following abdominal ultrasonography conducted three days post-operation revealed no dilation, normal thickness of the small intestine, and a standard peristalsis rate of six times per minute. There was no evidence of ascites or peritonitis. No signs of recurrence were detected 78 days post-operation. Regrettably, the cat returned with ascites. A subsequent abdominal ultrasonography showed diffuse thickening across all sections of the small intestine, with a prominent muscularis layer. Anechoic peritoneal fluid was observed, earning an AFAST score of 4/4. The cat passed away 21 days after the initial detection of ascites. Fluid cytology samples revealed a high protein concentration and a moderate nucleated cell count. Numerous small clusters of papillary projections consisting of oval to polygonal tumor cells were observed, along with a significant number of neutrophils and macrophages. The tumor cells exhibited large oval nuclei, prominent multiple nucleoli, and abundant vacuolated cytoplasm. The cytologic diagnosis pointed towards neoplastic effusion, with carcinoma being the most suspected condition.

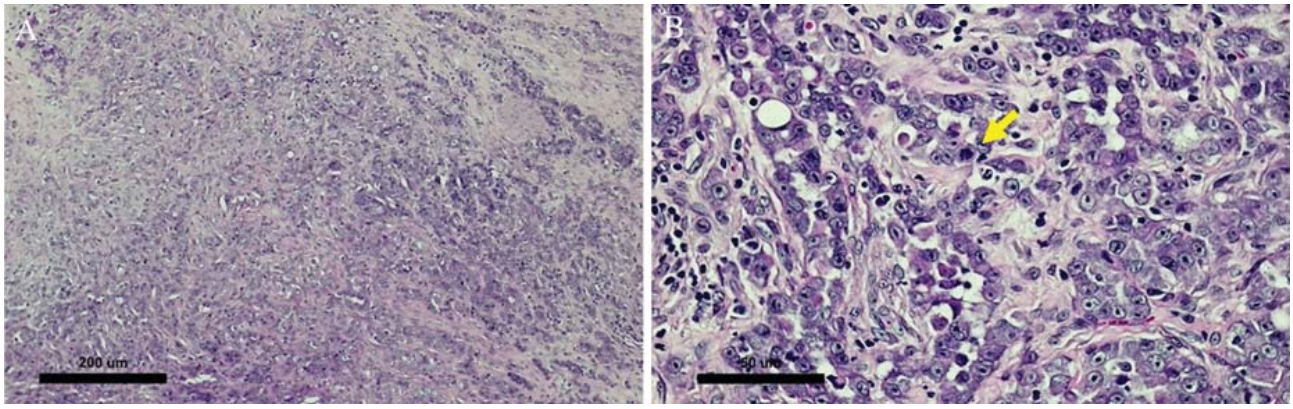

Figure 4. Histopathological findings. A) Hematoxylin and eosin stain of jejunal section at 100x, 200 μm scale bar (left). B) Hematoxylin and eosin stain of jejunal section at 400x, 50 μm scale bar showed neoplastic cells appeared as poorly arranged glands. Small to moderate amount of eosinophilic cytoplasm was noted with round to oval shaped nuclei, finely granulated chromatin and often with single prominent nucleolus. Mitotic figure is presented (arrow)

Discussion

Feline intestinal adenocarcinoma (FIA), the most common non-hematopoietic gastrointestinal tumor, accounts for 8% of all non-hematopoietic tumors (Turk et al., 1981; Rissetto et al., 2011). Adenocarcinoma (ACA), a malignant tumor resulting from unregulated cell growth within glandular tissue, is generally locally invasive and often metastasizes to local or distant sites, with rates of local and distant metastases reported to range from 55-76% (Patnaik et al., 1976; Czajkowski et al., 2022). FIA represents 7-27% of gastrointestinal neoplasia in cats (Patnaik et al., 1976; Turk et al., 1981; Cribb 1988; Rissetto et al., 2011). Cats diagnosed with intestinal adenocarcinoma typically fall within the middle to old age bracket, with affected individuals ranging from 5 to 17 years old and an average age of 11.3 years (Patnaik et al., 1976). A more recent study suggests an older age trend, with a median age of 14 years and mean ages spanning 8.7 to 11.3 years (Green et al., 2011). The most comprehensive case series on feline intestinal neoplasia, which include 1,129 cases, also highlights that Siamese cats and those over the age of 7 are at increased risk for developing this condition. Specifically, Siamese cats have a 3.7-fold higher risk of developing any form of intestinal neoplasia (Rissetto et al., 2011). While a male predominance is commonly reported in the literature, some studies have found an equal gender distribution (Patnaik et al., 1975, 1976; Turk et al., 1981; Cribb 1988; Kosovsky et al., 1988; Rissetto et al., 2011). In the present case, the 15-year-old cat falls into the high-risk category for developing intestinal tumors.

In this case report, the cat exhibited clinical signs consistent with feline intestinal adenocarcinoma (FIA), including weight loss, reduced appetite, and chronic vomiting over a three-month period. These symptoms are among the most common clinical signs associated with small intestinal adenocarcinoma, as reported in the literatures (Green et al., 2011; John et al., 2017; Czajkowski et al., 2022). Such symptoms often result from the rapid growth of the tumor, which can lead to a partial or complete intestinal obstruction due to its annular stenosing growth pattern (Patnaik et al., 1976; Cribb 1988). The most frequent physical examination findings include a palpable abdominal mass, emaciation, and dehydration (Cribb 1988; Kosovsky et al., 1988; Green et al., 2011). The absence of abdominal discomfort upon palpation and the lack of internal parasites in fecal examination further support a neoplastic diagnosis. The hematological profile revealed mild leukocytosis and neutrophilia, which were common in cats with systemic inflammation or stress. The presence of left shift and mild thrombocytopenia could be indicative of an ongoing inflammatory response (Rivers et al., 1997; Czajkowski et al., 2022). The normal biochemistry profile, fPL, serum folate, and serum cobalamin ruled out other potential causes, such as pancreatitis and malabsorption syndromes (Zoran 2006; Watanabe et al., 2012). The radiographic and ultrasonographic findings provided further evidence towards a neoplastic condition. The mass-like lesion observed cranially to the urinary bladder and the diffuse thickening of the small intestinal wall, particularly the jejunum, were indicative of a localized neoplastic process. The enlargement of the jejunal lymph nodes could suggest a possible cancer cells invasion. However, only 9% of cats have imaging results that indicate intrathoracic metastases (Czajkowski et al., 2022).

The most accurate diagnosis of Feline Intestinal Adenocarcinoma (FIA) is typically achieved through a surgical biopsy. For cats undergoing ultrasonography-guided fine needle aspiration cytology, less than half of

the cases showed results that were consistent with histopathology (Czajkowski et al., 2022). Adenocarcinomas are classified into four groups based on histologic characteristics include adenocarcinomas with a solid group of cells (carcinoid), adenocarcinomas with both solid and acinar cells, papillary adenocarcinoma, and mucinous adenocarcinoma (Patnaik et al., 1976). In this case, In this case, the histopathological examination confirmed the diagnosis of intestinal adenocarcinoma. Three months following intestinal mass resection, a cat developed a neoplastic abdominal effusion, which was suspected to be carcinoma. As a result, this cat possibly had FIA at a metastatic stage. FIA metastasizes rapidly, with 72-84% reported to have detectable metastases at diagnosis. Rates of local and distant metastases have been reported with range from 55-67% (Turk et al., 1981; Green et al., 2011; Czajkowski et al., 2022). Regional lymph nodes, peritoneum, liver, and lungs have been reported to be the most frequent sites of ACA metastases (Turk et al., 1981; Cribb 1988; Kosovsky et al., 1988; Green et al., 2011).

In this report, *Aspergillus* sp. was identified by fungal culture. Based on macroscopic and microscopic characters, *A. fumigatus.* was suspected. The standard diagnostic techniques for identifying species were matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF MS) and polymerase chain reaction (PCR) (Arastehfar et al., 2022). A metagenomic study has revealed that fungi constitute between 0.02% and 0.3% of the feline gastrointestinal microbiota. Among these, Aspergillus and Saccharomyces are reported to be the most abundant fungal genera (Barry et al., 2010; Handl et al., 2011; Minamoto et al., 2012; Tun et al., 2012). However, the absence of fungal elements in histopathology and negative PAS staining suggest that this could be a contamination rather than a true infection in this cat. Therefore, it is crucial to consider the results of the fungal culture identification in conjunction with the histopathological findings to confirm the diagnosis.

Surgical resection is the treatment of choice for malignant non-hematopoietic intestinal tumors in cats regardless of the presence or absence of metastasis. Cats diagnosed with ACA and subsequently treated with surgery demonstrated a significantly extended survival time, with a median survival duration of 365 days. Obtaining clean margins following the surgical resection of an intestinal mass is widely recognized to lead to improved outcomes (Bakaeen et al., 2000). In order to achieve a comprehensive removal of intestinal tumors, it has been suggested that the surgical boundaries should range from a minimum of 2 cm to a maximum of 8 cm (Vail 2011). In contrast, cats suspected of having ACA but did not undergo surgical removal had a median survival time of only 22 days. Moreover, cats showing no signs of metastatic disease at the time of surgery had a median survival time of 843 days, compared to 358 days for those with metastatic disease (Green et al., 2011). However, it's important to note that complete mural margins were only present in 15% of cats, and local lymph node metastases were identified in 52% of cats. A recent study revealed that the administration of adjuvant chemotherapy was not significantly associated with improved disease-free or overall survival. However, it is possible that a selection bias was present, which the adjuvant chemotherapy is more likely administered in cats with more advanced disease. (Czajkowski et al., 2022).

After the intestinal resection and anastomosis were performed, all previous clinical signs, including weight

loss, vomiting, and anorexia, were resolved. Post-operative abdominal ultrasonography revealed a normal thickness throughout the small intestine. This improvement may be attributed to the cat having concurrent intestinal adenocarcinoma and food-responsive enteropathy; the intestinal thickening was resolved as a result of a food trial with a hydrolyzed protein diet. (Heilmann et al., 2024). However, the cat's owner was lost to a follow up thereafter. Regrettably, 78 days post-surgery, the disease relapsed with neoplastic abdominal effusion, and the cat died four months after the operation.

In conclusion, this case report provides valuable insights into the clinical, radiographic, ultrasonographic, and histopathological findings in a cat diagnosed with intestinal adenocarcinoma. It highlights the importance of a comprehensive diagnostic approach to ensure an accurate diagnosis. Additionally, complete surgical resection with adequate margins is crucial and directly affects the disease-free and overall survival time.

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Conflict of interest

The author has no conflicts of interest to declare.

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Case Report

Successful Surgical and Medical Management of Liver Lobe Torsion and Severe Multiple Renal Cysts Concurrently in a Rabbit: A Case Report

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Abstract

Liver lobe torsion is a potentially fatal condition in rabbits, often necessitating diagnostic imaging such as ultrasonography or a computerized tomography scan for confirmation. Surgical intervention is frequently required for optimal outcomes. Renal cysts are uncommon in rabbits, making this case particularly unique. This case study describes the successful management of concurrent liver lobe torsion and multiple severe renal cysts in a single rabbit. A 2-year-old spayed female Mini Rex rabbit, weighing 1.33 kg with a body condition score of 2/5, presented with acute anorexia, depression, and reduced fecal output. Ultrasound imaging revealed a dilated left ureter and renal pelvis with multiple cysts, along with heterogeneous parenchymal echogenicity of the caudate liver lobe with no Doppler signal detected. Emergency surgery, including hepatic lobectomy and nephroureterectomy, was performed, and a blood transfusion was administered immediately. Postoperative management included pain control, monitoring of blood chemistry parameters, and clinical presentation, resulting in subsequent normalization. Ongoing follow-up is essential to assess for complications such as renal insufficiency or hepatitis. This case adds to our understanding of managing complex conditions in rabbits and underscores the importance of a comprehensive approach to optimize clinical outcomes.

Keywords: Liver lobe torsion, Renal cyst, Rabbit

รายงานสัตว์ป่วย: การจัดการภาวะตับบิดและโรคถุงน้ำในไต ด้วยการผ่าตัดพร้อมกันในกระต่าย

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บทคัดย่อ

ภาวะตับบิดเป็นภาวะที่มีความรุนแรงถึงขั้นเสียชีวิตในกระต่าย โดยส่วนใหญ่ต้องมีการใช้เทคนิคทางรังสีวิทยาในการวินิจฉัยยืนยันโรค เช่น การตรวจอัลตราซาวด์ (Ultrasound) หรือการเอกซเรย์คอมพิวเตอร์ (CT Scan) ทั้งนี้การผ่าตัดเป็นวิธีการรักษาที่ทำให้สัตว์มีโอกาสรอดชีวิตมากที่สุด ส่วนโรคถุงน้ำในไตเป็นโรคที่พบได้ยากในกระต่ายเช่นกันและมีข้อมูลการศึกษาค่อนข้างจำกัด ซึ่งกรณีศึกษานี้เป็นการพบโรคตับบิดร่วมกับโรคถุงน้ำในไตพร้อมกัน กระต่ายอายุ 2 ปี เพศเมียที่ได้รับการทำหมันแล้ว น้ำหนัก 1.33 กิโลกรัมซึ่งมีค่าคะแนนความสมบูรณ์ของร่างกายที่ 2/5 เข้ารับการรักษาด้วยปัญหาไม่กินอาหาร ซึม และขับถ่ายน้อยลง จากผลการวินิจฉัยด้วยการอัลตราซาวด์พบว่ามีการขยายใหญ่ขึ้นของท่อไตและกรวยไตฝั่งซ้าย รวมทั้งมีถุงน้ำจำนวนมากในไต นอกจากนี้ยังพบลักษณะเนื้อเยื่อที่ไม่สม่ำเสมอกันและไม่มีการไหลเวียนของเลือดที่บริเวณพูคอเดตของตับ (caudate lobe) กระต่ายได้รับการผ่าตัดฉุกเฉินซึ่งประกอบไปด้วยการตัดตับส่วนที่มีการบิดและการตัดไตกับท่อไตฝั่งซ้ายออก จากนั้นจึงได้รับการถ่ายเลือดโดยทันทีหลังผ่าตัดและได้รับการรักษาทางยาเพื่อระงับความเจ็บปวดต่อเนื่องจนกระทั่งกลับมามีความอยากอาหารปกติ ร่าเริง ขับถ่ายปกติและสามารถจำหน่ายสัตว์ป่วยกลับบ้านภายหลังรักษาตัวในโรงพยาบาล อย่างไรก็ตาม การติดตามอาการต่อเนื่องในระยะยาวเป็นสิ่งที่สำคัญเพื่อประเมินภาวะแทรกซ้อนที่อาจเกิดขึ้นได้ต่อไป เช่น ภาวะไตวาย (renal insufficiency) หรือภาวะตับอักเสบ (hepatitis) กรณีศึกษานี้จึงเน้นย้ำความสำคัญและเพิ่มความเข้าใจในการจัดการภาวะที่มีความซับซ้อนในกระต่ายเพื่อผลการรักษาทางคลินิกที่มีประสิทธิภาพยิ่งขึ้นในอนาคต

คำสำคัญ : ภาวะตับบิด โรคถุงน้ำในไต กระต่าย

Introduction

Liver lobe torsion, a rare and potentially fatal condition in rabbits, necessitates diagnostic imaging for confirmation, typically through ultrasound and computerized tomography (CT) scans (Sheen et al., 2022). While the exact cause of liver lobe torsions remains uncertain (Graham et al., 2014), studies in dogs and cats have proposed that congenital absence of supporting ligaments or their laxity, possibly trauma or dilation of other abdominal organs could play a role (Swann and Brown 2001). In rabbits, it is speculated that the caudate lobes have a predisposition to torsion may be due to its narrow attachment at the hilus, serving as a pivot point for rotation (Quesenberry et al., 2021). The Ultrasonographic diagnosis of liver lobe torsion typically reveals heterogeneous liver parenchyma, and the presence of free abdominal fluid. Additionally, characteristic features may include hypoechoic lesions with rounded margins, surrounded by hyperechoic fat. Contrast-enhanced ultrasonography often demonstrates a complete lack of perfusion in the affected liver lobe (Wenger et al., 2009; Stock et al., 2019). CT scans commonly depict liver lobe torsion as enlarged, rounded lesions with hypoattenuating and heterogeneous characteristics, often lacking contrast enhancement. Scant regional peritoneal effusion may accompany these findings. Moreover, contrast enhancement of the affected liver lobe typically registers approximately 50% lower compared to healthy liver tissue (Daggett et al., 2020). Although medical management may suffice in some cases, it had a low survival rate. Surgical intervention is often imperative for optimal outcomes, with liver lobectomy associated with higher survival rates (Ozawa et al., 2022). While the presence of renal cysts in rabbits suggests potential shared molecular pathways with human cystic disorders like Autosomal Dominant Polycystic Kidney Disease (ADPKD) and Autosomal recessive polycystic kidney disease (ARPKD), yet precise mechanisms remain elusive (Maurer et al., 2004), warranting further investigation. This case study documents the unique occurrence of both conditions in a single rabbit, emphasizing the need to devise effective case management strategies for survival. This study aims to contribute valuable insights into the management of these rare concurrent conditions in rabbits, thereby enhancing our understanding and improving clinical outcomes for affected animals.

Patient and methods

On January 27, 2024, A 2-year-old spayed female mini rex rabbit weighted 1.33 kg with body condition score of 2/5 presented at the Animal Space Exotic Pet Hospital with anorexia, depression, and reduced fecal output over the past 24 hours. The rabbit was the sole indoor pet of the owner and had been maintained on a consistent diet without any recent changes in its environment. Physical examination revealed pale mucous membranes, poor perfusion, delayed capillary refill time (>2 seconds), cranial abdominal discomfort, a Rabbit Grimace Scale (RbtGS) score of 2/2, 7% dehydration and normal rectal temperature (38.3 ^{o}C). Subsequently, abdominal radiography, abdominal ultrasonography, and hematological and biochemical tests were conducted.

Results and discussion

The radiographic examination revealed mild gas accumulation in the small intestine and cecum, indicative of ileus grade 1/4 (Weerakhun 2024), with no evidence of other lesions. Ultrasonography demonstrated dilation of the left ureter and left renal pelvis, accompanied by multiple cysts (Figure 2). Additionally, the caudate liver lobe exhibited heterogeneous parenchymal echogenicity, with no

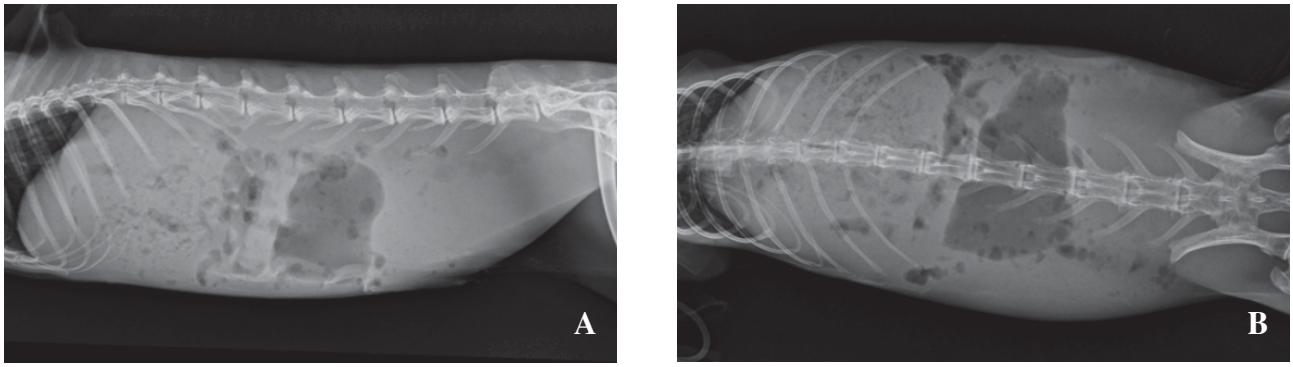

Figure 1. Illustrates mild localized gas accumulation in the small intestine and cecum, with no evidence of other lesions (A; Lateral, B; Ventrodorsal).

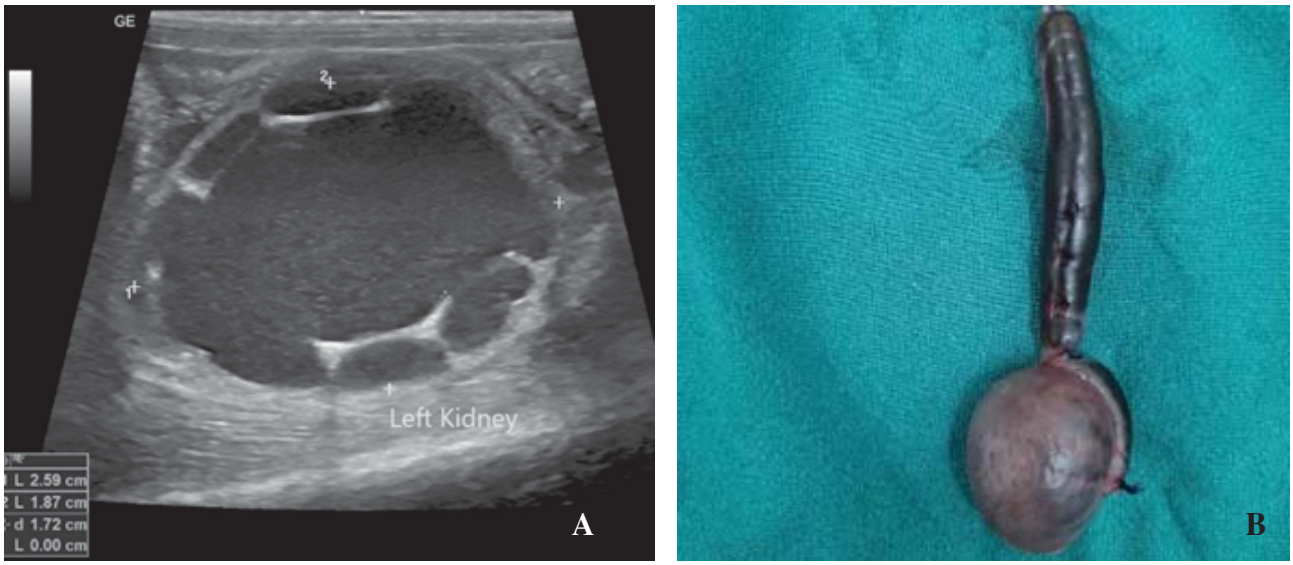

Figure 2. Illustrates Ultrasonography showing dilation of the left renal pelvis, accompanied by multiple cysts (A), along with macroscopic findings of dilation of the left ureter and severe multiple renal cysts (B).

Doppler signal detected within the affected lobe's ultrasound window. Surrounding the affected lobe, free anechoic abdominal fluid was observed (Figure 3). Although creatinine and blood urea nitrogen levels remained within normal ranges (creatinine: 1.6 mg/dL, blood urea nitrogen: 26 mg/dL), there was a marked increase in Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) (ALT: 483 U/L, AST: 798 U/L). Furthermore, severe anemia was evident, with a hematocrit level of 10.7% as depicted in Table 1 and 2.

Intramuscular morphine (0.5 mg/kg) was administered for premedication, followed by intravenous etomidate (1 mg/kg) for induction, with maintenance using 3 - 5% sevoflurane. Emergency surgery was then performed, commencing with a hepatic lobectomy of the caudate lobe, followed by a left nephroureterectomy. A ventral midline approach was utilized, extending from the xiphoid cartilage to the caudal pair of nipples. Hepatic lobectomy was performed as follows: A ventral midline laparotomy was made from the xiphoid process to the umbilicus. The

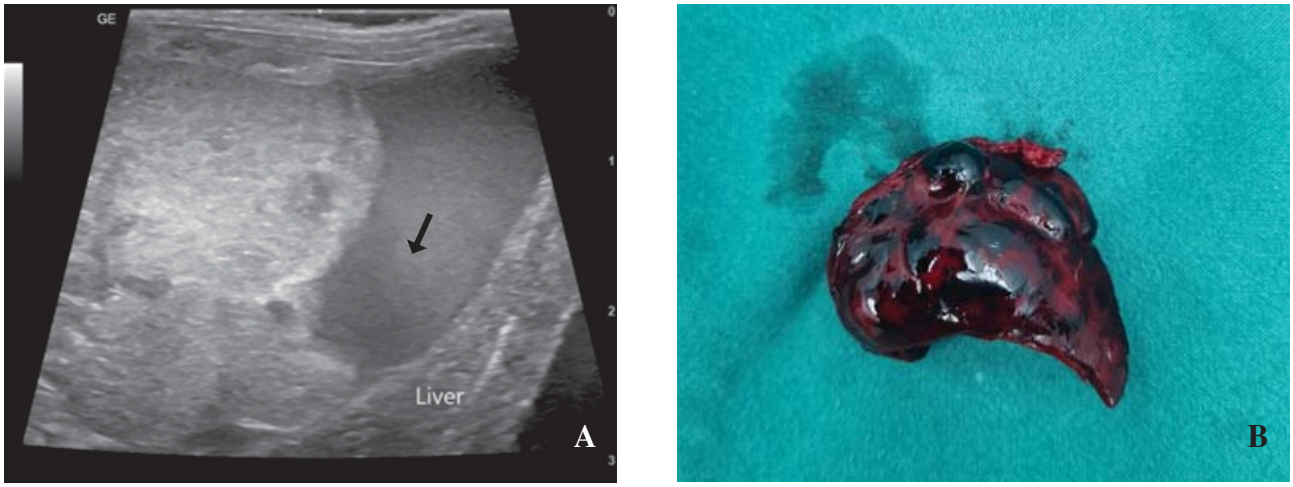

Figure 3. Illustrates Ultrasonography showing heterogeneous parenchymal echogenicity at the caudate liver lobe (A), accompanied by abdominal effusion (arrow), along with macroscopic findings of caudate liver lobe torsion (B).

stomach was mobilized and retracted caudally. The caudate lobe of the liver was palpated using the index finger, followed by dissection and mobilization of the lobe. The caudate lobe vessels were ligated with 3-0 polyglycolic acid sutures, and the caudate lobe was then resected. Nephroureterectomy was carried out with the following steps: The laparotomy incision was extended from the umbilicus to the pelvis. The left renal artery and vein were ligated with 3-0 polyglycolic acid sutures, and the distal left ureter was ligated near the trigone of the urinary bladder. An abdominal swab was obtained for bacterial culture. For closure: The laparotomy was closed using 3-0 polydioxanone sutures in a double suture simple continuous and simple interrupted pattern. Musculofascial closure was achieved with a simple continuous suture. The subcutaneous tissue was closed with a simple continuous suture, followed by subcuticular closure with absorbable subcuticular sutures. Finally, the skin was closed with interrupted 3-0 nylon sutures. The abdominal bleeding of approximately 20 ml was encountered during the procedure, and no abnormalities were noted in other organs. During the procedure, the rabbit received a blood transfusion immediately, as it is generally indicated in rabbits when the PCV decreases below 20% (Nugent-Deal and Palmer 2016). Prior to the blood transfusion, the donor PCV was determined at 40% and the recipient PCV was determined to at 10%. Crossmatching revealed compatibility for both major and minor reactions. Given the acute blood loss in this case, a target PCV of 35% was set. Consequently, 40 ml of blood was collected from the donor and transfused to the recipient. Additionally, no transfusion reactions were observed. No bacterial growth was observed in the abdominal effusion culture 7 days after surgery, while biopsy results confirmed severe necrotic hemorrhagic hepatitis, hepatic lobe torsion syndrome, and severe multiple renal cysts with renal atrophy. Postoperative pain management included Fentanyl-Lidocaine-Ketamine (FLK) constant rate infusion (CRI) initially (Fentanyl: 1 μg/kg/h, Lidocaine: 1 mg/kg/h, Ketamine: 0.5 mg/kg/h), transitioning to Lidocaine CRI alone after 48 hours (dose = 3 mg/kg/h). The Lidocaine CRI was discontinued on January 31, 2024. The rabbit received treatment upon admission to the hospital, including acetate Ringer's solution administered intravenously at a rate of 100 - 150 mL/kg/day for 3 days, Marbofloxacin given

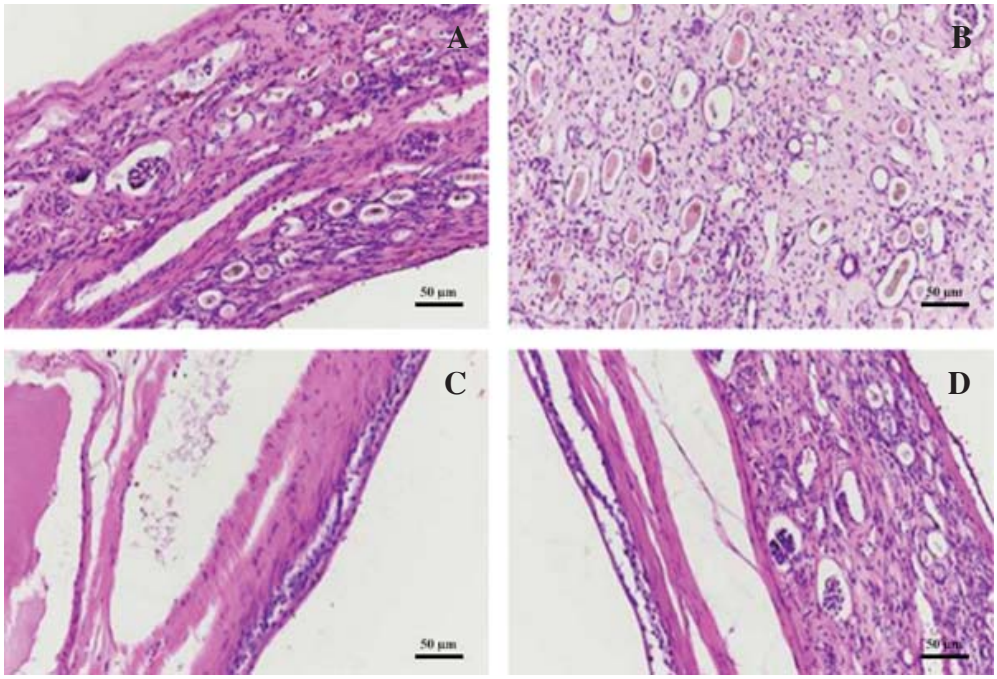

Figure 4. The section of the left kidney with a hydronephrotic and ureter dilatation revealed a multifocal large renal cyst in the cortex, lined by flatted renal tubular epithelial cells and contained clear intraluminal fluid (A, C, D). Renal tissue revealed severe diffuse atrophy of renal parenchyma in both the cortex and medullar layers (A, B, D). Tubular cells showed severe tubular-nephrosis and partial tubular necrosis (B).

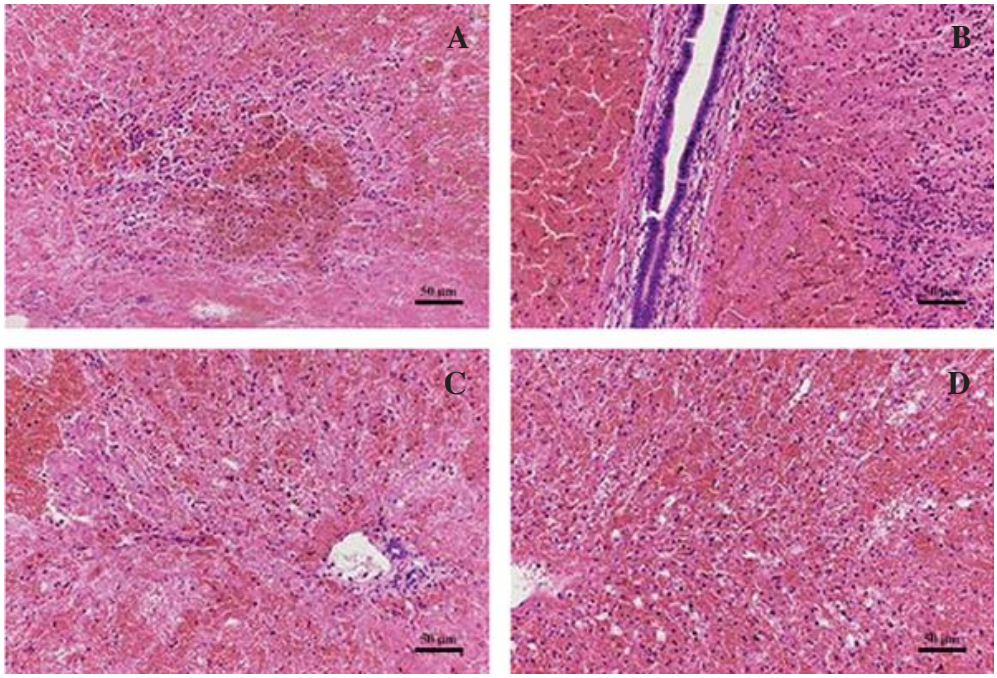

Figure 5. The section of liver revealed dilatation of sinusoids and diffuse irregular arrangement of hepatic cell cords with a severe diffuse accumulation of erythrocytes in sinusoids (A, B, D). Multifocal to coalescing coagulative necrosis was observed (C). Mainly some hepatocytes were necrosis, large round hyperchromatic nuclear walls and contained karyorrhexis and karyolitic nuclei. The remaining hepatocytes showed moderate diffuse hydropic degeneration. The hepatocytes contained cloudy swelling of cytoplasm with round dense nuclei.

Table 1. The complete blood count results from the initial visit on January 27, 2024, and subsequently reassessed postoperatively on January 30, 2024.

Parameter	Value (27/01/2024)	Value (30/01/2024)	Unit	Reference[1]
WBC	2.53	4.59	10^3/μL	3.0-11.5
Monocyte	0.22 (8.86%)	0.04 (0.8%)	10^3/μL	0.0-0.5
Neutrophil	1.75 (69.13%)	3.68 (80.1%)	10^3/μL	0.0-2.8
Lymphocyte	0.55 (21.79%)	0.87 (19.1%)	10^3/μL	2.0-9.1
Eosinophil	0 (0%)	0 (0%)	10^3/μL	0.0-0.5
Basophil	0 (0%)	0 (0%)	10^3/μL	0.0-0.9
RBC	1.77	5.33	10^6/μL	5.0-9.0
Hct	10.7	37.48	%	36.0-50.0
Hb	3.9	8.9	g/dL	12.7-16.3
MCV	60.8	70.0	fL	57.0-70.0
MCH	21.9	16.7	pg	17.5-23.5
MCHC	36.2	23.8	g/dL	30.0-38.0
Platelet	23	411	10^3/μL	218-641

Hct: Hematocrit, Hb: Hemoglobin, MCV: Mean Corpuscular Volume, MCH: Mean cell hemoglobin, MCHC: Mean corpuscular hemoglobin concentration. [1]VETSCAN® HM5 Operator Manual, LBL-03063, Zoetis, Inc.

Table 2. The blood chemistry results from the initial visit on January 27, 2024, and subsequently reassessed postoperatively on February 5, 2024.

Parameter	Value (27/01/2024)	Value (5/02/2024)	Unit	Reference[2]
ALP	43	58	U/L	18-128
ALT	483	85	U/L	20-109
AST	798	52	U/L	10-98
BUN	26.0	28.0	mg/dL	10.0-32.0
Creatinine	1.6	0.9	mg/dL	0.5-1.6

ALP: Alkaline phosphatase, ALT: Alanine transaminase, AST: Aspartate transaminase, BUN: Blood urea nitrogen. [2]VETSCAN® VS2 Operator's Manual, LBL-03064, Zoetis Inc.

orally at a dose of 5 mg/kg every 24 hours for 7 days, Metoclopramide administered orally at a dose of 0.5 mg/kg every 12 hours for 7 days, Cisapride administered orally at a dose of 0.5 mg/kg every 12 hours for 7 days, and Gabapentin administered orally at a dose of 5 mg/kg every 12 hours for 7 days. Additionally, the rabbit was primarily syringe fed Critical Care® Herbivore via forced feeding (10 g/kg, orally, every 6 hours), along with ad libitum access to Timothy hay and drinking water. We monitored feed intake (force-fed), water intake, fecal score, fecal quantity, fecal quality, and pain score at least twice daily. The rabbit was housed in a stainless-steel cage with dimensions of 60 x 60 x 60 cm. Sutures were removed 8 days post-surgery, and subsequent blood chemistry evaluations indicated normalization of all parameters as depicted in Table 2, along with an increase in hematocrit to 37.48% as indicated in Table 2, obtained three days post-surgery on January 30, 2024. With restored appetite, alertness, normal fecal output, and urination, the rabbit was discharged from the hospital on February 5, 2024.

The consequences of liver lobe torsion in rabbits encompass hemorrhage, the release of bacterial toxins, and ischemic by-products, leading to shock, disseminated intravascular coagulopathy, and potentially death. Unfortunately, due to the typically nonspecific signs observed during initial evaluation, there may be a delay in identifying and treating liver lobe torsion in rabbits (Stanke et al., 2011). This study indicates that secondary gastrointestinal problems, manifested by abdominal cramping during physical examination, may warrant consideration of liver lobe torsion as a differential diagnosis. Diagnostic imaging, particularly abdominal ultrasound, revealing markedly elevated serum ALT, AST, or ALP activity, can further support or rule out the diagnosis, as X-rays may not provide conclusive evidence of liver lobe torsion. Early diagnosis and treatment are crucial, as they typically yield better outcomes.

Pignon et al. (2013) emphasize the criticality of prompt surgical intervention within 24 hours of liver lobe torsion in rabbits to prevent acute mortality. Interestingly, Ozawa et al. (2022) found no significant difference in survival rates between medical treatment alone and surgical treatment for liver lobe torsion in rabbits. However, rabbits undergoing liver lobectomy demonstrated a prolonged median survival time compared to those receiving only medical treatment, highlighting the potential benefits of surgical intervention. In this case, the rabbit received both medical and surgical treatment, aligning with the approach advocated by current literatures.

Nephroureterectomy was indicated in this case due to severe hydronephrosis that could not improve with medical management. The affected kidney was non-functional and posed a risk to the overall health of the rabbit, including potential complications such as secondary urinary tract infection, azotemia, and kidney stones (Rhody 2006). Nephroureterectomy was chosen after evaluating the potential benefits of surgery in improving the rabbit's quality of life and overall health outcomes.

While there is limited research on nephrectomy in rabbits, study by Hassan et al. (2012) demonstrated that even in severe cases of polycythemia resulting from nephroblastoma, nephrectomy can be a viable treatment option. Additionally, insights from similar procedures in dogs provide valuable considerations. Duarte et al. (2022) demonstrate that unilateral nephrectomy in dogs with renal disease can lead to long-term survival, with some cases surviving up to 11 years post-surgery. Although complications such as oliguria and organ laceration may arise (Gookin 1996), overall, nephrectomy is well-tolerated and not detrimental to the remaining kidney. However,

long-term renal function post-nephrectomy may vary, warranting monitoring of creatinine and blood urea nitrogen levels as prognostic markers to predict outcomes in similar cases, as well as performing Doppler ultrasound.

Conclusion

This comprehensive approach to diagnosis and surgical intervention successfully managed concurrent liver lobe torsion and severe multiple renal cysts in the rabbit. This underscores the significance of early diagnosis and appropriate therapeutic measures in optimizing clinical outcomes for affected animals. However, long-term management and follow-up are necessary to monitor for complications such as renal insufficiency or hepatitis, especially considering the rabbit's remaining single kidney and five liver lobes.

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Case Report

Canine Intrahepatic Portosystemic Shunt in a Poodle Toy: A Case Report

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Abstract

An 8-month-old intact female poodle visited Prasu Arthorn Animal Hospital, Mahidol University, due to disorientation, ptyalism, and vomiting. The clinical examination revealed normal findings, except for ataxia, intermittent head shaking, and a normal pupillary light reflex with anisocoria, dazzle reflex, and threat response. Biochemical parameter measurements showed high alkaline phosphatase, ammonia, and fasting serum bile acids with a low albumin value. Ultrasonography of the abdomen showed a small liver with uniformly markedly diffuse hyperechoic parenchyma and a strange vessel coming from the intrahepatic portal vein and curving into the left part of the liver before entering the caudal vena cava. A computerized tomography (CT) scan examination confirmed a single left divisional intrahepatic portosystemic shunt (IHPSS). Based on clinical and laboratory diagnosis (hemogram and biochemistry) and CT scan examinations, portosystemic shunt (PSS) was diagnosed. Medical treatments included a hepatic formula diet and lactulose (0.5 mL/kg three times a day). A significant improvement in clinical signs was observed within a month, suggesting that medical treatments might be beneficial before considering surgical interventions for PSS. This case emphasizes the need for a collaborative approach and regular follow-up care in managing canine IHPSS, and it underscores the urgent need for further research to enhance patient outcomes.

Keywords: A computerized tomography scan, Canine intrahepatic portosystemic shunt, Canine, Ptyalism

ภาวะความผิดปกติเส้นเลือดลัดข้ามตับในพุดเดิ้ล

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บทคัดย่อ

สุนัขพุดเดิลเพศเมียอายุ 8 เดือนที่ยังไม่ได้ทำหมัน ได้เข้ารับการรักษาที่โรงพยาบาลสัตว์ประศุอาทร มหาวิทยาลัยมหิดล เนื่องจากมีอาการสับสน น้ำลายไหลมาก และอาเจียน การตรวจร่างกายพบว่าปกติ ยกเว้นอาการเดินเซ การกระตุกศีรษะเป็นช่วงๆ และมีปฏิกิริยารูม่านตาต่อแสงปกติแต่รูม่านตาขนาดไม่เท่ากัน ทดสอบการกระพริบของตาเมื่อได้รับการกระทบจากไฟที่สว่างจ้าปกติ และประเมินการมองเห็น การวัดค่าทางชีวเคมีพบว่า ค่าอัลคาไลน์ฟอสฟาเตส แอมโมเนีย และกรดน้ำดีในซีรั่มขณะอดอาหารสูง ในขณะที่ค่าอัลบูมินต่ำ การตรวจอัลตราซาวด์ช่องท้องพบตับขนาดเล็กและเนื้อตับมีความทึบแสงสูงอย่างสม่ำเสมอทั่วทั้งตับ นอกจากนี้ยังพบหลอดเลือดผิดปกติที่โค้งเข้าสู่ส่วนซ้ายของตับจากหลอดเลือดพอร์ทัลในตับก่อนเข้าสู่หลอดเลือดดำใหญ่ส่วนท้อง การตรวจด้วยเครื่องเอกซเรย์คอมพิวเตอร์ พบภาวะเส้นเลือดลัดข้ามในตับทางด้านซ้าย จากการวินิจฉัยทางคลินิกและการตรวจทางห้องปฏิบัติการ (การตรวจนับเม็ดเลือดและชีวเคมี) รวมถึงการตรวจเอกซเรย์คอมพิวเตอร์ สรุปได้ว่าเป็นภาวะความผิดปกติเส้นเลือดลัดข้ามตับ การรักษาทางยาประกอบด้วยอาหารสูตรสำหรับตับและให้ยาแล็กทูโลสขนาด 0.5 มล./กก. วันละ 3 ครั้ง ภายใน 1 เดือนพบว่าอาการทางคลินิกดีขึ้นอย่างมีนัยสำคัญ ซึ่งบ่งชี้ว่าการรักษาทางยาอาจเป็นประโยชน์ก่อนพิจารณาการผ่าตัดสำหรับภาวะเส้นเลือดลัดข้ามตับ กรณีนี้เน้นย้ำถึงความจำเป็นในการใช้วิธีการรักษาแบบร่วมมือกันและการติดตามผลอย่างสม่ำเสมอในการจัดการภาวะความผิดปกติเส้นเลือดลัดข้ามตับในสุนัข ซึ่งชี้ให้เห็นถึงความสำคัญของการวิจัยเพิ่มเติมเพื่อปรับปรุงผลลัพธ์ของสัตว์ป่วยต่อไป

คำสำคัญ : การตรวจวินิจฉัยโรคด้วยเครื่องเอกซเรย์คอมพิวเตอร์ ความผิดปกติเส้นเลือดลัดข้ามตับในสุนัข สุนัข น้ำลายไหล

Introduction

Canine intrahepatic portosystemic shunts (IHPSS) are birth defects in the blood vessels that cause the portal and systemic circulations in the liver to not connect properly (Van den Bossche and Van Steenbeek 2016). These problems send portal blood flow away from the liver, around the hepatic sinusoids and hurting the liver's ability to break down food and remove toxins (Ferrell et al., 2003). Unlike extrahepatic shunts located outside the liver, intrahepatic shunts are situated within the liver parenchyma (Ettinger et al., 2016). Although IHPSS are less common in small-breed dogs than extrahepatic shunts (Winkler et al., 2003), they are harder to diagnose and treat because of how complicated they are anatomically and how their symptoms vary.

Signs of hepatic encephalopathy (HE) can range from obvious to subtle and are often associated with abnormal behavior. More prominent central nervous system (CNS) signs include ataxia, unresponsiveness, pacing, circling, blindness, seizures, random barking, and coma (Ettinger et al., 2016). Approximately 30% of affected dogs exhibit gastrointestinal (GI) signs such as vomiting, diarrhea, anorexia, pica, and GI bleeding (melena/hematemesis) (Weisse et al., 2014). Ptyalism is thought to be a manifestation of HE or GI upset. Additionally, some pets may present with signs of lower urinary tract disease, including hematuria, stranguria, pollakiuria, or urethral obstruction (Berent and Weisse 2007). Due to decreased urea production, increased ammonia excretion, and decreased uric acid metabolism, ammonium urate calculi or debris formation is common in dogs with hepatic encephalopathy (Caporali et al., 2015). These signs may occur episodically or progress gradually, with severity influenced by factors such as shunt size, location, and degree of portal blood diversion (Konstantinidis et al., 2023). Diagnosis typically involves a combination of imaging modalities such as ultrasonography, computed tomography (CT), and selective angiography (Spies et al., 2024), along with functional assessments like serum bile acid and ammonia testing shunts (Winkler et al., 2003).

Several factors influenced the decision to treat IHPSS medically rather than surgically in this case. Medical management, including dietary modifications and medications such as lactulose, aims to control clinical signs and minimize hepatic encephalopathy shunts (Winkler et al., 2003). This approach can provide significant symptomatic relief and improve the quality of life, particularly in cases where surgical intervention may pose high risks or is not feasible due to the patient's overall health status (Favier et al., 2020).

Surgical treatments, on the other hand, like shunt attenuation or occlusion, can be curative but come with risks like portal hypertension and need precise anatomical localization and technical know-how (Mehl et al., 2007). Different types of surgery, like partial ligation and ameroid ring constrictor placement, have had different levels of success. Some studies have shown that controlled and predictable attenuation methods have better long-term results (Mehl et al., 2007). However, surgery might not always be a viable option due to factors such as the patient's age, comorbidities, or owner preference (Plested et al., 2020).

Moreover, the management criteria for extrahepatic portosystemic shunts (EHPSS) differ from those for IHPSS. EHPSS, being located outside the liver, are often easier to access and treat surgically. They are more common in small breeds and may present with less severe clinical signs than IHPSS, making surgical correction more straightforward (Weisse et al., 2014). In contrast, IHPSS require a more nuanced approach due to their intrahepatic location and potential for more severe hepatic dysfunction (Berent and Weisse 2007).

Treatment options for canine IHPSS include medical management to control clinical signs and minimize hepatic encephalopathy and interventional procedures such as surgical attenuation or occlusion of the shunt (Mehl et al., 2007). Treatment choice depends on factors such as shunt size, location, concurrent hepatic anomalies, and overall patient health. Despite advancements in diagnostic imaging and therapeutic techniques, managing PSS in dogs remains challenging, emphasizing the need for further research to optimize patient outcomes. This case report examines the diagnosis, follow-up, and treatment of IHPSS in dogs without surgical intervention.

Case description

Signalment and chief complaints

An 8-month-old puppy Poodle presented at Prasu Arthorn Animal Hospital with clinical signs of ptyalism and vomiting.

History taking

According to the owner's history, the puppy experienced ptyalism and vomiting once after consuming a snack containing a cannabis component (terpene). The puppy also has a history of previous seizures and received rectal diazepam treatment at another clinic before coming to Prasu Arthorn Animal Hospital. Additionally, the dog has lateral patella luxation in both hindlimbs.

Physical examination

Clinical examination revealed disorientation, ataxia, 5% dehydration, a body condition score (BCS) of 2/9, hypersalivation, normal capillary refill time (<2 seconds), normal heart sounds, clear lung sounds, a heart rate of 150 beats per minute, a respiratory rate of 35 breaths per minute, no abdominal discomfort, a rectal temperature of 100°F, and a systolic blood pressure of 130 mmHg by doppler device. The pupillary light reflex was responsive with equal pupil size (isocoria), and both dazzle and menace responses were positive. Proprioceptive deficits were noted in the right forelimb and both hindlimbs, with delayed responses. The puppy also exhibited intermittent head shaking and head pressing.

Laboratory results

Complete blood count (CBC) revealed leukocytosis with neutrophilia (Table 1). Biochemical analysis showed elevated levels of alkaline phosphatase, ammonia, fasting serum bile acid, and decreased albumin levels (Table 2). The coagulation profile was normal. All other laboratory values were within normal limits. The signalment, physical examination findings, and laboratory results collectively suggest dysfunction within the hepatobiliary system.

Ultrasonography

Ultrasonography was initially performed, revealing that the liver appears small with a homogeneously markedly diffuse hyperechoic parenchyma in all lobes. The portal vein to aorta ratio was within normal limits, calculated as 0.77. An aberrant vessel originating from the intrahepatic portal vein and curving into the left portion of the liver before entering the caudal vena cava (CVC) was observed (Figure 1). Turbulent flow revealed a mosaic pattern in color mode at the communication site with the shunt and the CVC. The maximum portal blood flow velocity was measured at around 17.6 cm/sec, while the mean portal blood flow velocity was within normal limits (30 cm/sec). The urinary bladder appeared moderately distended with clear (anechoic) urine, and the wall thickness was within normal limits. Both kidneys exhibited a homogeneously hyperechoic cortex with a slight reduction noted at the corticomedullary (CM) junction.

Table 1. Hematological result.

Parameter	Day 0 (26/12/66)	Day 23 (18/1/67)	Day 65 (29/2/67)	Day 82 (27/3/67)	Reference range
WBC	18.14	12.64	12.88	19.03	6-17 10^3/μL
Monocyte	1.4	1	1	1.5	0.2-1.7 10^3/μL
Neutrophil	14.3	10	10.1	15	3.6-13 10^3/μL
Lymphocyte	2.3	1.6	1.6	2.5	0.7-5.1 10^3/μL
Eosinophil	0	0	0	0	0.1-1.7 10^3/μL
Basophil	0	0	0	0	0-0.2 10^3/μL
Band neutrophil	0	0	0	0	0-0.5 10^3/μL
RBC	8.04	6.82	7.16	6.96	5-9 10^6/μL
Hb	16.0	13.1	12.5	13.0	10-18 g/dL
Hct	48.9	40.7	40.8	39.0	35-55%
MCV	60.8	59.7	57	56.0	60-77 fL
MCH	19.9	19.2	18.9	18.7	20-25 pg
MCHC	32.7	32.2	33.1	33.3	32-36 g/dL
PLT	206	136	219	216	200-500 10^3/μL
RDW	14.2	13.2	12.8	13.0	12-15%

WBC: white Blood Cell, RBC: red blood cell, Hct: hematocrit, Hb: hemoglobin, MCV: mean corpuscular Volume, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration, PLT: platelet, RDW: Red Cell Distribution Width.

Table 2. Blood chemistry result.

Parameter	Day 0 (26/12/66)	Day 23 (18/1/67)	Day 65 (29/2/67)	Day 82 (27/3/67)	Reference range
ALT	57	72	73	41	10-100 U/L
ALP	306	217	318	370	23-212 U/L
Creatinine	0.77	0.59	0.58	0.67	0.5 - 1.8 mg/dL
BUN	12	5	5	4	7-27 mg/dL
Albumin	2.6	2.3	2.2	2.2	2.7-3.8 g/dL
Total Protein	5.5	4.5	4.8	4.7	5.2-8.2 g/dL
Glucose	108	87	89	86	77-125 mg/dL
Ammonia	187	-	34	46	0-98 umol/L
Pre-prandial Bile acid	100.5	-	141.2	-	0-14.9 umol/L
APTT	11.3	-	-	-	8.5-18.5
PT	9.2	-	-	-	3.5-7.5
TT	20.9	-	-	-	11.3-28.1

BUN: blood urea nitrogen, ALT: alanine aminotransferase, ALP: alkaline phosphatase, PT: Prothrombin time, APTT: activated thromboplastin time, TT: thrombin time.

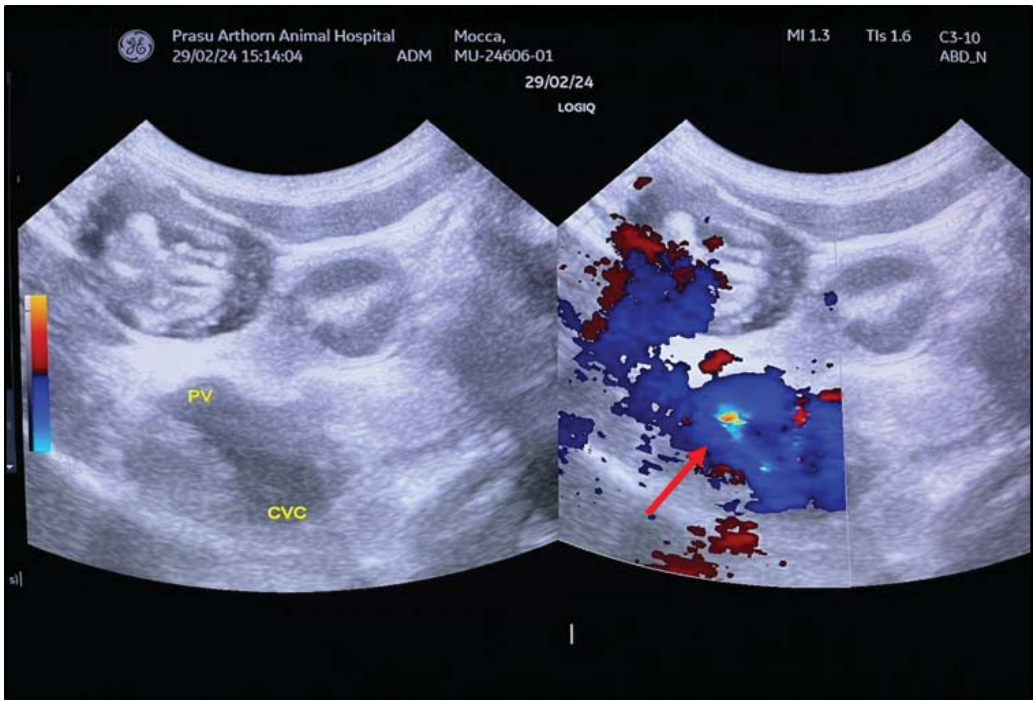

Figure 1. Abdominal ultrasonography revealed an anomalous vessel originating from the intrahepatic portal vein and coursing towards the left portion of the liver before joining the caudal vena cava (CVC). Turbulent flow was observed (red arrow), displaying a mosaic pattern in color mode at the communication site with the shunt and the CVC.

Computed tomography (CT) scan

Subsequently, a computed tomography (CT) scan was conducted to confirm the diagnosis. A single left divisional IHPSS was detected, characterized by abnormal communication between the portal and systemic circulations. This anomaly was presented as a single dilated looping vessel branching off the left intrahepatic portal vein, which was then inserted into the left phrenic vein and joined with the caudal vena cava (CVC). The tentative diagnosis was left divisional IHPSS (Figures 2 and 3).

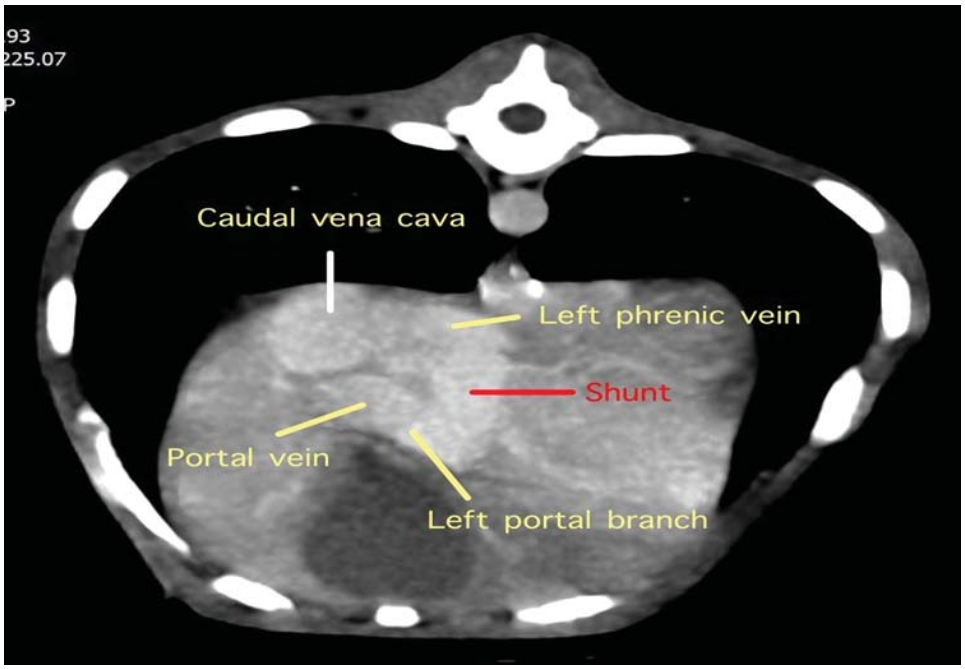

Figure 2. A CT scan (axial view) indicated a left divisional IHPSS (red letter).

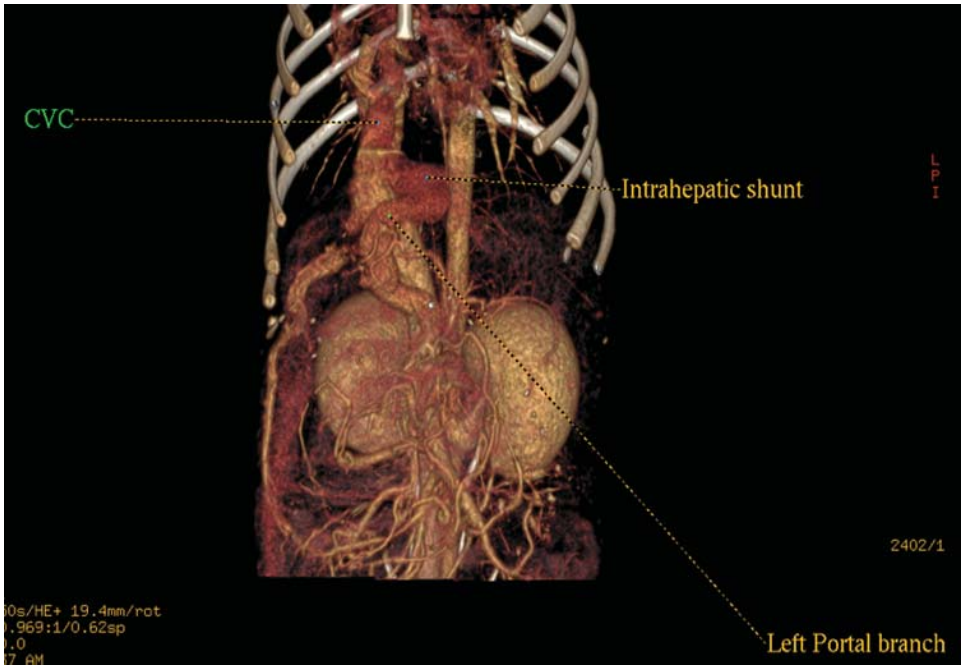

Figure 3. The three-dimensional computed tomography (CT) result revealed an anomalous communicating shunt between the portal and systemic circulation. This anomaly appeared as a single dilated looping vessel branch originating from the left intrahepatic portal vein, inserted into the left phrenic vein, and communicating with the caudal vena cava (CVC).

Treatment

The puppy was treated with a subcutaneous injection of ondansetron (Onsia®) at 0.5 mg/kg and a rectal enema with lactulose (Hepalac, Osoth interlaboratory CO., LTD., Thailand) administration (3 ml in 7 ml of normal saline) during the first visit. Lactulose was administered at 0.5 mL/kg up to three times daily for one month, and a hepatic formula diet (Hepatic, Royal Canin, Aimargues, France) was prescribed. Nutritional management was calculated as 1.6 times the resting energy requirement (RER) based on the puppy's ideal weight due to the puppy's low BCS. Despite two days of treatment, the puppy continued to exhibit vomiting and ptyalism, leading to further administration of rectal enema with lactulose and ondansetron.

After a three-week follow-up, the dog showed improvement in clinical signs, including ptyalism, vomiting, and neurological signs. The CBC and blood chemistry were rechecked, revealing thrombocytopenia, increased ALP, low blood urea nitrogen (BUN), hypoproteinemia, and decreased albumin levels (Table 2). Monthly follow-ups were conducted, with rechecking of clinical signs of hepatic encephalopathy (HE), including vomiting, ptyalism, head pressing, and intermittent head shaking, as well as monitoring body weight, BCS, CBC, and blood chemistry (Table 2).

Since the initiation of treatment with hepatic dietary and lactulose, the dog has not shown any recurrence of clinical signs. However, blood chemistry still revealed hypoproteinemia, hypoalbuminemia, decreased BUN, and elevated pre-prandial bile acid. Ammonia levels significantly decreased after the dog received hepatic dietary and lactulose. Despite an increased RER, the puppy's BCS and body weight did not improve.

Discussion

The presented case report describes an 8-month-old intact female puppy poodle with clinical signs suggestive of HE due to a single left divisional IHPSS. The diagnosis was supported by clinical examination, biochemical parameters, abdominal ultrasonography, and computed tomography (CT) scan findings. Treatment with a hepatic formula diet and lactulose resulted in significant clinical improvement within a month. Canine IHPSS are congenital vascular anomalies that divert portal blood flow from the liver, compromising its metabolic and detoxification functions (Ferrell et al., 2003, Van den Bossche and Van Steenbeek 2016). The clinical presentation can vary widely, with typical signs of HE, such as ataxia, unresponsiveness, pacing, circling, and seizures (Ettinger et al., 2016). Additionally, approximately 30% of affected dogs may exhibit GI signs, including vomiting and diarrhea (Weisse et al., 2014). The amount of cannabis snack consumed by the puppy was insufficient to cause a terpene overdose (Wakshlag et al., 2020).

The prevalence of IHPSS in small dogs has been reported at 7%, with previous studies ranging from 10 to 153 dogs (Hunt 2004). This condition has been identified in Toy and Miniature Poodles, Silky Terriers, Maltese, Pomeranians, Staffordshire Bull Terriers, and Scottish Terriers (Hunt 2004).

The diagnostic evaluation of PSS encompasses a comprehensive assessment of hematological, biochemical, urinary, and liver function parameters. Hematological findings commonly include microcytic anemia, which may result from various factors such as defective iron-transport mechanisms, decreased serum iron concentrations, decreased total iron-binding capacity, and possibly increased hepatic iron stores in Kupffer cells (Bunch et al., 1995; Simpson et al., 1997). In this case, hematological parameters were within the normal limits, with hematocrit (HCT) at 48%

(reference range 35-55 %), but mean corpuscular volume (MCV) was lower than the standard limit, with an average of 58 fL (reference range 60-77 fL)

Serum biochemical profiles frequently reveal decreased hepatic synthesis, characterized by low albumin and BUN levels, hypocholesterolemia, and hypoglycemia (Bunch et al., 1995). Additionally, mild to moderate increases in ALP and ALT activities are common. Serum bile acids (SBAs) and blood ammonia levels serve as crucial markers for liver function assessment, with increased postprandial SBAs and blood ammonia concentrations being highly sensitive and specific for detecting PSS (Van Straten et al., 2015). Urinalysis in congenital Portosystemic Shunts (cPSS) often shows low urine specific gravity (USG) and ammonium biurate crystalluria (Caporali et al., 2015). USGs are likely a consequence of polyuria/polydipsia (PU/PD) and the compromised medullary concentration gradient that arises from BUN levels due to an inefficient urea cycle. Proteinuria is common in canines PSSs, potentially secondary to glomerulopathy (Tisdall et al., 1996). The blood chemistry panel, including ALP, pre-prandial bile acid, total protein, albumin, and BUN, was consistent with previous reports (averages were ALP = 302 reference range 23 - 212 U/G, Pre-prandial bile acid = 120 umol/L reference range 0-14.9 umol/L, TP = 4.8 reference range 5.2-8.2 g/dL, albumin = 2.3 reference range 2.7-3.8 g/dL, BUN = 6.5 reference range 7-27 mg/dL) (Konstantinidis et al., 2023). No clinical signs of urination disorders such as PUPD, crystalluria, or stranguria were observed.

The previous report comparing soy protein isolate versus meat-based low-protein diets in dogs with cPSS offers valuable insights into dietary management strategies. The study's findings suggest that a soy-based diet may offer benefits in terms of reducing plasma ammonia levels and improving liver function parameters (Proot et al., 2009). These findings could be particularly relevant for long-term management or pre-surgical preparation of dogs with PSS, warranting further exploration of dietary interventions tailored to individual patient needs.

Another study highlighted the outcomes of non-surgical treatment approaches, either dietary management alone or in combination with lactulose, in dogs with cPSS (Favier et al., 2020). The study reported significant improvements in quality of life and clinical performance with non-surgical treatment, with an estimated median survival time of 3.2 years for non-surgically treated dogs. This reinforces the potential benefits of medical management as a viable option, especially when surgical intervention is not feasible.

A study compared the efficacy of two surgical approaches, partial ligation (PL) and ameroid ring constrictor (ARC) placement, in managing left-divisional IHPSS in dogs (Mehl et al., 2007). The analysis revealed that partial ligation offered more controlled and predictable attenuation compared to ARC placement, resulting in superior long-term outcomes. While both techniques exhibited similar short-term morbidity and mortality rates, PL emerged as the preferred treatment option for achieving favorable long-term outcomes in dogs with left-divisional IHPSS.

CT angiography (CTA) offers several advantages in evaluating IHPSS. It provides detailed anatomical information for accurate classification and surgical planning by identifying shunt insertion points into hepatic or phrenic veins. This enhances the consistency and reliability of IHPSS classification compared to ultrasonography or mesenteric portovenography (Plested et al., 2020). CTA also detects additional vascular anomalies and small vessels not visible with other modalities, aiding in complex shunt identification and surgical planning. Three-dimensional reconstruction

further enhances understanding of the shunt's relationship with surrounding tissues (Plested et al., 2020). However, CTA has drawbacks, including variability in contrast protocols across institutions, affecting image quality and consistency. Differences in injection rates, scan timing, and contrast opacification can lead to small vessel detection and evaluation accuracy variations. Additionally, reliance on pre- and post-contrast imaging may not capture dynamic blood flow through shunts, which is better assessed with intraoperative techniques like mesenteric portovenography.

Dogs with intrahepatic IHPSS treated non-surgically, survival outcomes reveal a moderate prognosis. In a cohort of 78 dogs with cPSS treated with non-surgical methods, the subgroup with IHPSS exhibited an estimated median survival time (EMST) of 26.5 months. This treatment typically involved a diet restricted in protein, sometimes supplemented with lactulose. Despite the relatively moderate survival expectancy, non-surgical treatment remains a viable option for managing clinical symptoms when surgical intervention is not feasible (Favier et al., 2020).

Hematology and blood chemistry parameters are significant prognostic factors for survival time in dogs with CPSS. Elevated blood ammonia levels, increased bile acids, and elevated liver enzymes such as ALT and ALP are crucial indicators of the liver's reduced capacity to detoxify blood due to the shunt. High blood ammonia levels are closely linked to hepatic encephalopathy, a significant factor in reducing quality of life and survival time. Increased bile acid concentrations and elevated liver enzymes indicate impaired liver function and ongoing liver damage, respectively, both of which contribute to a poorer prognosis. Additionally, hypoproteinemia and hypoalbuminemia can indicate severe hepatic impairment, further reducing survival times (Greenhalgh et al., 2014, Favier et al., 2020).

In conclusion, the prognosis for these cases was poor as the blood chemistry worsened progressively with each monthly follow-up. Managing canine IHPSS challenging due to their complex nature and variable clinical presentations. This case highlights the importance of a comprehensive diagnostic approach, including advanced imaging techniques and a tailored treatment strategy based on individual patient needs. Further research, particularly in dietary management and non-surgical treatment options, is essential to optimize patient outcomes and enhance our understanding of this complex condition.

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Case Report

Terbutaline Responsiveness in a Cat with Sinus Arrest

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Abstract

An 8-year-old neutered male Persian breed cat presented at the private practice for investigation of seizure-like episodes. An echocardiography revealed mild enlargement of the left atrium (La/AO: 1.73) with spontaneous echo contrast and mitral regurgitation. A left anterior fascicular block was also detected in the electrocardiogram. The cat had no response to the atropine response test. Aminophylline, pimobendan, clopidogrel, and furosemide were initially prescribed at the private clinic, and then the cat was referred to Prasu Arthon Animal Hospital, Faculty of Veterinary Science, Mahidol University, Thailand. Repeated echocardiogram and electrocardiogram demonstrated left atrium enlargement (La/AO: 1.85) and sinus arrest, respectively. The cat was diagnosed with feline nonspecific phenotype cardiomyopathy. As the cat has no improvement after aminophylline administration and the owners declined further management with pacemaker implantation, therefore, terbutaline at 0.625 mg/cat PO q12h was given to replace aminophylline. The cat responded well to this prescription. The mean interval of each syncope episode was markedly increased. Terbutaline increased the mean syncopal episode interval from 8.4 days of aminophylline treatment to 15.5 days. In this case, terbutaline could increase the mean heart rate (MHR) to 190 bpm, which might be an advantage over aminophylline, which increased the MHR to 165 bpm. Unfortunately, the cat died 62 days after starting a new medication. The objective of this case report is to describe medical management in a cat with sinus arrest without atropine responsiveness by using oral terbutaline.

Keywords: Sinus arrest, Terbutaline, Feline nonspecific phenotype cardiomyopathy

การตอบสนองต่อเทอร์บูทาลีนในแมวที่มีภาวะการหยุดเต้นของปุ่มไซนัสหัวใจห้องบน

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บทคัดย่อ

แมวพันธุ์เปอร์เซียอายุแปดปีเพศผู้ทำหมันแล้วเข้ารับการรักษาที่โรงพยาบาลสัตว์เอกชนเพื่อวินิจฉัยอาการคล้ายชัก การตรวจหัวใจด้วยคลื่นเสียงความถี่สูงเผยให้เห็นการขยายตัวในระดับต่ำของหัวใจห้องบนซ้าย (La/AO: 1.73) พร้อมด้วยการไหลเวียนเลือดผิดปกติ ลักษณะคล้ายควันบุหรี่ไหลวนและลิ้นไมตรัลรั่ว จากการตรวจคลื่นไฟฟ้าหัวใจพบภาวะแขนงประสาทข้างซ้ายส่วนหน้าของการนำไฟฟ้าในหัวใจผิดปกติ (left anterior fascicular block) แมวไม่ตอบสนองต่อการทดสอบการตอบสนองต่อยาอะโทรปีน และได้รับการรักษาจากโรงพยาบาลสัตว์เอกชนด้วยยาอะมิโนฟิลลีน พิโมเบนแดนโคลพิโดเกรล และฟูโรซีไมด์ จากนั้นแมวถูกส่งตัวไปยังโรงพยาบาลสัตว์ปศุอาทร คณะสัตวแพทยศาสตร์ มหาวิทยาลัยมหิดล ประเทศไทย การตรวจหัวใจด้วยคลื่นเสียงความถี่สูงและคลื่นไฟฟ้าหัวใจซ้ำแสดงให้เห็นถึงการขยายตัวของหัวใจห้องบนซ้าย (La/AO: 1.85) และภาวะการหยุดเต้นของปุ่มไซนัสหัวใจห้องบนตามลำดับ สัตว์ได้รับการวินิจฉัยว่ามีภาวะ feline nonspecific phenotype cardiomyopathy เนื่องจากอาการของแมวไม่ดีขึ้นหลังจากให้ยาอะมิโนฟิลลีน และเจ้าของปฏิเสธที่จะรักษาต่อด้วยการฝังเครื่องกระตุ้นหัวใจ ดังนั้นยาเทอร์บูทาลีนที่ขนาด 0.625 มิลลิกรัมต่อตัวแมว รับประทานทุก 12 ชั่วโมง จึงถูกนำมาใช้แทนที่ยาอะมิโนฟิลลีน แมวตอบสนองต่อยาตัวใหม่เป็นอย่างดี ค่าเฉลี่ยระยะห่างของอาการเป็นลมหมดสติเพิ่มขึ้นอย่างเห็นได้ชัด เทอร์บูทาลีนช่วยเพิ่มค่าเฉลี่ยระยะห่างของการเป็นลมหมดสติได้จาก 8.5 วันของการใช้อะมิโนฟิลลีน เป็น 15.5 วัน และสามารถเพิ่มอัตราการเต้นหัวใจเฉลี่ยได้ที่ 190 ครั้งต่อนาที ซึ่งอาจดีกว่าอะมิโนฟิลลีนที่ 165 ครั้งต่อนาที แต่แมวเสียชีวิต 62 วันหลังจากเริ่มใช้ยาตัวใหม่ วัตถุประสงค์ของรายงานสัตว์ป่วยนี้คือ เพื่อนำเสนอการจัดการทางยาในแมวที่มีภาวะการหยุดเต้นของปุ่มไซนัสหัวใจห้องบนซึ่งไม่ตอบสนองต่อการทดสอบด้วยยาอะโทรปีน โดยการให้ยาเทอร์บูทาลีนแบบรับประทาน

คำสำคัญ : การหยุดเต้นของปุ่มไซนัสหัวใจห้องบน เทอร์บูทาลีน Feline nonspecific phenotype cardiomyopathy

Introduction

Sinus arrest is a condition occurring when the discharge from SA node fails to deliver, leading to the absence of the heart rhythm. The pause may be due at least twice R-R interval or last 5-12 seconds if severe. Ventricular escape complex or normal complex will end the pause for survival. There are many causes including fibrosis of SA nodal tissue, enormously increased vagal stimulation, drugs and neoplasia. Sick sinus syndrome (SSS) is the most common cause of symptomatic sinus arrest in dogs. It is characterized by a variety of arrhythmias such as sinus bradycardia, sinus arrest, paroxysmal atrial tachycardia (bradycardia-tachycardia syndrome) and intermittent AV nodal block (Madron 2000). Miniature Schnauzers, Cocker Spaniels, Dachshunds, Pugs and West Highland White Terriers are breeds predisposed to this condition. Clinical signs associated with sinus arrest may present with intermittent weakness and syncope if the pause is severe and frequent (Tilley et al., 2008).

Medical management of sinus arrest is indicated in asymptomatic patients. The atropine response test might help select candidates that would respond to the prescription. Atropine 0.02 mg/kg IM or IV will increase 50% of baseline HR within 5-10 minutes after injection. Even if the patients have partial response to atropine, they are one of good candidates for medical management. Initially, the medication will start with parasympatholytic therapy followed by sympathomimetic drugs (Côté 2001). Atropine 0.04 mg/kg IV might be used to elevate heart rate. In normal dogs, a lower dose (0.02 mg/kg) of atropine showed ineffectively parasympathetic blockage (Rishniw et al., 2023). Beta-1 agonist drugs can be given in addition to speeding ventricular escape rate. The most common drug is isoproterenol in dogs. Dopamine is another option in cats and dogs (Côté 2001). Dobutamine might be one of the choices, but its positive chronotropic effect is less than dopamine. Sinus bradycardia or sick sinus syndrome can be managed with medicine in unstable patients or if pacemaker therapy is not an option. Treatment options aimed at breaking high vagal tone by using vagolytic drugs, such as propantheline, hyoscyamine sulfate, or phosphodiesterase inhibitor, theophylline, aminophylline. Sympathomimetic drugs, albuterol, terbutaline, could be prescribed as an alternative. In the case of symptomatic patients such as syncope or episodic weakness, artificial pacemaker therapy is indicated (Tilley et al., 2008).

Terbutaline, a selective beta 2 agonist, has been studied for its effect on the cardiovascular system. It increases in cardiac output, heart rate and systolic blood pressure, but decreases in diastolic blood pressure and total peripheral resistance (Kendall et al., 1982). Terbutaline does not impact on pulmonary vascular resistance or pressure. The beta 2 receptors are predominantly found in the bronchi and peripheral arteries, but few in the heart. Canine coronary vascular sympathetic receptors are classified as a constricting alpha 2 receptor and a vasodilating beta 2 receptor. The selective beta 2 agonist indirectly decreases myocardial blood flow as a result of systemic vasodilation and directly affects myocardial perfusion by enhancing vasodilation on coronary circulation. This helps protect a heart from ischemic events by enhance myocardial response to an increased oxygen demand for external work. Terbutaline induces tachycardia through a baroreceptor reflex mechanism. It is useful in heart failure condition by reducing the left ventricular afterload per se (Hansen et al., 1988).

There is only one case report of terbutaline usage for treating feline cardiomyopathy (Penning et al., 2009), but they neither do atropine response test nor provide the follow-up after treated. The objective of this case report is

to describe medical management in a cat with sinus arrest without atropine responsive by using terbutaline.

Case description

An 8-year-old neutered male Persian breed cat presented at a private practice for investigation of seizure-like episodes. The owner took the cat to the first animal hospital. The veterinarian found bradycardia (HR 66 bpm), normal heart sound, tachypnea (RR 67 bpm), increased lung sound and weak femoral pulse with pulse deficit on physical examination. The cat fell into lateral recumbency and had all limbs increased in tonicity during the examination for 5 seconds. Consciousness was impaired during the episode. The complete blood count (CBC) and blood chemistry were normal. Thoracic radiography revealed cardiomegaly (VHS 9.48). The cat was referred to perform echocardiogram and electrocardiogram at the second private practice. They found mildly enlargement of left atrium (La/AO: 1.73) with spontaneous echo contrast (SEC) and functional mitral regurgitation were found. The left anterior fascicular block (LAFB) was suspected on electrocardiogram, according to their discharge report. The cat had no response to the atropine response test. Due to the financial constraints of the owner, the oral medications were prescribed from the private practice with aminophylline, pimobendan, clopidogrel and furosemide at 5.32 mg/kg PO q12h, 0.26 mg/kg PO q8h, 18.75 mg/cat q24h and 2.12 mg/kg PO q24h, respectively on day 0. The cat showed no improvement in clinical signs. Therefore, the owner took the cat to Prasu Arthon Animal Hospital (PAAH), Faculty of veterinary science, Mahidol University, Thailand the next day.

On physical examination, the cat was conscious and his mental status was still responsive. The vital signs and neurological examination were unremarkable. A CBC found mild leukocytosis (19.89x10^3/uL; reference range [RR], 5.5-19x10^3/uL) and thrombocytopenia (PLT, 27x10^3/uL; RR 300-600x10^3/uL) because of platelet clumping in blood smear. Mild increased creatinine (1.96 mg/dL; RR 0.80-2.40 mg/dL) presented on blood chemistry. Cardiomegaly (VHS 8.5) and bronchial lung pattern are shown in thoracic radiography (Figure 1 and 2). Repeated echocardiogram and electrocardiogram indicated left atrium enlargement (La/AO: 1.85) and sinus bradycardia (HR 100 bpm) with triplet ventricular beats (Figure 3), respectively. Feline nonspecific phenotype cardiomyopathy (NCM) was a tentative diagnosis in this case. The owner refused further diagnosis with 24-hour ECG (Holter monitoring) and further management with a pacemaker implantation because of financial difficulties. The medication continued with pimobendan, clopidogrel, aminophylline and furosemide without adjusting doses.

Figure 1. Thoracic radiography on ventrodorsal view revealed generalized bronchial lung pattern.

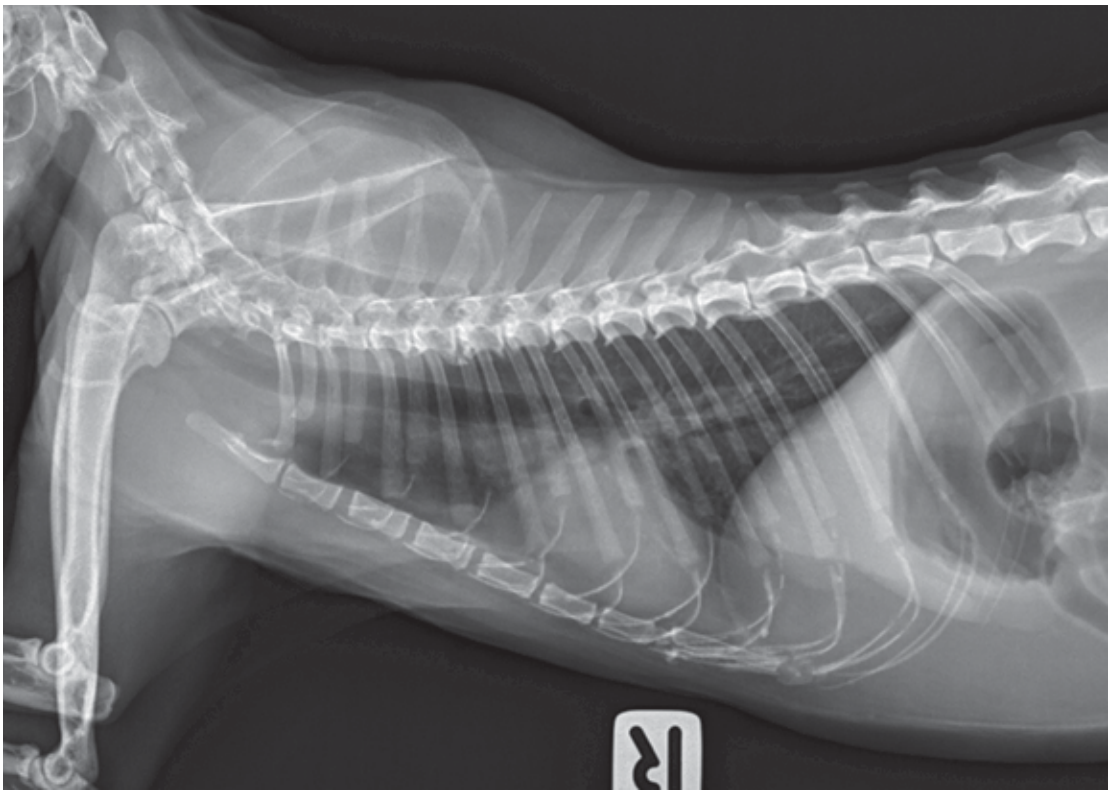

Figure 2. Thoracic radiography on lateral view revealed cardiomegaly (VHS 8.2) and bronchial lung pattern.

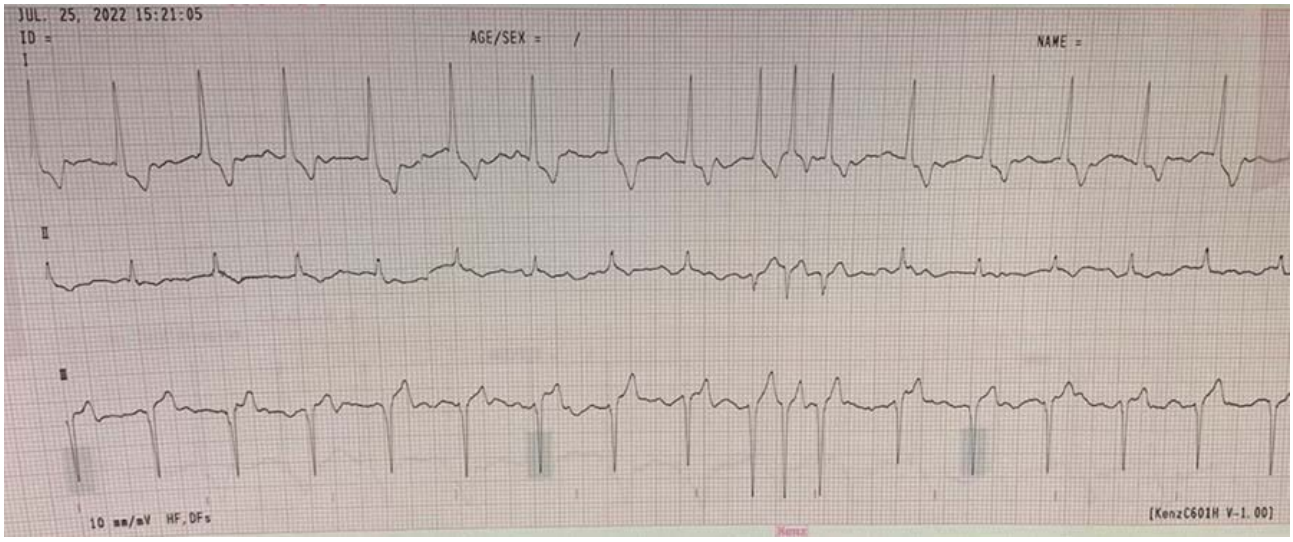

Figure 3. Sinus bradycardia (HR 100 bpm) with triplet ventricular beats (red box) found on ECG (25 mm/s and 10 mm/mV).

On day 35, the cat returned to PAAH due to syncope recurrence more than 6 times per day. The CBC found mild leukocytosis (19.23x10^3/uL; RR 5.5-19x10^3/uL). Hypokalemia (K, 2.7 mmol/L; RR 2.9-4.2 mmol/L) was also detected. Potassium chloride tablets (KCl) were added using dose 60 mEq PO q24h. The cat was admitted at PAAH on day 35-37. During hospitalization, pimobendan and furosemide were increased to high dose of 0.53 mg/kg PO q12h and 2 mg/kg IV q12h, respectively, because the disease progressed. On day 35, electrocardiogram demonstrated left anterior fascicular block with two atrial premature contraction (APC) and sinus arrest (Figure 4). The cat recovered to normal after correcting hypokalemia. The furosemide dosage decreased to 1.4 mg/kg PO q12h as the result of hypokalemia on day 37 and the cat was discharged.

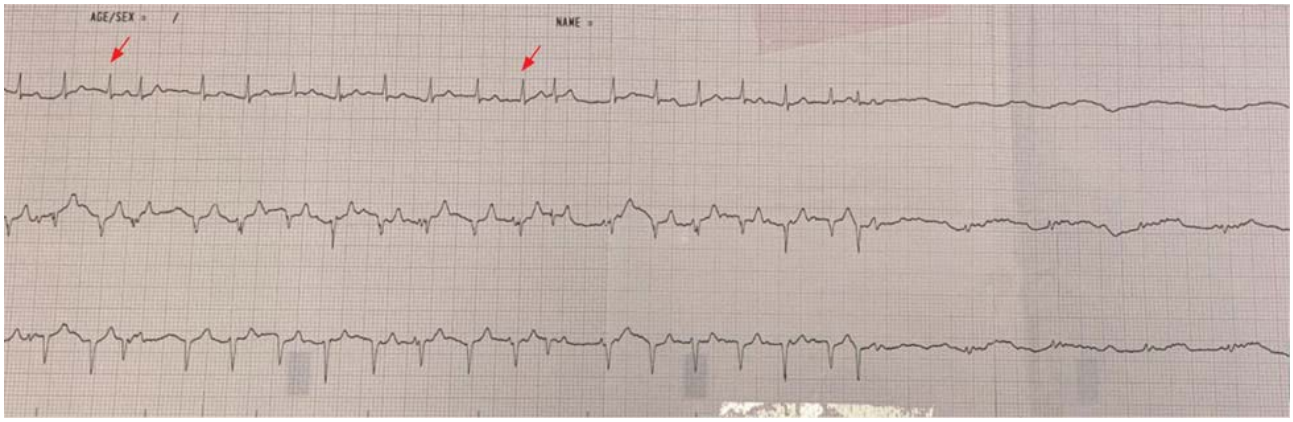

Figure 4. ECG demonstrated left anterior fascicular block with two APC (red arrow) and sinus arrest (25 mm/s and 10 mm/mV).

On day 41, syncope occurred more than 45 times per day in total and hypokalemia was returned, so the cat was admitted on day 41-46 at PAAH. Terbutaline 0.625 mg/cat PO q24h was tested as an alternative to aminophylline to increase heart rate on day 44. Surprisingly, the cat had no syncope at all after changing medication for 48 hours. Spironolactone 2 mg/kg PO q24h was used for potassium-sparing effects. Electrocardiogram was detected right on time as syncope occurred on day 44 and it showed sinus arrest followed by ventricular rhythm (Figure 5). Intermittent hypokalemia was generally found in old cats with hyperaldosteronism, so abdominal ultrasonography was evaluated. The results discovered chronic hepatopathy, cholestasis with bile sludge, bilateral nephropathy with renal insufficiency and no abdominal mass were found. On day 46, the cat had no syncope episodes for 48 hours so we discharged him with terbutaline, clopidogrel, pimobendan, furosemide, KCl and spironolactone. The cats had an appointment for a recheck of clinical signs on day 51 at PAAH, but the owner missed the appointment.

Figure 5. ECG showed sinus arrest, followed by ventricular rhythm, correlated with syncope (50 mm/s and 10 mm/mV).

On day 80, the cat came back with syncope estimated more than 20 times per day. The potassium level was normal. Terbutaline was increased to the maximum dose using 1.25 mg/cat PO q12h. No syncope occurred after adjusting the dose. On day 86, an electrocardiogram found first-degree AV block even though the cat had no clinical signs. Unfortunately, the cat died after syncope recurred on day 106. Survival time since started terbutaline was 62 days in this case. The owner was inconvenienced to allow necropsy the cat.

Table 1. Chronological summary of vital signs, potassium, clinical signs and treatment in a cat with sinus arrest.

Day	Heart rate (beats/min)	Respiratory rate (breaths/min)	Systolic blood pressure (mmHg)	Potassium (mmol/L)	Syncope (Yes/No)	Treatment (PO)
1	66	67	N/A	3.5	Y	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.26 mg/kg q8h Furosemide 2.12 mg/kg q24h
2	140	36	N/A	N/A	Y	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/catq24h Pimobendan 0.26 mg/kg q8h Furosemide 2.12 mg/kg q24h
35	150	42	130	2.7	Y	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 2 mg/kg q12h KCl 60 mEq q24h
36	190	24	110	4.06	N	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 2 mg/kg q12h KCl 60 mEq 24h
37	180	40	110	N/A	N	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq 24h
41	168	60	100	2.92	Y	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq 24h
42	250	48	120	3.23	N	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq 24h

Table 1. Chronological summary of vital signs, potassium, clinical signs and treatment in a cat with sinus arrest. (Cont.)

Day	Heart rate (beats/min)	Respiratory rate (breaths/min)	Systolic blood pressure (mmHg)	Potassium (mmol/L)	Syncope (Yes/No)	Treatment (PO)
43	180	30	110	2.51	Y	Aminophylline 5.32 mg/kg q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq 24h
44	220	40	120	3.18	Y	Terbutaline 0.625 mg/cat q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h
45	210	25	140	4.14	N	Terbutaline 0.625 mg/cat q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.53 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h
46	200	20	110	3.79	N	Terbutaline 0.625 mg/cat q12h Clopidogrel 18.75 mg/kg q24h Pimobendan 0.53 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h Spironolactone 2 mg/kg q24h
80	160	40	100	3.81	Y	Terbutaline 0.625 mg/cat q12h Clopidogrel 18.75 mg/kg q24h Pimobendan 0.3 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h Spironolactone 2 mg/kg q24h
81	180	28	120	N/A	Y	Terbutaline 1.25 mg/cat q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.3 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h Spironolactone 2 mg/kg q24h

Table 1. Chronological summary of vital signs, potassium, clinical signs and treatment in a cat with sinus arrest. (Cont.)

Day	Heart rate (beats/min)	Respiratory rate (breaths/min)	Systolic blood pressure (mmHg)	Potassium (mmol/L)	Syncope (Yes/No)	Treatment (PO)
82	160	40	N/A	N/A	N	Terbutaline 1.25 mg/cat q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.3 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h Spironolactone 2 mg/kg q24h
86	200	24	N/A	N/A	N	Terbutaline 1.25 mg/cat q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.3 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h Spironolactone 2 mg/kg q24h
106	Cardiac arrest	N/A	N/A	N/A	Y	Terbutaline 1.25 mg/cat q12h Clopidogrel 18.75 mg/cat q24h Pimobendan 0.3 mg/kg q12h Furosemide 1.4 mg/kg q12h KCl 60 mEq q24h Spironolactone 2 mg/kg q24h

N/A = not available

Table 2. The mean of heart rate, syncopal events, and the mean syncopal episodes interval when using aminophylline in comparison with terbutaline.

Drugs	The mean of heart rate (bpm)	Syncopal events* (times)	The mean syncopal episodes interval (days)
Aminophylline	165	5	8.4
Terbutaline	190	4	15.5

*The frequency of syncope was counted in 43 days follow-up in each treatment as shown in table 1

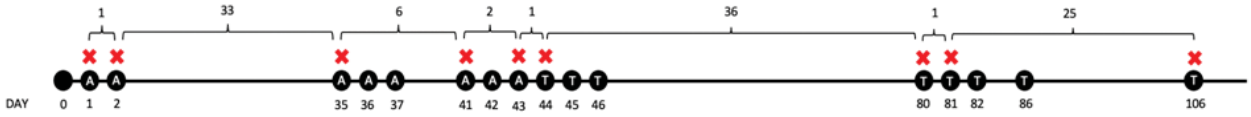

Figure 6. Timelines summary of cardiac syncopal events and interval of each syncopal episodes for aminophylline (A) and terbutaline (T) treatment.

Discussion

Syncope is a subset of collapse, a loss of postural tone suddenly, but includes loss of consciousness. Insufficient blood flow to the brain is the main cause of syncope. This can be classified as cardiogenic syncope and neurocardiogenic syncope. Cardiogenic syncope is associated with cardiogenic arrhythmias or neurocardiogenic reflexes causing hypotension. Blood pressure is estimated to fall at least 50%. Cardiac arrythmia has to be profound and sustained enough to originate systemic arterial hypotension. Asystole, such as bradyarrhythmia from sinus arrest, or a marked reduction in cardiac output could produce much degree of arrhythmias causing systemic arterial hypotension. This condition can be intermittent and might be detected only on Holter. It is fortunate that this case, we could detect the absence of electrical signal during episode of syncope simultaneously. We assume that the cause of sinus arrest in this case is because of primary cardiac disease, but the neurological cause could not be ruled out, even though the neurological examination was nonremarkable. There is limitation of the financial constraints of animal owners, making it impossible to diagnose further. Neurocardiogenic syncope is well-known as vasovagal syncope in small animals. It is the consequence of a profound bradyarrhythmia combine with reflex vasodilation generating hypotension. The mechanism is believed that autonomic nervous system was sudden failed, sympathetic tone terminated and rapid increase in vagal tone took place. The explicit mechanism remains unknown. Triggering events are usually associated with intense excitement situation as greeting owner etc. Structural heart disease, for example aortic stenosis, stimulating high left ventricular pressure which promote ventricular pressure receptors and trigger this reflex (Martin 2016).

Feline nonspecific phenotype cardiomyopathy (NCM) is a feline cardiomyopathy category that describes an abnormal echocardiographic pattern which does not match of all common cardiomyopathies in cat including hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy (DCM), restrictive cardiomyopathy (RCM) and arrhythmogenic right ventricular cardiomyopathy (ARVC). It is formerly known as unclassified cardiomyopathy. NCM was originally described as an echocardiographic finding of a large left atrium (LA) and a common figure of the left ventricle without abnormal diastolic function (Kittleson and Côté 2021). The echocardiographic finding in this case showed left atrial enlargement (La/AO: 1.85) with normal systolic and diastolic function. Parameters including NLVIDd (0.89), %FS (58.15), MV E:A ratio (1.54), IVSDd (0.43 cm.) and LVPWd (0.44 cm.). It is not compatible with another category of feline cardiomyopathy so the cat has cardiomyopathy-nonspecific phenotype.

Sick sinus syndrome (SSS) is the most common cause of symptomatic sinus arrest. This condition is often found in many dog breeds including Miniature Schnauzers, Cocker Spaniel, West Highland White Terrier and

Dachshunds, rare in cats (Tilley et al., 2008). The disturbance is not only affected in sinus activity, but also involved in those of other cardiac conductive tissues such as AV conduction, supraventricular and ventricular excitability. The cause is still unknown. The histological finding of SSS in dogs showed extensive depletion of nodal cells with fatty or fibrofatty tissue replacement (Machida and Hirakawa 2021). In human, they believe that the most common cause of intrinsic changes in the SA node is degenerative fibrosis of nodal tissue producing sick sinus syndrome. The diagnosis is maybe difficult. It relies on repeated and sufficiently long ECG, approximately 2-3 minutes. Sinus bradycardia maybe only present in the early stage. The dysrhythmias of the syndrome are hardly detected if the patient is asymptomatic. Holter monitoring is the most common method used in diagnosis (Adán and Crown 2003). Severe hyperkalemia, a serum potassium level of >7.5-8mEq/L, might be one of the causes inducing cardiac arrest, but this case experienced intermittent hypokalemia, as shown in table 1, which we presume it was a consequence of furosemide administration after investigating possible causes and no abnormalities were found. If there were smaller and biphasic T waves presented on ECG, it is the result of hypokalemia (Madron 2000). An atropine response test could predict the ability of the heart to respond to vagolytic drugs and long-term drug management success. Propantheline or hyoscyamine or aminophylline/theophylline help improving the condition by reducing bradycardia episodes and sinus arrest. Median survival time of dogs with SSS was 538 days. 54% of SSS dogs were successfully syncope controlled by using positive chronotropic drugs (Ward et al., 2016). Canine and feline bradyarrhythmia are considered pacemaker implantation as a first line therapy in most cases, improving quality of life and survival time (Santilli et al., 2019).

Aminophylline was initially prescribed in order to increase cardiac output. It is a methylated xanthine derivative which combine theophylline and ethylenediamine. A previous study of aminophylline on cardiovascular effects demonstrated myocardial contractility stimulation effects not only depend on dose, but also depend on route of administration (Rutherford et al., 1981), and it could temporary increase cardiac output (Howarth et al., 1947). Aminophylline, used to manage SSS, is recommended at dose 6-10 mg/kg PO q8h (Madron 2000). The unresponsiveness of using aminophylline in this case might be depended on dose.

Terbutaline 0.3 mg PO q8h was prescribed in a cat with history of bradycardia. The cat was reported to respond well after started terbutaline and had no additional event of collapsing after discharged for 3 months. There was no additional follow-up data (Penning et al., 2009). Ward et al. (2016) prescribed oral positive chronotropic drugs including theophylline, propantheline, hyoscyamine and terbutaline. The specific those of drugs chosen did not affect the treatment responsiveness. Terbutaline stimulates systemic vascular effect inducing heart rate and cardiac output (Hansen et al., 1988). Cilostazol is other medical choices to increase heart rate and prolong survival time in cats with syncope. High-grade atrioventricular block in a cat was reported using long-term management with cilostazol, an antiplatelet aggregation with phosphodiesterase III inhibitor, at 8-10 mg/kg PO q12h. It prolonged survival time for 650 days without surgical correction (Iwasa et al., 2019).

Pimobendan is a benzimidazole pyridazinone drug, act as positive inotrope and balanced vasodilatory effect. It improved left atrial function in HCM cats with CHF, but did not worsen HOCM (Oldach et al., 2019). Pimobendan 0.075-0.5 mg/kg PO q12h showed significant advantage in survival time not only in HCM-affected cat, but also

HOCM-affected cat (Reina-Doreste et al., 2014). The most common dose prescription of pimobendan is 1.25 mg PO q12h per cat (median initially total daily dose of 0.56 mg/kg/day; range 0.12-1.74 mg/kg/day). The cats with CHF, regardless of HCM or HOCM, are safe and well tolerated to pimobendan (Ward et al., 2020). Study has shown that high and standard doses of pimobendan do not differ in cardiac performance of dogs with natural-occurring myxomatous mitral valve disease (MMVD) (Kaplan et al., 2022). On the other hand, experimentally induced mitral regurgitation (MR) had proved to be benefit on using the high dose of pimobendan. They found that pimobendan has dose-dependent manner to decrease left atrial pressure caused by experimental MR (Suzuki et al., 2011). Further studies evaluating high dose pimobendan on long-term clinical benefit for animals with congestive heart disease are warranted.

In conclusion, this case report mainly describes medical management in a cat with sinus arrest without atropine response by using terbutaline. In this case, terbutaline can increase the mean of heart rate to 190 bpm which might advantage over aminophylline that is 165 bpm. Terbutaline also helps increasing mean syncopal episodes interval from 8.4 days of aminophylline treatment to 15.5 days of terbutaline treatment, as shown in table 2, and prolonging survival time for 62 days. Timelines summary of cardiac syncopal events and interval of each syncopal episodes for aminophylline and terbutaline treatment is shown in Figure 6. Atropine response test was negative but the cat still responded well to terbutaline. The syncope recurred even though we maximize the terbutaline and pimobendan dosage, but the effectiveness of pimobendan is not dose dependent in natural-occurring heart disease, as mentioned above. Therefore, we assumed that terbutaline improves the clinical symptoms. We hypotheses the recurrences might be the consequence of cerebral hypoxia during the episodes. MRI should be done to investigate brain lesions. A limitation of this study is the lack of Holter-monitoring. It could detect any electrical abnormalities more precisely, especially when the cat is in normal condition.

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