



**UNIVERSITI PUTRA MALAYSIA**

***APPLICATION OF CANINE PEDICLE SCREW AND ROD FIXATION  
SYSTEM IN THE LUMBAR 1 AND 2 VERTEBRAL BODY OF  
MONGREL DOGS***

**MURSHIDAH BINTI MOHD ASRI**

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DOGS**

By

**MURSHIDAH BINTI MOHD ASRI**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra  
Malaysia, in Fulfilment of the Requirements for the Degree of  
Master of Veterinary Science**

**January 2021**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Veterinary Science

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**Chairman : Intan Nur Fatiha binti Shafie, PhD**  
**Faculty : Veterinary Medicine**

Vertebral fractures and luxation (VFL) is a common spinal cord disorder in dogs, mostly affect the thoracolumbar region. Canine pedicle screw and rod fixation (CPSRF) system is a modified system from pedicle screw and rod fixation system (PSRFS), a device tailored for canine spine that offers a great alternative to commercially available implants. The aims of this study were; (1) to document VFL cases in University Veterinary Hospital, Universiti Putra Malaysia (UVH, UPM), (2) to determine the optimal corridor implantation of CPSRF in medium size dogs and (3) to examine gross and microscopic lesion to the vertebrae and spinal cord after CPSRF system implantation. Retrospective evaluation showed 49% of spinal cord cases were contributed by VFL. Adult, outdoor and intact male dog were prone to VFL. Nearly 40% of VFL cases were represented by local dogs ( $p < 0.01$ ) with the odds of VFL were four times higher than pure breed dogs (OR = 4.21, 95% CI 1.32-13.25). The most common site for VFL were at T13- L2 hence L1 and L2 region were chosen for the experiment. Two screws of 16mm and 20mm and rod of 40mm and 45mm were inserted into the pedicles of L1 and L2 in six dogs. Safe implantation angle for 16mm screw at L1 were  $52.67^{\circ} \pm 10.40^{\circ}$  and at L2 were  $58.59^{\circ} \pm 7.72^{\circ}$ . The mean distance of 16mm screw tips to aorta and caudal vena cava at L1 were  $9.21 \pm 3.67$ mm and  $18.96 \pm 5.17$ mm while average distance for 20mm were  $8.91 \pm 2.45$ mm and  $20.78 \pm 6.32$ mm. At L2, the distance of 16mm screw tips to aorta and caudal vena cava were  $11.32 \pm 1.47$ mm and  $19.26 \pm 5.12$ mm while average distance of 20mm were  $10.23 \pm 2.40$ mm and  $21.15 \pm 1.84$ mm at L2. No gross lesion was found on the vertebrae although minimal microfractures was found in all vertebral samples through histological examination. None of the spinal cord had penetrative or lacerative injury however longer observation period was required to assess the long-term effect of the implant. Findings from computed tomography scan and histological examination suggest that 16mm screw is suitable for medium sized dog with safe implantation corridor between at  $58.42^{\circ} \pm 7.25^{\circ}$ . This study had

shown that CPSRF is feasible for medium sized dogs however long-term study is required to determine stability and durability of the system.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains Veterinar

## **APLIKASI SISTEM PENGIKATAN SKRU DAN ROD PEDIKEL KANIN PADA BADAN VERTEBRA LUMBAR 1 DAN 2 ANJING MONGREL.**

Oleh

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Fraktur dan luksasi vertebra (VFL) merupakan penyakit saraf tunjang yang lazim pada torakolumbar anjing. Sistem pengikatan skru dan rod pedikel kanin (CPSRF) adalah sistem yang diubah suai daripada sistem pengikatan skru dan rod pedikel (PSRFS) dan merupakan alat alternatif baharu yang direka khas mengikut bentuk vertebra kanin. Tujuan kajian ini adalah untuk; (1) mendokumen bilangan kes VFL di Hospital Veterinar Universiti, Universiti Putra Malaysia (UVH, UPM), (2) menentukan koridor implantasi yang selamat untuk sistem CPSRF pada anjing bersaiz sederhana dan (3) memeriksa lesi-lesi pada vertebra dan saraf tunjang secara mata kasar dan mikroskopik. Kajian retrospektif menunjukkan 49% kes saraf tunjang adalah daripada kes VFL. Anjing jantan dewasa yang liar atau anjing dipelihara di luar rumah adalah cenderung untuk mengalami VFL. Sebanyak 40% daripada kes VFL daripada kalangan anjing tempatan ( $p < 0.01$ ) dan mempunyai nilai pekali sebanyak empat kali lebih tinggi berbanding anjing berbakat (OR = 4.21, 95% CI 1.32-13.25). VFL selalu berlaku pada bahagian T13-L2 oleh itu, L1 dan L2 telah dipilih untuk eksperimen ini. Dua skru iaitu 16mm dan 20mm dan juga rod sepanjang 40mm dan 45mm telah diimplankan kepada enam ekor anjing pada pedikel L1 dan L2. Sudut pemasangan skru yang selamat untuk 16mm skru pada L1 adalah  $52.67^{\circ} \pm 10.40^{\circ}$  dan pada L2 adalah  $58.59^{\circ} \pm 7.72^{\circ}$ . Purata sudut untuk 20mm skru pada L1 adalah  $56.03^{\circ} \pm 5.34^{\circ}$  dan pada L2 adalah  $55.67^{\circ} \pm 2.89^{\circ}$ . Purata jarak daripada tip skru dengan aorta dan vena kava untuk 16mm pada L1 adalah  $9.21 \pm 3.67$ mm dan  $18.96 \pm 5.17$ mm. Namun begitu, purata jarak daripada tip 20mm skru dengan aorta dan vena kava pada L1 adalah  $8.91 \pm 2.45$ mm dan  $20.78 \pm 6.32$ mm. Pada lumbar L2, jarak tip skru 16mm dengan aorta dan vena kava adalah  $11.32 \pm 1.47$ mm dan  $19.26 \pm 5.12$ mm, manakala, jarak tip skru 20mm dengan aorta dan vena kava adalah  $10.23 \pm 2.40$ mm dan  $21.15 \pm 1.84$ mm pada L2. Secara kasar, tiada lesi didapati pada sampel tulang belakang namun melalui kajian histologi, semua sampel menunjukkan mikrofraktur yang minima. Tiada kecederaan penembusan mahupun laserasi terhadap saraf tunjang tetapi, pemerhatian yang lebih lama diperlukan untuk mengkaji kesan jangka masa

panjang implan tersebut. Dapatan dari kajian imbasan tomografi berkomputer dan pemerhatian histologi menunjukkan skru bersaiz 16mm sesuai untuk anjing bersaiz sederhana dan koridor implantasi yang selamat direkodkan pada  $58.42^{\circ} \pm 7.25^{\circ}$ . Kajian ini menunjukkan CPSRF sesuai untuk anjing bersaiz sederhana namun kajian masa panjang perlu dijalankan untuk menentukan kestabilan and kelasakan sistem ini.



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## LIST OF ABBREVIATIONS

3D	Three-dimensional
$\alpha$	Transverse insertion angle
CSF	Cerebrospinal fluid
CT	Computed tomography
CPSRF	Canine pedicle screw and rod fixation
dAo	Distance of vertebral body to aorta
dCvc	Distance of vertebral body to caudal vena cava
dSAo	Distance of screw tip to aorta
dSCvc	Distance of screw tip to caudal vena cava
EDTA	Ethylenediaminetetraacetic acid
ETT	Endotracheal tube
FCE	Fibrocartilaginous embolism
IVDD	Intervertebral disc disease
L1	Lumbar- 1
L2	Lumbar- 2
L3	Lumbar- 3
L4	Lumbar- 4
L5	Lumbar- 5
L7	Lumbar- 7
MRI	Magnetic resonance imaging
MMA	Methylmethacrylate
PMMA	Polymethylmethacrylate
PSRFS	Pedicle screw and rod fixation system

S1	Sacrum- 1
SCI	Spinal cord injury
T3	Thoracic- 3
T10	Thoracic- 10
T12	Thoracic- 12
TIVDD	Traumatic intervertebral disc injury
UMN	Upper motor neuron
UPM	Universiti Putra Malaysia
UVH	University Veterinary Hospital
VD	Ventro-dorsal
VFL	Vertebral fracture and luxation



# CHAPTER 1

## INTRODUCTION

### 1.1 Background of study

Spinal cord disorders are common in dogs and can be categorized into congenital or developmental, inflammatory, infectious, vascular, neoplasia and traumatic injury conditions (Lorenz et al., 2010; Partridge & Rossmesl, 2020). Intervertebral disc disease (IVDD) is considered as the most common disorder followed by vertebral fracture and luxation (VFL) and fibrocartilaginous embolism (FCE) (Granger & Carwardine, 2014; Šulla et al., 2018). Reports show that VFL accounts up to 7% of all spinal cord disorders in companion animals (Jeffery, 2010; Partridge & Rossmesl, 2020), frequently caused by road traffic accident (Granger & Carwardine, 2014; Intarapanich et al., 2016; Schmidli et al., 2019). The diagnosis of VFL is achieved via radiograph or computed tomography (CT), which also crucial in surgical planning (Lorenz et al., 2010; Kendler et al., 2016). The most common site of VFL is at the thoracolumbar junction (Jeffery, 2010; Wang, Zhou, et al., 2017; Lewis et al., 2020). VFL is considered as an emergency, thus immediate stabilization is required in most cases. Secondary injuries such as pulmonary contusion, fractures of the rib, long bone or pelvis and wound must be treated concurrently with VFL (Bruce et al., 2008; Jeffery, 2010; Klainbart et al., 2018). The management of VFL is centred on the repair of the contusion, decompression and stabilization (Baliga & Ahmed, 2016; Wang, Zhou, et al., 2017; Julien et al., 2020). The decision-making whether to manage medically or surgically mainly rely on the severity of the systemic and neurological dysfunctions (Olby, 2012; J. Lee & Thumbikat, 2015; Hettlich, 2017). Medical intervention includes strict cage rest, pain control and rehabilitation are mostly recommended in patients with stable fractures and mild neurological deficits (Jeffery, 2010; Granger & Carwardine, 2014; Schmidli et al., 2019). Dogs with unstable fractures and intact deep pain sensation always require surgical fixation to improve neurological recovery (Olby, 2012; Baliga & Ahmed, 2016; Hettlich, 2017).

### 1.2 Problem statement

Surgical treatment improves prognosis by 40% in the patients with intact deep pain perception compared to dogs that undergone medical treatment (Lorenz et al., 2011; Kuricova et al., 2016). There are multiple devices used to repair VFL including pin or screw in combination with polymethylmethacrylate (PMMA), vertebral plating and percutaneous pinning (Hettlich et al., 2017; Kenzig et al., 2017; Nel et al., 2017). These techniques require a highly skilled surgeon with various complications reported such as implant migration and failure, tract infection, inflammation and loosening of implant-bone interphase and pressure necrosis (Bruce et al., 2008; Krauss et al., 2012; Di Dona et al., 2016). Aside

from that, in the local setting, the device such as vertebral plate is expensive and often associated with major soft tissue manipulation, which may prolong surgical time and increase the risk of infection (Tobias & Johnston, 2012; Sturges et al., 2016). Screw and PMMA are relatively cheap and easily available but may delay bone healing (Ricker et al., 2008; Lewchalemwong et al., 2018; Li et al., 2020).

Several studies have also explored a human implant, pedicle screw and rod fixation system (PSRFS) in large breed dogs with promising outcomes (Smolders et al., 2012; Tellegen et al., 2015; Özak & Yardimci, 2018; Reints Bok et al., 2020). Paediatric PSRFS were used in most cases as the adult implants were too big for dogs that weighing less than 22kg (Tellegen et al., 2015; Özak & Yardimci, 2018). Therefore, there is a clinical need to modify the size and dimension of PSRFS for various body weight and breed of canine patients. In 2017, Lewchalemwong & Linharattanaruksa have introduced canine pedicle screw and rod fixation system (CPSRF) as an alternative to PSRFS. A mechanical study of CPSRF system using polymer blocks revealed better bending yield load, compressive bending stiffness and compressive ultimate load compared to screw and PMMA technique (Lewchalemwong, Suwana, et al., 2018). To date, there are several cases reports available on CPSRF system in dogs, however no study was done to investigate the safe implantation corridor of this system and its potential injury towards the vertebrae and spinal cord in dogs.

### **1.3 Research objectives**

The aims of this study were:

1. To determine the case distribution of vertebral fracture and luxation in University Veterinary Hospital, Universiti Putra Malaysia (UVH, UPM).
2. To evaluate the safe implantation corridor for canine pedicle screw and rod fixation system (CPSRF) system in dogs.
3. To assess the gross and histopathological changes of vertebrae and spinal cord post CPSRF system implantation.

#### 1.4 Summary of the chapters

- Chapter 2 described a brief review on the canine vertebral anatomy, discussion on VFL pathophysiology, clinical signs, diagnostic approach, management and introduction to CPSRF system.
- Chapter 3 summarized the VFL case distribution in dogs presented to UVH, UPM.
- Chapter 4 contained data on surgical procedure and measurement of specific parameters in relation to safe implantation corridor of CPSRF system.
- Chapter 5 explained the gross and histopathological findings on vertebrae and spinal cord post-CPSRF system implantation.
- Chapter 6 summarized the important findings and future recommendations.

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