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Mechanical evaluation of canine sacroiliac joint stabilization using two short screws

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Abstract

Objective: To assess the feasibility and mechanical stability of sacroiliac (SI) joint stabilization using 2 short 3.5 mm cortical screws, each spanning an average of 23% of the width of the sacral body.

Study design: Cadaveric experimental study.

Sample population: Twenty-four canine pelvis specimens.

Methods: Pelvis specimens were prepared by disarticulation of the left SI joint and osteotomy of the left pubis and left ischium, and stabilized using a single long lag screw (LLS), 2 short lag screws (SLS) or 2 short positional screws (SPS). Computed tomography (CT) imaging was used to determine standardized screw lengths for each group and was repeated following implant insertion. Specimens were secured within a servohydraulic test frame and loaded through the acetabulum to simulate weight bearing under displacement control at 4 mm/min for 20 mm total displacement. Group mechanical testing data were compared.

Results: Peak load, yield load, and stiffness were more than 2 times greater in both the SLS and SPS groups when compared with the LLS group. No mechanical difference was identified between the short-screw groups.

Conclusion: Sacroiliac luxation fixation using 2 short screws created a stronger, stiffer construct when compared with fixation using a single lag screw spanning 60% of the width of the sacral body. No mechanical advantage was observed between short screws inserted in positional vs. lag fashion.

Clinical significance: Sacroiliac luxation fixation using 2 short screws creates a mechanically superior construct with a larger region of acceptable implant positioning and potentially reduced risk of iatrogenic injury compared with conventional fixation.

1 | INTRODUCTION

Sacroiliac (SI) joint luxation is a common and often debilitating injury in veterinary patients, typically occurring secondary to blunt force trauma.[1] Between 15% and 21% of all patients with pelvic fractures have concurrent SI luxation and, though observable as an isolated injury, up to 93% of unilateral SI luxation cases have been reported in conjunction with other pelvic fractures.[1,2] Beyond discomfort and subsequent lameness, SI joint luxation and the often concurrent pelvic fractures can cause pelvic canal narrowing and disruption of the neurologic supply to the urinary bladder, anus, and the pelvic limbs.[3–6]

Conservative management of SI luxation consisting of strict rest for 4-8 weeks can have good clinical outcomes and high owner satisfaction.[7,8] Conservative management is ideally pursued in patients without significant pelvic canal collapse, with minimal SI joint displacement and minimal concurrent orthopedic injury, or in circumstances of financial or patient constraints.[1,3,4,7–11] Unfortunately, many patients do not meet these criteria and evidence suggests that conservative management of dogs with SI luxation leads to a slower return to weight bearing and has a prolonged recovery when compared with those dogs managed surgically.[5,12,13]

Both open and minimally invasive techniques have been described for surgical stabilization of SI luxation.[2,5,10,13,14] Regardless of the technique employed, the goal of surgery is to reduce the SI joint anatomically and stabilize the ilium in this reduced position. To prevent implant loosening, the currently accepted technique uses screw insertion from the ilium into the sacral body, with the recommendations the screw span at least 60% of the sacral body width and screw diameter is maximized.[2,3] Current techniques use the sacral body for screw anchoring as its significant bone mass permits longer and larger diameter screw use. Implant insertion entirely within the sacral body, however, presents a significant surgical challenge, requiring accurate determination of the location of the sacral body and appropriate drill bit orientation while drilling. Inaccurate drill bit direction or off-axis implant insertion at this site can result in life-altering complications such as irreversible neurologic damage.[2,10,15] The sacral body lies near the spinal canal and associated nerve roots dorsally, the L7-S1 intervertebral disc space cranially, and branches of the caudal aorta ventrally. Fluoroscopic guidance of implant placement has been shown to improve implant placement accuracy, reducing but not eliminating these risks.[11] Unfortunately, fluoroscopic equipment is not available in most veterinary practices, supporting the need for a fixation technique with less reliance on fluoroscopy for its accuracy and safety.

Given the common occurrence of SI luxation and the risks associated with the traditional surgical stabilization techniques, alternative stabilization techniques should be explored. The sacral wing has been described as a site for antirotational pin/screw placement, as a supplement to a screw placed into the sacral body.[3,14,16] Although it is much narrower than the bone width available in the sacral body, the sacral wing offers a large surface area of bone for implant insertion. The purpose of this study was to evaluate the feasibility of and stability provided by stabilization of the SI joint using 2 short cortical screws inserted from the ilium into the sacral wing, either positionally or lag fashion. We further sought to compare these novel 2-screw stabilization techniques with SI joint stabilization using the widely accepted technique of a single, long cortical screw inserted in lag fashion, spanning at least 60% of the width of the sacral body. We hypothesized the 2 short cortical screw stabilization technique would provide equivalent or better mechanical stabilization of the SI joint as compared to the single long cortical screw SI stabilization technique. We also hypothesized that the screw insertion technique (lag versus positional) would not alter construct stability when stabilizing the SI joint using 2 short cortical screws.

2 | MATERIALS AND METHODS

2.1 | Specimens and preparation

Canine pelvis specimens including the sacrum were harvested from normal dogs of similar size, euthanized for reasons unrelated to the study and previously used in a veterinary surgery continuing education course. Cadavers were sourced from Skulls Unlimited International, Inc., Oklahoma City, Oklahoma. This study was approved by the institutional animal care and use committee of the Ohio State University (IACUC Number 2020A00000112). All pelvis specimens were evaluated as skeletally mature and free of radiographic evidence of orthopedic disease affecting the hip or sacroiliac joints prior to inclusion in the study. Dog bodyweight was recorded prior to harvest of the pelvis specimens. Specimens were dissected free of all soft tissue structures, other than the tissues associated with the SI joint, and then stored at $-20\,^{\circ}C$. Pelvis specimens were thawed at room temperature overnight prior to testing.

2.2 | Pelvis imaging and screw length calculation

A computed tomography (CT) scan of each pelvis specimen was obtained with a 1 mm slice thickness using a 128 slice GE Revolution EVO CT scanner (GE Healthcare, Chicago, Illinois). Pelvis CT images were imported into medical image viewing software (Vet Rocket, Santa Clara, California). A 3D multiplanar reconstruction view was used to obtain a transverse plane image of the sacrum at the dorsal-ventral center of the sacral body. The width of the sacrum, the width of the left ilium, and the width of the left SI joint space were measured on the coronal plane image at the level of the cranial-caudal center of the sacral body. The length equal to 61% of the width of the sacrum was calculated for each specimen. A screw length extending through the ilium and at least 61% of the width of the sacral body, not accounting for any potential compression across the SI joint, on the largest pelvis specimen was determined to be 40 mm. All sacroiliac joints stabilized using a single screw utilized 3.5 mm cortical screws measuring 40 mm in length (VOI, St. Augustine, Florida). A dorsal plane image at the dorsal-ventral center of the spinal canal in the sacrum was identified and the distance from the left lateral cortex of the ilial wing to the most left lateral extent of the spinal canal was measured. A screw length extending through the ilium and the lateral wing/body of the sacrum but stopping at least 1 mm short of the spinal canal in the smallest pelvis specimen, assuming complete SI joint compression, was determined to be 24 mm, so 3.5 mm cortical screws measuring 24 mm in length (VOI) were used for all sacroiliac joints stabilized using 2 screws.

2.3 | Screw insertion torque determination

To determine the average cortical screw stripping torque in each study group prior to specimen preparation, 5 × 3.5 mm cortical screws were inserted in both lag (24 mm and 40 mm screws) and positional (24 mm screws only) fashion, through the ilial wing and into the sacral body of 5 pilot pelvis specimens. Each cortical screw was inserted with a calibrated electronic torque screwdriver (Capri Tools, Pomona, California), capable of recording the applied torque. The maximum torque applied at the time of screw stripping was recorded in *N*m*. The mean screw stripping torque for the 5 cortical screws of each length and insertional technique was calculated. A torque value representative of 80% of the mean screw stripping torque for each cortical screw length was calculated and recorded as the target insertional torque for each length and insertional technique of the cortical screws.[17]

2.4 | Drill guide generation

To standardize the screw insertion location within and between the 2 screw testing groups, a single drill guide was 3D printed in the shape of an equilateral triangle with sides 1 cm in length and with 1.1 mm diameter drill guide holes at each of the 3 corners as well as within the center of the guide (Figure 1). The guide design and dimensions were based on radiographic measurements of sacral size in dogs of a similar weight range to those used in this study. The guide was designed to allow consistent screw placement in the sacral wing in the SLS and SPS groups without risk of cranial sacral endplate penetration when centered over the center of the sacral body. This guide was therefore not custom printed for each individual cadaver in this study.

2.5 | Sacroiliac stabilization – single long lag screw (LLS)

The left sacroiliac joint capsule of 8 pelvis specimens was disarticulated using a scalpel blade. A sagittal saw was used to perform an osteotomy of the left pubis midway between the pubic symphysis and the left iliopubic eminence. An ischial osteotomy was also performed, extending from the left obturator foramen cranially to the ischiatic arch caudally (Figure 4A). Care was taken to minimize disruption of the bone surfaces of the ilium and sacral wing during disarticulation. With the left ilium displaced, the location on the left lateral aspect of the wing of the sacrum, which represented the cranial-to-caudal and proximal-to-distal center of the body of the sacrum was identified.[2,18] A 1.1 mm K-wire was inserted at the identified location and directed perpendicular to the long axis of the dorsal spinous process and parallel to the cranial endplate of the S1 vertebra from left to right so the K-wire passed through the middle of the sacral body and exited through the lateral aspect of the right ilium. The K-wire was grasped from the side exiting the right ilium and extracted until the tip of the K-wire was seated below the surface of the left sacral wing. The left sacroiliac joint was then anatomically reduced. The K-wire was then driven from right to left until the wire exited the lateral cortex of the left ilium. This K-wire was overdrilled from left to right using a cannulated 3.5 mm drill bit until the drill bit penetrated the trans cortex of the ilium. A cannulated 2.5 mm drill bit was then used to overdrill the portion of the K-wire in sacrum, from left to right, starting in the left sacral wing and ending at a depth equal to the intended insertion depth of the single (long) cortical screw. The drill bit and K-wire were removed from the sacrum. The left SI joint was stabilized by inserting a single 3.5 mm diameter 40 mm long self-tapping cortical screw to an insertional torque of 110 *N*m* (based on 80% of the average stripping torque identified in preliminary testing).

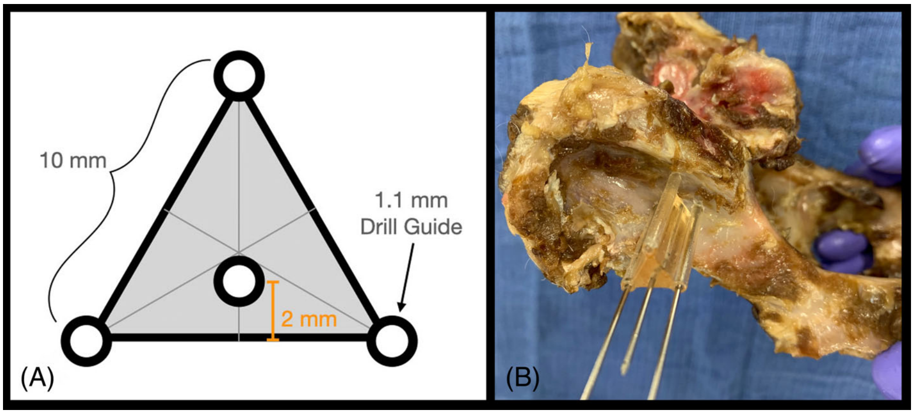

FIGURE 1 (A) Rendition of the K-wire drill guide with 1.1 mm holes located at the corners of an equilateral triangle shape and a fourth, 1.1 mm hole in the central region designed to be placed over the 1.1 mm K-wire inserted in the center of the sacral body. Each arm of the triangle is 1 cm in length. (B) Three-dimensional printed drill guide positioned over the lateral aspect of the left ilium with K-wires inserted through the central and 2 corner holes. The K-wires in the corner holes were overdrilled using a cannulated drill bit to allow insertion of 2 short cortical screws in the short lag screw (SLS) and short positional screw (SPS) groups

2.6 | Sacroiliac stabilization – 2 short positional screws (SPS)

Eight pelvis specimens were prepared by performance of SI joint disarticulation and pubic and ischial osteotomies as described above for the LLS samples. A 1.1 mm K-wire was inserted in the center of the sacral body, using the same technique as described previously for the single-screw samples.[2,18] The previously described 3D printed drill guide was positioned on the lateral aspect of the left ilium, with the K-wire exiting the lateral cortex of the left ilium positioned inside the central guide hole (Figure 1B). The base of the drill guide was positioned ventrally and oriented such that the base was parallel to the ventral cortex of the sacral body (Figure 2), and 1.1 mm K-wires were driven through the drill guide holes located at the cranioventral and caudodorsal corners of the triangular drill guide into and through the ilium and then into the sacrum (Figures 1B and 2). The K-wires were inserted to a depth equivalent to the length of the short 3.5 mm screws (24 mm). The drill bit and K-wires were removed from the specimen. The left SI joint was stabilized by inserting 2 × 3.5 mm diameter 24 mm long self-tapping cortical screws to an insertional torque of 120 $N*m$ (based on 80% of the average stripping torque identified in preliminary testing).

2.7 | Sacroiliac stabilization – 2 short-lag screws (SLS)

Eight pelvis specimens were prepared, and 3 K-wires were inserted utilizing the drill guide for the insertion of the final 2 K-wires as described above for the SPS samples. Following removal of the drill guide along with the K-wire through the center of the sacral body, the 2 remaining K-wires were overdrilled from left to right using a cannulated 3.5 mm drill bit until the drill bit penetrated the trans cortex of the ilium. A cannulated 2.5 mm drill bit was then used to overdrill the portion of the K-wires in sacrum, from left to right, starting in the left sacral wing and ending at a depth equal to the intended penetration depth of the 24 mm cortical screws. The drill bit and K-wires were removed from the sacrum. The left SI joint was stabilized by inserting 2, 3.5 mm diameter 24 mm long self-tapping cortical screws to an

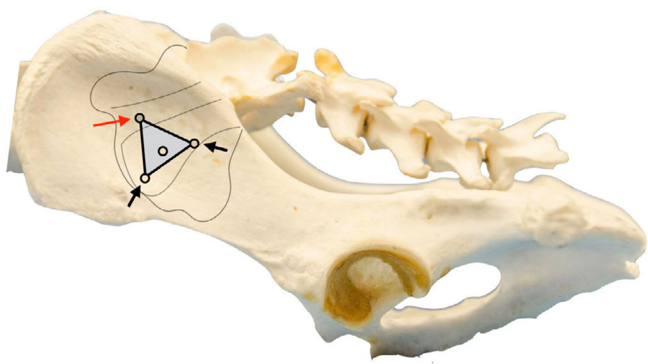

FIGURE 2 Rendition of the 3D printed K-wire drill guide positioned over the lateral aspect of the ilial wing and centered over the center of the sacral body. Cranioventral and caudodorsal guide holes (black arrows) were used to insert K-wires, which were subsequently overdrilled with cannulated drill bits for screw insertion in all specimens within both short positional screw (SPS) and short lag screw (SLS) groups. In the clinical scenario, positioning of the caudal screw in a more cranial or craniodorsal location (red arrow) may lead to reduced sacral foraminal trauma

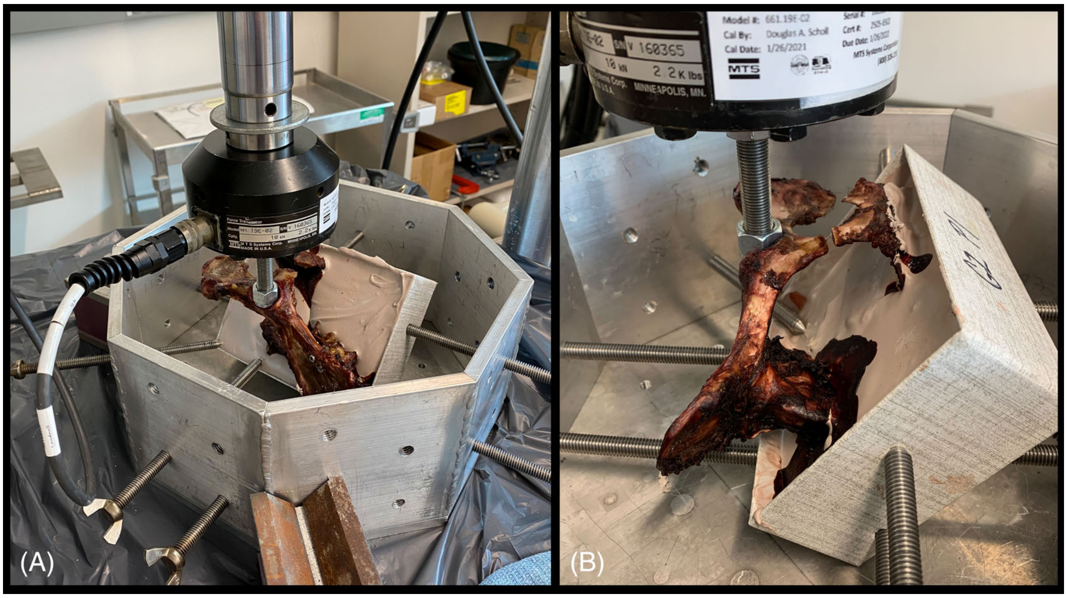

FIGURE 3 Pelvis specimen from the lateral (A) and cranial (B) aspects, potted in polyester resin and secured in a servohydraulic materials test frame in a custom-built fixture while load is applied in a craniodorsal direction through the left acetabulum

insertional torque of 50 *N***m* (based on 80% of the average stripping torque measured in preliminary testing).

2.8 | Premechanical testing specimen assessment

Following screw insertion but prior to mechanical testing, all specimens were again imaged using the CT scanner and imaging platform previously described. LLS specimen implant location within the sacral body and length relative to the width of the sacral body was assessed. The SLS and SPS specimen implant position relative to surrounding anatomic structures was assessed. Any displacement about the osteotomies was also assessed.

2.9 | Mechanical specimen testing

All pelvis specimens were potted by incorporating the right ilium and the sacrum to the right of dorsal midline in a block of polyester resin (Bondo 3M, Saint Paul, Minnesota). The resin was allowed to harden for 24 h. Specimens were then sequentially secured to the base of a servohydraulic materials test frame (Bionix 858; MTS Corp., Eden Prairie, MN) in a custom-built fixture. A threaded rod segment capped with a nut and attached to the actuator of the testing frame was placed within the acetabulum (Figure 3). The load was applied through the acetabulum in a cranio-dorsal direction to simulate a weight-bearing force under displacement control at 4 mm/min up to 20 mm total displacement. Load and displacement were recorded at a rate of 0.33 Hz and used to generate load-displacement curves for each sample. Load displacement curves were evaluated, and construct stiffness was calculated as the slope of the linear region of the load displacement curve. Peak load and yield load were also calculated for each construct. For this study, peak load was defined as the maximum load measured before 20 mm of left hemipelvis construct displacement and/or prior to left hemipelvis contact with any other aspect of the construct. Yield load was defined as the load measured at 5 mm of left hemipelvis construct displacement, a distance determined prior to testing as being consistent with clinical failure of the construct. Displacement at peak load was also recorded for all constructs.

2.10 | Statistical analysis

An ANOVA sample-size calculation was performed on an initial pilot group of pelvis specimens. Six specimens per group was identified as the minimum number necessary to achieve a power of 0.8 with an alpha of 0.05. Descriptive statistics were reported as means $\pm$ SD for normally distributed data and median (interquartile range) for data not normally distributed. Normality was assessed using a Kolmogorov-Smirnov test. Specimen body weight, stiffness, peak load and yield load (load at 5 mm of displacement) were compared between groups

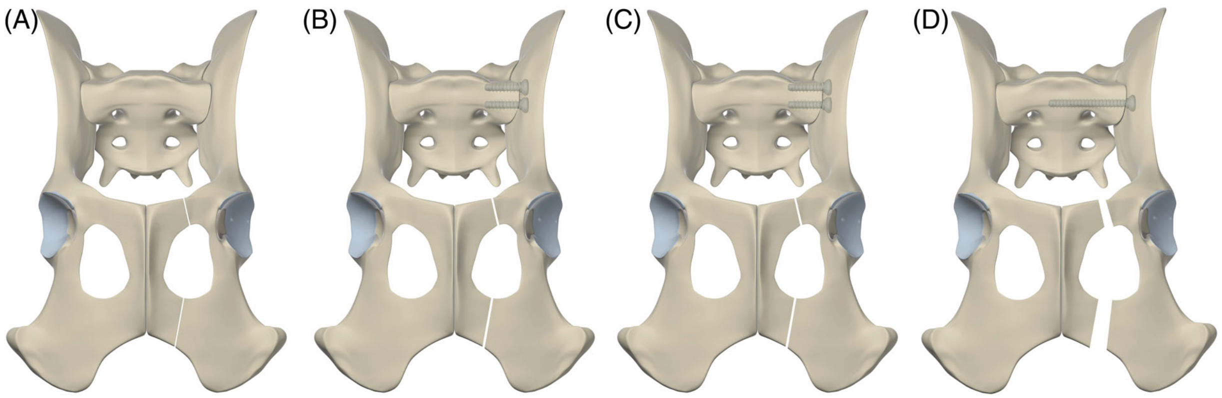

FIGURE 4 (A) Rendition of a pelvic specimen demonstrating the osteotomies performed on all specimens prior to implant placement. (B) Rendition of a pelvic specimen from the short lag screw (SLS) group following implant placement. (C) Rendition of a pelvic specimen from the short positional screw (SPS) group following implant placement. (D) Rendition of a pelvic specimen from the long lag screw (LLS) group following implant placement. Abaxial displacement observed at the osteotomies is demonstrated following insertion of the single screw in lag fashion with more abaxial displacement observed at the ischial osteotomy site

TABLE 1 Stiffness, peak load, yield load and displacement at peak load listed by group

Group	Stiffness (*N*/mm)	Peak load (*N*)	Yield load (*N*)	Displacement at peak load (mm)
LLS	16.7 ± 10.0[a]	87.9 ± 24.1[a]	65.3 ± 24.7[a]	15.5 (12.1)[a]
SPS	41.5 ± 21.2[b]	254.1 ± 135.6[b]	167.6 ± 82.2[b]	12.9 (9.5)[a]
SLS	41.0 ± 22.6[b]	247.3 ± 111.1[b]	167.2 ± 80.7[b]	14.3 (11.5)[a]

Note: For stiffness, peak load and yield load, values are means ± SDs. For displacement at peak load, values are medians (IQRs). Values in the same column not connected by the same letter are significantly different. $P < .05$ was set as significant for all analyses.
Abbreviations: LLS, long lag screw; SPS, short positional screw; SLS, short lag screw.

using a 1-way ANOVA with pairwise multiple comparisons performed using the Holm-Sidak method. Displacement at peak load was compared between groups using a 1-way ANOVA on ranks. A $P < .05$ was considered significant for all analyses. All statistical analyses were performed using SigmaPlot 14 (Systat Software, Inc., San Jose, California).

3 | RESULTS

3.1 | Specimen body weights

Cadaver body weights were 24.1 ± 2.9 kg in the LLS group, 24.2 ± 2.7 kg in the SPS groups, and 25.9 ± 2.9 kg in the SLS group. No differences were identified in mean body weight between groups ($P = .40$).

3.2 | Implant positioning

Based on CT evaluation, all LLS sample screws were confirmed to be inserted entirely within and spanning at least 60% the width of the sacral body with no spinal canal impingement. All short screws were confirmed to be located within the sacrum (body or wing) with no penetration of the spinal canal in any specimen. Short screws spanned an average of 23% of the width of the sacral body and the tips of all short screws terminated abaxial to the spinal canal. Transcortical K-wire penetration with concurrent cis cortical drill and screw penetration of the ventral sacral nerve foramina was observed in 1 specimen in the SPS group and in 2 specimens in the SLS group. In each of these samples, it was the caudal implant involved in this impingement.

3.3 | Mechanical testing

Mechanical testing results are summarized in Table 1. Differences in construct stiffness were identified between the LLS and SPS groups ($P = .02$) as well as between the LLS and SLS groups ($P = .02$). No differences in construct stiffness were identified between SPS and SLS groups ($P = .95$). Differences in peak load were identified between the LLS and SPS groups ($P = .01$) as well as between the LLS and SLS groups ($P = .01$). No differences in peak load were identified between the SPS and

SLS groups (P = .89). Differences in yield load were identified between the LLS and SPS groups (P = .02) as well as between the LLS and SLS groups (P = .02). No differences in yield load were identified between the SPS and SLS groups (P = .99). No differences in median displacement at peak load were identified between groups (P = .71).

4 | DISCUSSION

Previous studies on SI joint stablization have focused on approach or technique development for easier, more consistent and more accurate lag-screw insertion within the body of the sacrum using a screw length extending through the ilium and at least 60% the width of the sacral body.[4,5,9,10,13,15,19,20] The goal of our study was to evaluate the feasibility and mechanical strength of SI joint stabilization using 2 shorter screws terminating abaxial to the sensitive neurovascular structures at risk through traditional repair methods. The results of this study confirmed our hypothesis, finding that the 2-screw stabilization technique provided superior stability during mechanical testing in a single load to failure testing cycle. Our secondary hypothesis, that the screw insertion technique (lag versus positional) would not affect the mechanical stability provided by the 2-screw constructs was also confirmed.

Several benefits of 2-screw fixation techniques for SI joint stabilization have previously been demonstrated and described, including greater resistance to rotational forces and an increased bone-implant interface providing additive resistance to bending and shear.[3] In the current study, the cumulative implant surface area present in the 2 short screw groups was greater than that present in the LLS group. All study groups utilized 3.5 mm diameter, cortical bone screws with the short screw constructs possessing a cumulative implant length of 48 mm. This length is in comparison with the implant length of 40 mm present in the single long screw group. This larger cumulative bone-implant interface, coupled with improved resistance to rotational forces through 2-point fixation, likely contributed to the improved construct stiffness and increased yield and peak loads documented in the short screw groups in this study. These improved mechanical properties might be expected to result in superior construct stability and reduced risk of implant loosening over time in SI joints stabilized with 2 screws.

Interestingly, the application of compression across the SI joint in the SLS group did not result in any improvement in construct strength or stiffness when compared with SI joint stabilization with 2 short screws placed in positional fashion (the SPS group). The short screws inserted in positional fashion had a higher stripping torque compared to short screws placed in lag fashion, presumably due to greater screw thread purchase in the denser bone of the ilium. The authors hypothesize the stronger thread purchase obtained by the short positional screws in the ilium, may have allowed the screws in the SPS group to function somewhat similarly to locking screws inserted in a locking plate. This theory may explain why the increased frictional interface between the medial aspect of the ilium and the lateral aspect of the sacrum in the SLS group did not result in improved mechanical performance compared to the SPS group.

All screws in both short screw groups were inserted entirely within the sacral body or sacral wing. No spinal canal penetration, ventral sacral body cortical violation, or penetration into the L7-S1 intervertebral disc space was identified in any sample in this study. Utilizing a screw length shorter than the distance from the lateral aspect of the ilial cortex to the ipsilateral spinal canal wall increases the area for safe implant placement and permits greater implant deviation from intended trajectory with reduced risk of sensitive structure impingement. Though no spinal canal penetration was observed in this study, the described methodology of short screw measurement within 1 mm of the spinal canal leaves little margin for error in clinical application. A slightly shorter screw length (eg, within 3-5 mm of spinal canal) is unlikely to have significant negative mechanical impacts while providing even greater safety in a clinical setting.

Ventral sacral nerve foraminal impingement was observed in 3 samples within the SLS and SPS testing groups. The pudendal nerve and contributions to the superior gluteal and sciatic nerves occupy this foraminal space, with branches of the pudendal nerve supplying both the urinary bladder and anal sphincter.[21] Though more likely associated with bilateral nerve damage, unilateral pudendal nerve injury associated with K-wire, drill bit or screw impingement could affect urinary or fecal continence. The clinical consequences of this impingement are unknown but the effects are unlikely to be permanent if incurred unilaterally, considering the continued innervation of the urinary bladder, urethral sphincter, and anal sphincter from the contralateral side.[22] Given the caudal location of the foramina in the sacrum, more cranial or craniodorsal insertion of the more caudal and dorsal screw could be considered to reduce the probability of interfering with the ventral sacral nerve root (Figure 2). Significant canine sacrum anatomic variability exists, however, highlighting the need for appropriate preoperative imaging and planning to ensure K-wire insertion, drilling or screw insertion does not impinge the ventral sacral foramina.[4]

Given the common presence of pelvic fractures in clinical scenarios of SI luxation, this study used ipsilateral pubic and ischial osteotomies to simulate concurrent pelvic injury in a consistent way across all specimens (Figure 4A).[2] Following screw tightening but prior to mechanical testing, samples in the LLS group were consistently observed to have abaxial pubic and ischial displacement at the osteotomy, when compared with samples in the 2 screw groups, despite the LLS being placed in the recommended anatomic location (Figure 4D).[18] The displacement differences were not objectively quantified but may be significant in clinical patients with SI luxation and ipsilateral pelvic fractures. Sacroiliac luxation stabilization is commonly used to bring concurrent pelvic fractures located outside the weight-bearing axis into closer apposition for healing. In addition to providing a stronger and stiffer SI joint fixation, the 2 short-screw stabilization techniques investigated in this study may also better align concurrent ipsilateral pelvic fracture fragments by causing less abaxial caudal hemipelvis displacement as compared with fixation with a single long screw. This reduced iatrogenic displacement may promote faster healing of concurrent pelvic fractures. This variance in observed abaxial displacement between test groups also suggests uneven compression of the SI joint articular surfaces when using a single lag screw through the center of the sacral body for reduction and stabilization. Improved bone contact across the SI joint when utilizing 2 screws may also contribute to the improved mechanical stability observed in the 2 screw constructs.

Although loading forces were applied though the acetabulum to simulate weight bearing forces, this testing methodology does not mimic the complexity of an in vivo loading pattern. Cyclic loading of specimens with a more moderate load to simulate repetitive weight-bearing forces would generate more information on construct stiffness loss or screw loosening over time but was beyond the scope of our project. Furthermore, only a single configuration of ischial and pubic osteotomy was investigated. Different configurations of pelvis fractures in clinical patients may result in alterations in the load concentrated on the SI joint and might affect the success rate of SI stabilization. Despite efforts to standardize cadaver selection, variation in breed, age, lifestyle prior to euthanasia, presence of other systemic disease and time between specimen collection and mechanical testing could not be controlled and may have caused variation in bone quality between specimens. We attempted to address this through random assignment of specimens to test groups but this study limitation may be the cause of some of the larger-than-expected data variations within test groups (Table 1). Though all pelvis specimens were prepared in a similar way, the removal of the soft tissues surrounding the pelvis may have influenced our results. Differences in stability noted between the 1- and 2-screw constructs may be smaller in vivo where soft tissues intrinsically stabilize structures during weight-bearing forces. Finally, testing groups used pelvic specimens from cadavers of similar bodyweights. It is possible that the mechanical stability noted in the 1- and 2-screw constructs may vary in small or giant breed dogs.

Treatment recommendations are often influenced by surgeon confidence and risks associated with performance of a surgical procedure. Surgical stabilization of SI luxation typically offers improved patient comfort during recovery and a faster return to weight bearing;[5,9,10] however, risks associated with current surgical stabilization techniques may deter the selection of surgical stabilization in patients with less severe SI joint displacement. Despite technique development with improved implant insertion accuracy and mitigated risk in patients during surgical SI stabilization, risks of neurovascular damage when using the recommended long-lag screw stabilization technique cannot be eliminated. This study provides evidence for the feasibility and superior mechanical strength associated with SI luxation stabilization using 2, short, cortical bone screws, a technique that may greatly decrease the risk of injury to sensitive surrounding anatomy. With minimized risk, patient candidacy for surgical stabilization increases and benefits associated with surgical stabilization can be achieved in more patients with SI luxation.

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Author Contributions: Hanlon J, DVM: Primary manuscript authorship, specimen preparation, data gathering, and data assessment; Hudson CC, DVM, MS, DACVS: Project design, specimen preparation, statistical analysis of collected data, data assessment, manuscript figure design, and manuscript review; Litsky AS, MD, ScD: Mechanical testing apparatus design, testing methodology authorship, preparation and operation of mechanical testing equipment and collection of mechanical testing data; Jones SC, MVB, MS, DACVS, DECVS: Project design, organization of cadaveric specimens and supplies, specimen preparation, data assessment and manuscript review.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this report.

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