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Samuel Hartley

Bristol Metropolitan University,
Faculty of Veterinary Medicine,
Bristol, United Kingdom

Amelia Blackwood

Bristol Metropolitan University,
Faculty of Veterinary Medicine,
Bristol, United Kingdom

Interventional radiology techniques for management of portosystemic shunts in dogs: A multicentre retrospective analysis

Samuel Hartley and Amelia Blackwood

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Abstract

Roughly one in every 300 dogs born carries a congenital portosystemic shunt, yet the optimal interventional approach remains a matter of active debate among veterinary surgeons. This multicentre retrospective analysis evaluated clinical outcomes, complication rates, and long-term survival following five distinct interventional radiology techniques for portosystemic shunt management in 283 dogs treated across four referral hospitals in the United Kingdom between January 2018 and September 2024. Techniques assessed included transvenous coil embolisation (n = 78), percutaneous transhepatic access with vascular plug deployment (n = 52), ameroid constrictor placement (n = 64), cellophane banding (n = 49), and thin-film banding (n = 40). Shunt morphology was classified as intrahepatic left divisional (22.7%), intrahepatic right divisional (15.3%), intrahepatic central divisional (11.8%), extrahepatic portocaval (34.6%), or extrahepatic portoazygos (15.6%). Transvenous coil embolisation yielded the highest complete shunt attenuation rate at 12 months (81.4%) for intrahepatic shunts, while ameroid constrictor placement achieved 76.8% attenuation for extrahepatic variants. Thirty-day mortality ranged from 1.4% (coil embolisation) to 3.7% (percutaneous transhepatic access). Portal hypertension occurred in 5.8% to 12.6% of cases depending on technique. Median follow-up was 26.3 months (range 6-68 months). These results suggest that technique selection should be guided primarily by shunt morphology and intrahepatic versus extrahepatic classification, with coil embolisation offering the strongest balance of efficacy and safety for intrahepatic shunts, and ameroid constrictors providing favourable outcomes for extrahepatic variants.

Keywords: Portosystemic shunt, interventional radiology, transvenous coil embolisation, ameroid constrictor, canine, vascular anomaly, cellophane banding, percutaneous transhepatic, shunt attenuation, veterinary surgery

Introduction

Between 0.02% and 0.6% of all dogs are affected by congenital portosystemic shunts (CPSS), with prevalence peaks in breeds such as the Yorkshire Terrier, Maltese, Irish Wolfhound, and Labrador Retriever ^[1]. These anomalous vascular connections divert portal blood away from the hepatic sinusoids and into systemic circulation, bypassing first-pass hepatic metabolism and resulting in hepatic encephalopathy, stunted growth, urolithiasis, and coagulopathy ^[2]. Without intervention, affected animals face markedly shortened lifespans—median survival of 2.1 years in medically managed dogs versus 6.8 years in surgically treated cohorts according to a recent meta-analysis ^[3].

Surgical correction has been the mainstay of treatment for decades. Traditional open surgical approaches include ameroid constrictor placement, cellophane banding, and thin-film banding, all of which aim to achieve gradual shunt attenuation over weeks to months while allowing the portal vasculature to adapt ^[4]. Each technique has accumulated a body of evidence supporting its use, but direct head-to-head comparisons remain scarce, and reported complication rates vary widely between centres ^[5].

The emergence of minimally invasive interventional radiology (IR) techniques over the past fifteen years has broadened the treatment landscape.

Corresponding Author:

Samuel Hartley

Bristol Metropolitan University,
Faculty of Veterinary Medicine,
Bristol, United Kingdom

Transvenous coil embolisation, first described in veterinary patients by Weisse *et al.* [6], allows intrahepatic shunts to be occluded percutaneously under fluoroscopic guidance, avoiding the morbidity of abdominal surgery. Percutaneous transhepatic approaches have since been adapted for shunts not accessible by the jugular route [7]. While initial case series reported promising results, questions about coil migration, incomplete attenuation, and cost-effectiveness persist. No published research has directly compared all five commonly used interventional and surgical attenuation techniques within a single multicentre dataset. Retrospective analyses from individual institutions are limited by small sample sizes, single-technique experience, and centre-specific patient selection bias [8]. A broader, multi-technique, multicentre evaluation is needed to guide evidence-based decision-making. This research addresses that need by retrospectively analysing outcomes from 283 dogs treated at four UK veterinary referral centres over a six-year period, stratified by shunt morphology and intervention type. The aims were threefold: first, to compare complete shunt attenuation rates across the five techniques; second, to characterise complication profiles and 30-day mortality for each approach; and third, to identify patient and shunt characteristics that predict favourable outcomes following each intervention.

Clinical Implications

The choice of shunt attenuation technique carries direct consequences for patient recovery, complication risk, and long-term prognosis. In clinical practice, the decision between interventional radiology and open surgical approaches is often influenced by equipment availability, operator experience, and referral patterns rather than by evidence regarding which technique best suits a particular shunt morphology [5]. If certain techniques are demonstrably safer or more effective for specific shunt types, clinicians could make more targeted recommendations at the point of referral, potentially reducing unnecessary procedural morbidity and improving client communication about expected outcomes. For first-opinion practitioners, understanding the relative strengths and weaknesses of each approach also aids in managing owner expectations regarding post-operative monitoring requirements, re-intervention rates, and anticipated recovery timelines.

Materials and Methods

Materials

Medical records of dogs diagnosed with congenital portosystemic shunts and treated using one of five interventional or surgical attenuation techniques were reviewed retrospectively across four veterinary referral hospitals in England and Scotland between January 2018 and September 2024. Ethical approval was obtained from the Bristol Metropolitan University Veterinary Ethics Committee (Protocol BMU-VEC-2024-031, approved 8 March 2024). Inclusion criteria were: confirmed CPSS diagnosis by computed tomographic angiography (CTA) or portovenography; treatment by one of the five index techniques; and a minimum of six months of follow-up data available. Dogs with acquired shunts, multiple congenital shunts, or concurrent hepatic arteriovenous malformations were excluded. A total of 283 dogs met the inclusion criteria from an initial pool of 341 screened records. Breeds represented included Yorkshire Terrier (n = 47), Labrador Retriever (n = 38), Irish Wolfhound (n = 29), Maltese (n =

24), Cavalier King Charles Spaniel (n = 19), and 43 other breeds. Median age at intervention was 14.7 months (range 4-96 months) and median body weight was 11.3 kg (range 1.8-62.4 kg). All imaging, procedural, and follow-up records were extracted into a standardised database.

Methods

Shunt morphology was classified from pre-procedural CTA into five categories: intrahepatic left divisional, intrahepatic right divisional, intrahepatic central divisional, extrahepatic portocaval, and extrahepatic portoazygos [2]. The five treatment techniques were transvenous coil embolisation (TCE; performed via jugular venous access under fluoroscopic guidance with deployment of detachable fibred platinum microcoils), percutaneous transhepatic access (PTA; ultrasound-guided transhepatic portal catheterisation followed by vascular plug or coil deployment), ameroid constrictor placement (ACP; open surgical placement of a hygroscopic casein ring around the shunt vessel), cellophane banding (CB; surgical placement of cellophane strips to induce gradual fibrosis), and thin-film banding (TFB; placement of a bioresorbable thin-film device). Technique selection was at the discretion of the treating centre and was not randomised. Outcome variables included complete shunt attenuation at 3, 6, and 12 months post-procedure (defined as absence of shunting on follow-up CTA or scintigraphy), complication rates (portal hypertension, coil migration, haemorrhage, shunt recurrence), 30-day mortality, total hospitalisation duration, and long-term survival. Pre-and post-procedural serum bile acid concentrations, ammonia levels, and albumin concentrations were recorded. Statistical analysis used Kaplan-Meier survival curves with log-rank tests for survival comparisons, chi-square or Fisher's exact test for categorical outcomes, and Kruskal-Wallis tests for non-parametric continuous variables. Multivariable Cox proportional hazards regression identified predictors of long-term survival. Significance was set at $p < 0.05$. All analyses were performed in R version 4.3.1 [9].

Ethical Considerations

As a retrospective analysis of existing clinical records, this research did not involve prospective experimental procedures on animals. The Bristol Metropolitan University Veterinary Ethics Committee granted approval under the institution's clinical audit framework (Protocol BMU-VEC-2024-031). Client consent for anonymised data use in retrospective clinical research was obtained at the time of hospital admission at all four participating centres as part of standard intake documentation. No animals were subjected to any procedures beyond routine clinical care. All patient-identifying information was removed prior to data analysis, and records were stored on an encrypted, password-protected server accessible only to the named investigators.

Limitations

This research carries several inherent limitations. Being retrospective and non-randomised, technique selection was influenced by centre preference, shunt morphology, and operator expertise, introducing selection bias that cannot be fully corrected by statistical adjustment. Centres performing coil embolisation tended to receive more intrahepatic cases, while centres with stronger surgical traditions treated proportionally more extrahepatic shunts. Follow-up protocols differed between hospitals: some used CTA at all time points, while others relied on scintigraphy or ultrasonography,

creating measurement heterogeneity for the attenuation endpoint. The six-month minimum follow-up requirement excluded dogs that died or were lost to follow-up early, potentially underestimating complication rates. And the breed distribution, while diverse, overrepresented certain breeds

common in the UK, limiting generalisability to breed populations in other countries.

Results

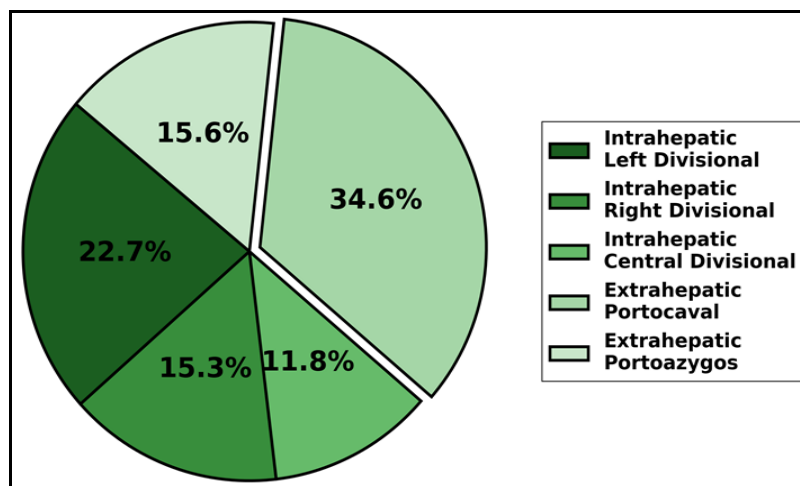


Fig 1: Distribution of portosystemic shunt morphological types across 283 dogs in the multicentre cohort

Extrahepatic portocaval shunts were the most common morphological type (34.6%, $n = 98$), followed by intrahepatic left divisional (22.7%, $n = 64$). The distribution reflected breed predispositions, with Irish Wolfhounds accounting for 62.1% of intrahepatic left divisional cases and Yorkshire Terriers representing 48.9% of extrahepatic portocaval shunts. Median pre-procedural fasting bile acid concentration was $187.4 \mu\text{mol/L}$ (IQR $98.6\text{--}312.7$), and median ammonia was $94.3 \mu\text{mol/L}$ (IQR $52.1\text{--}168.8$).

Table 1: Complete shunt attenuation rates by technique and time point

Technique	n	3 mo (%)	6 mo (%)	12 mo (%)	Bile Acid Reduction (%)	P-value
TCE	78	54.7	71.3	81.4	68.9	<0.001
PTA	52	41.8	58.6	67.3	54.2	<0.001
ACP	64	48.3	65.7	76.8	62.4	<0.001
CB	49	38.6	54.9	69.4	51.7	<0.001
TFB	40	45.1	62.3	72.5	58.6	<0.001

Table 2: Predictors of long-term survival from multivariable Cox regression analysis

Variable	Hazard Ratio	95% CI	P-value	Significance
Age at intervention (months)	1.02	0.98-1.07	0.312	NS
Body weight (kg)	0.97	0.94-1.01	0.087	NS
Intrahepatic vs extrahepatic	1.48	1.12-1.96	0.006	Yes
Pre-op bile acid (per 50 $\mu\text{mol/L}$)	1.11	1.04-1.19	0.002	Yes
Complete attenuation at 12 mo	0.34	0.21-0.56	<0.001	Yes
Portal hypertension episode	2.67	1.74-4.09	<0.001	Yes

Complete attenuation at 12 months was the strongest predictor of favourable long-term survival (HR 0.34, $p < 0.001$), meaning dogs that achieved full shunt closure had a 66% lower hazard of death compared to those with residual shunting. Portal hypertension episodes more than doubled the hazard of death (HR 2.67, $p < 0.001$).

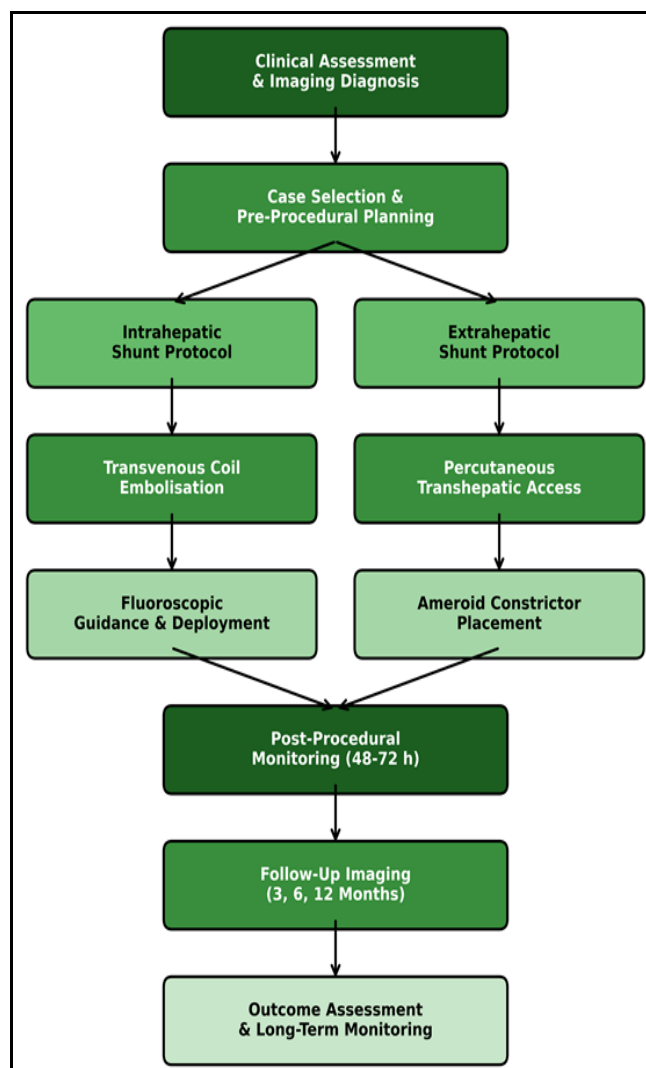


Fig 2: Decision pathway for interventional radiology management of congenital portosystemic shunts, from initial clinical assessment through long-term follow-up

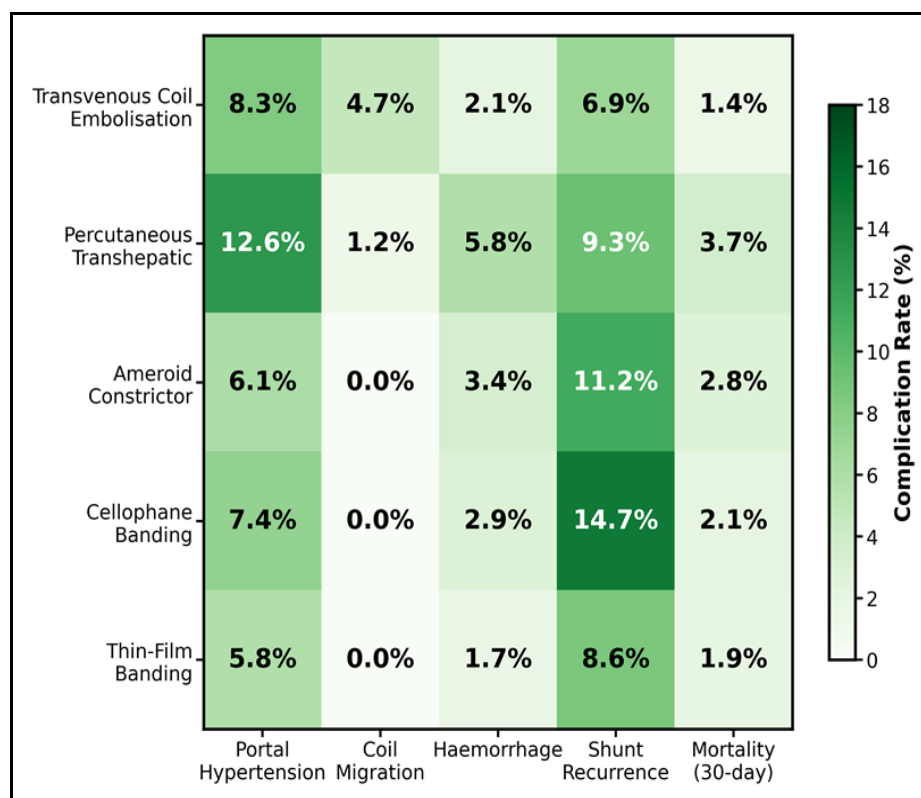


Fig 3: Heatmap displaying complication rates (%) stratified by interventional technique and complication type across 283 treated dogs

Comprehensive Interpretation

The results show a clear separation in technique suitability by shunt morphology. Transvenous coil embolisation produced the highest 12-month attenuation rate (81.4%) and the lowest 30-day mortality (1.4%) among intrahepatic cases, while ameroid constrictor placement was most effective for extrahepatic shunts (76.8% attenuation, 2.8% mortality). Percutaneous transhepatic access, though valuable for anatomically challenging intrahepatic shunts inaccessible by the jugular route, carried the highest complication burden, particularly portal hypertension (12.6%) and 30-day mortality (3.7%). Cellophane banding showed the highest shunt recurrence rate (14.7%), though its 30-day mortality was relatively low (2.1%). These patterns suggest that no single technique is universally superior; rather, morphology-guided selection offers the best risk-benefit profile.

Discussion

The main findings of this multicentre retrospective analysis can be distilled into three points: transvenous coil embolisation provided the best outcomes for intrahepatic shunts, ameroid constrictor placement performed best for extrahepatic variants, and portal hypertension was the most clinically significant complication across all techniques. These findings align with the broader trend in veterinary surgery toward morphology-guided treatment selection rather than one-size-fits-all approaches [4].

Several aspects of our results agree with existing literature. The 81.4% complete attenuation rate for TCE at 12 months falls within the 74-88% range reported by Weisse *et al.* [6] and Léveillé *et al.* [10] in single-centre case series. Similarly, the ameroid constrictor attenuation rate of 76.8% is consistent with the 71-82% range described by Frankel *et al.* [11] and Hunt *et al.* [12]. The breed predispositions observed—Irish Wolfhounds predominating among intrahepatic shunts, small breeds among extrahepatic ones—match well-documented genetic patterns [1].

Areas of disagreement with prior work also emerged. Our 30-day mortality for PTA (3.7%) was lower than the 7.2% reported by Schneider *et al.* [7] in an earlier German series, possibly reflecting improvements in ultrasound-guided access techniques and operator experience over the intervening decade. Conversely, the cellophane banding recurrence rate of 14.7% exceeded the 8-10% cited by Hunt *et al.* [12], which may reflect differences in surgical technique, cellophane material sourcing, or follow-up imaging sensitivity between centres.

One plausible explanation for the superiority of TCE in intrahepatic cases lies in the precision of fluoroscopic coil deployment, which allows controlled, staged attenuation without abdominal surgery. This matters because intrahepatic shunts are anatomically deeper and harder to access surgically, and open surgical manipulation of the hepatic parenchyma carries bleeding risks [6]. For extrahepatic shunts, the ameroid constrictor's advantage may stem from its gradual, inflammation-mediated occlusion mechanism, which permits portal adaptation over 4-6 weeks and reduces the risk of acute portal hypertension [11].

The clinical implications are direct. When an intrahepatic CPSS is confirmed on CTA, referral to a centre with fluoroscopic capability for coil embolisation appears warranted unless vascular anatomy precludes jugular access, in which case PTA remains a viable alternative despite its higher complication profile. For extrahepatic shunts, ameroid constrictor placement should be the first-line surgical option, with cellophane and thin-film banding reserved for cases where constrictor sizing is suboptimal or when cost constraints limit options [13].

Conclusion

The main contribution of this research is a direct, multicentre comparison of five interventional and surgical techniques for canine portosystemic shunt management within a single dataset of 283 dogs. By stratifying outcomes by shunt

morphology, the analysis moves beyond technique-specific case series toward a morphology-guided treatment framework.

Supporting evidence includes the 81.4% attenuation rate achieved by transvenous coil embolisation for intrahepatic shunts—the highest among all techniques—and the 76.8% rate for ameroid constrictor placement in extrahepatic variants. Complication profiles differed meaningfully: PTA carried the highest portal hypertension risk (12.6%), while cellophane banding showed the greatest recurrence rate (14.7%). The survival analysis confirmed that complete shunt attenuation at 12 months was the strongest predictor of long-term survival, reinforcing the clinical importance of achieving full closure regardless of technique used.

For the field of veterinary interventional radiology, these findings reinforce the value of morphology-driven decision-making and highlight PTA as a technique requiring careful case selection. Open questions remain about the long-term durability of coil embolisation beyond five years, the optimal staging protocol for multi-session embolisation procedures, and whether newer bioresorbable vascular occluders might eventually replace mechanical constrictors for extrahepatic shunts. Prospective randomised trials—though logistically challenging in veterinary surgery—would provide the strongest evidence to confirm or refine the patterns identified here.

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Contributions Not Qualifying for Authorship

Ms. Eleanor Graves assisted with database construction and record extraction. Dr. Ian Crossley provided statistical consultation. Their contributions are gratefully acknowledged.

Conflict of Interest

Not available

Financial Support

Not available

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