

RESEARCH ARTICLE

Evaluation of Traumatic Pelvic Fractures in Cats: Morbidity and Mortality Rates- A Retrospective Study (2022-2023)

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Abstract

The aim of this study was to determine the incidence of pelvic fractures in cats and to evaluate the causes of trauma, morbidity and mortality. The study included 224 cats of various breeds, sexes and ages that presented with pelvic injuries between February 2022 and December 2023. Data were collected using the hospital's patient database and by surveying pet owners by telephone. Data included sex, type of trauma, concomitant injuries with pelvic trauma, treatment methods and outcomes including mortality and morbidity. According to Messmer and Montavon's alphanumeric pelvic fracture classification, unilateral sacroiliac luxation was found in 23.2% of cases (n=52), bilateral sacroiliac luxation in 23.7% of cases (n=53), and bilateral corpus ilium fracture in 25% of cases (n=56). The most common injuries associated with pelvic fractures were pneumothorax in 36.6% (n=82) of cases, pulmonary contusion in 21% (n=47) of cases, hindlimb fractures in 21.8% (n=49) of cases, urinary incontinence due to peripheral nerve injury in 10.8% of cases, and forelimb fractures in 7.1% (n=16) of cases. Prognosis was excellent in 41.1% (n=92), good in 30.8% (n=69), poor in 1.3% (n=3) and death in 26.8% (n=60). Injuries to the nonweightbearing and unilateral weightbearing portions of the pelvis generally had a favorable outcome. However, as the number of bilateral fractures and injuries to the weightbearing portions of the pelvis increased, the mortality rate also increased.

Keywords: Cat, Trauma, Pelvic fracture

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INTRODUCTION

The incidence of pelvic fractures in cats has increased in parallel with increases in the cat population, traffic, industry and urbanisation. Estimates of the incidence of pelvic fractures (Hill 1977, Bookbinder and Flanders 1992) range from 20 to 32% of all fractures. Causes of pelvic trauma include road traffic accidents, high rise syndrome, gunshot wounds, bite wounds and other types of trauma. While high-rise syndrome causes pelvic trauma in about 9-16% of cases, this rate rises to 27% in road traffic accidents. The sacroiliac joint and the ilium are the most commonly affected weight-bearing parts of the pelvis. According to some retrospective studies, the percentages of pelvic fractures were as follows: sacroiliac luxations 50-90%, iliac fractures 51-68%, ischial fractures 37-51%, pubic fractures 36-

72% and acetabular fractures 18.6-26% (Meeson and Geddes 2017, Çatalıkaya et al 2024). The sacrum (19%), femur, coxofemoral joint and thoracic region are the most commonly affected regions in pelvic injuries. In addition to pelvic fractures, neurological disorders such as loss of innervation of the hind limbs, tail, bladder and anal reflexes may occur due to injury to the peripheral and autonomic nervous system structures of the lumbo-sacral plexus. Sciatic nerve damage due to pelvic injury occurs in 11% to 23% of cases (Vnuk et al 2004, Rochlitz 2004, Strohbach 2007, Merbl et al 2013).

This study was designed based on the hypothesis that the involvement of bilateral weight-bearing pelvic structures in cats with pelvic trauma, particularly when accompanied by thoracic, abdominal, craniofacial and/or musculoskeletal injuries, as well as central or peripheral nervous system injuries, may be related to



Table 1. Alphanumeric pelvic fracture classification method by Messmer and Montavon (2004).

61 No Pelvic Weight-Bearing Bone Fracture	61A	Fractures of the pelvic edge
	61B	Fractures of the pelvic floor (including pubic bone, pubic symphysis and ischial symphysis)
	61C	Fractures of the ischial corpus
62 Unilateral Fracture of a Weight-Bearing Elements	62A	Unilateral sacroiliac joint luxation
	62B	Unilateral fractures of the iliac corpus
	62C	Unilateral acetabular fractures
63 Bilateral Fracture of a Weight-Bearing Elements	63A	Bilateral sacroiliac joint luxations
	63B	Fracture of the ilium and accompanying sacroiliac luxation, fracture of the ischium or bilateral iliac fractures
	63C	Acetabular fracture (unilateral or bilateral); acetabular and ilium fracture (unilateral or bilateral); and acetabular and sacroiliac luxation
	63CX	Fractures involving at least two separate regions of the iliac, acetabular and sacroiliac bones

high mortality and morbidity rates. The aim of the study was therefore to use radiographic classification to identify the types of pelvic fracture and associated injuries, and to establish their relationship with mortality and morbidity rates in cats with pelvic trauma caused by various factors.

MATERIAL AND METHODS

Clinical assessment

The study data were obtained from the patient database of Selcuk University, Faculty of Veterinary Medicine, Veterinary Hospital and by contacting the owners by telephone. Information was collected on sex, type of trauma, organs affected concomitantly with pelvic trauma, neurological findings, surgery performed, conservative treatment, other minor surgical treatment, mortality and morbidity. Our inclusion criteria included cats with pelvic trauma and pelvic bone fractures regardless of age, breed and gender. Injuries accompanying pelvic fracture were categorised without exclusion.

Radiological assessment

Radiographic assessment was performed using standard ventrodorsal and lateral pelvic radiographs. A total of 224 feline pelvic radiographs were evaluated. Radiographs of the thorax, abdomen, extremities and skull were also examined. Radiographs were classified using the alphanumeric classification method proposed by Messmer and Montavon for pelvic fractures (Messmer and Montavon 2004) (Table 1).

Statistical Methods

The SPSS 25 statistical program (IBM Corp. 2017. IBM SPSS Statistics for Windows, Version 25.0 Armonk, NY: IBM Corp.) was used to evaluate the data. The chi-squared

test was used to analyze categorical data. A value of $p < 0.05$ was accepted for the significance level of the test.

RESULTS

Clinical assessment results

According to the sex classification of the study, 135 (60.2%) were male and 89 (39.7%) were female. Trauma was attributed to high-rise syndrome in 104 (46.4%) cats and to road traffic accidents in 99 (44.2%) cats (Figure 1). In 21 (9.4%) cats the cause of trauma was unknown. The sex, ownership and neutering status of the cases; the distribution of trauma; the types and rates of injuries accompanying pelvic trauma; the treatment methods applied; and the information on prognosis are presented in Tables 2 and 3.

The most common injuries associated with pelvic fractures were: pneumothorax in 36.6% (82) of cases, pulmonary contusion in 21% (47) of cases, hind limb fractures in 21.8% (49) of cases, urinary incontinence may due to peripheral nerve injury in 10.8% of cases, and forelimb fractures in 7.1% (16) of cases (Table 2).

The prognosis of pelvic fractures was excellent in 41.1% (92), good in 30.8% (69), poor in 1.3% (3) and death in 26.7% ($n=60$) ($p > 0.05$) (Figure 2).

Fractures involving the pelvic floor, including the pubic bone, pubic symphysis, and ischial symphysis, as well as fractures of non-weight-bearing elements classified as ischial corpus fractures, were generally managed conservatively. A total of 20 cats had these injuries. Among them, 2 underwent orthopedic surgery, 1 received extremity bandaging, 1 underwent spinal surgery, and 1 had a caudectomy.

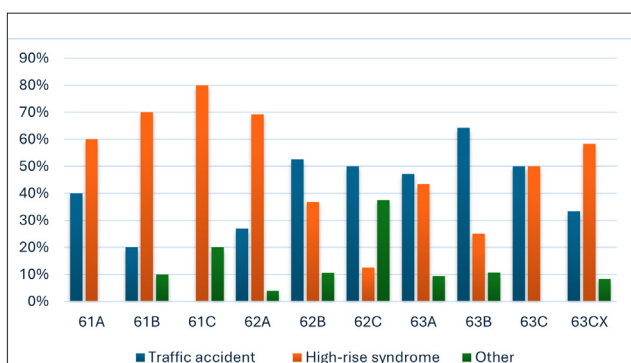


Figure 1. Relationship between pelvic fractures and type of trauma

In 79 cats with unilateral sacroiliac joint luxation, unilateral fractures of the iliac corpus, and acetabular fractures in weight-bearing areas, 30 cats underwent orthopedic surgery. Of these, 8 had ilium plating, 5 had minor surgical treatments, 2 received sacroiliac screw fixation, and 8 were treated with extremity-supported bandaging. Associated injuries in this group were more commonly treated than the pelvic fractures themselves.

Among 113 cats presenting with weight-bearing segment injuries, including bilateral sacroiliac joint luxations, ilium fractures accompanied by sacroiliac luxations, ischium fractures or bilateral iliac fractures, acetabular fractures (unilateral or bilateral), combined acetabular and ilium fractures (unilateral or bilateral), and acetabular fractures with sacroiliac luxation, surgical interventions were performed as follows: ilium plate osteosynthesis in 15 cats, orthopedic surgery on the extremities in 12 cats, and sacroiliac joint screw fixation in 5 cats. Conservative treatment was applied in the majority of cases.

It was determined that eight of the twelve cats had been treated for fractures involving at least two separate regions of the iliac, acetabular, and sacroiliac bones (see Table 3).

The treatment modalities according to the types of pelvic fractures and associated injuries are summarised in Table 3.

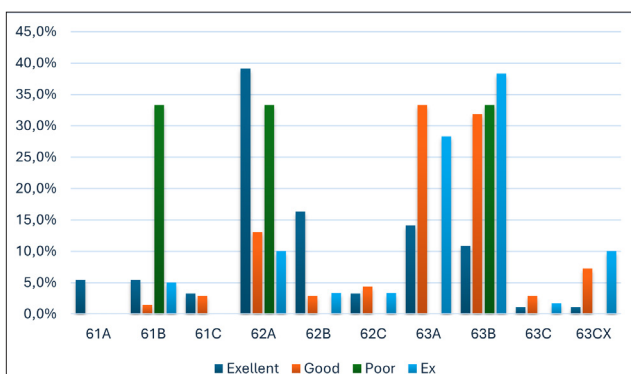


Figure 2. Distribution and prognosis of pelvic fractures

Results of radiological assessment

In terms of pelvic fracture classification: 2.2% (5) were pelvic margin fractures (61A), 4.5% (10) were pelvic floor fractures (61B) including pubic bone, pubic symphysis and ischial symphysis, and 2.2% (5) were ischial corpus fractures (61C). In addition, 23.2% (52) of cases were unilateral sacroiliac joint luxations (62A), 8.5% (19) were unilateral fractures of the iliac corpus (62B), and 3.6% (8) were unilateral fractures of the acetabulum (62C). In addition, 23.7% (53) were bilateral sacroiliac joint luxations (63A), 25% (56) were bilateral fractures of the iliac corpus (63B), and 1.8% (4) were bilateral fractures of the acetabulum (63C). Finally, 5.4% (12) of cases were fractures involving at least two of the iliac, acetabular and sacroiliac segments (63CX).

DISCUSSION

This study aimed to classify pelvic fractures in cats using radiographic evaluation, identify associated injuries, and investigate their correlation with morbidity and mortality in feline pelvic trauma resulting from various etiologies. The results of our study showed that the majority of the 224 cats with pelvic trauma had fractures to the weight-bearing elements of the pelvis (bilateral sacroiliac luxations and bilateral fractures of the iliac body). The most frequently observed concurrent injuries included thoracic trauma, hindlimb fractures, urinary incontinence secondary to peripheral nerve injury, and forelimb fractures. Cats with unilateral pelvic fractures and minimal multisystem involvement generally demonstrated favorable responses to treatment. In contrast, fatalities were predominantly observed in cases presenting with bilateral pelvic fractures accompanied by severe thoracic trauma (pneumothorax, pulmonary contusions), urinary incontinence, and paraplegia.

Mortality following pelvic trauma in animals is closely associated with the severity and extent of injuries. In dogs involved in road traffic accidents, increased injury severity correlates with higher mortality rates. In 33% of dogs with pelvic fractures, mortality was attributed to septic abdomen secondary to the fractures (Hoffberg et al 2016). Deaths within the first 6 hours post-trauma are typically due to pelvic and abdominal haemorrhage, while those within 24 hours result from multiple organ failure. The mortality rate from pelvic trauma in cats is 20%, with particularly high rates observed in cases involving neurological damage (Meeson and Corr 2011, Hammer et al 2019).

As known from previous studies, the most common causes of pelvic fractures in cats are road traffic accidents and high-rise syndrome (Rochlitz 2004, Merbl et al 2013, Conroy et al 2019). In the study by Hammer et

Table 2. Sex distribution and concurrent injuries in cats with pelvic fractures.

Variable		n	%
Number of cats		224	100,0
Sex	Male	135	60.2
	Female	89	39.7
Ownership status	Client-owned cat	154	68.8
	Stray Cat	69	30.8
	Unknown	1	0.4
Neutering status	Neutered	9	4.0
	Not neutered males and intact females	147	65.6
	Unknown	68	30.4
Concurrent Injuries			
Head Trauma		5	2.2
Spinal Cord Injury		1	1.8
Pneumothorax, Pulmonary contusion, Pleural effusion		139	62.1
Hernia Diaphragmatica		9	4.0
Hernia Abdominalis		13	5.8
Forelimb fractures		16	7.1
Hind limb fractures		49	21.8
Sacroccygeal luxation		14	6.3
Tail lesions		1	0.4
Open Wound, Subcutaneous emphysema		23	10.2
Urinary incontinence		24	10.8
Prognosis	Excellent	92	41.1
	Good	69	30.8
	Poor	3	1.3
	Death	60	26.8

al (2019), 82.1% of 280 cats with pelvic fractures were recorded as road traffic accidents and 10.4% as high rise syndrome. Similarly, Conroy et al (2019) and Bouabdallah et al (2020) found that the majority of trauma was due to road traffic accidents. In contrast to these data, Çatalakaya et al (2024) reported that 67.64% of cats with pelvic trauma were due to high-rise syndrome, while only 3.92% were due to road traffic accidents and 1.96% were due to undetermined causes. The incidence of high-rise syndrome in our study was 46.4% (104), which is consistent with the findings of Çatalakaya et al (2024), but different from the data of Hammer et al (2019), Conroy et al (2019), and Bouabdallah et al (2020). The high rate of high-rise syndrome in our study may be related to the fact that the majority of patients admitted

to our clinic were cat owners (68.8%). However, the fact that the incidence of road traffic accidents (44.2%) in our study is almost the same as the incidence of high-rise syndrome (46.4%) explains that the number of road traffic accidents in our country is too high. We also hypothesise that this situation could be influenced by the location of our veterinary clinic in the city centre, where there is a high traffic density, numerous high-rise buildings and a dense cat population.

According to the results of our study, it was found that male cats (60.2%) were more exposed to pelvic trauma than female cats (39.7%) (Hammer et al 2019, Çatalakaya et al 2024). However, there are also studies that contradict these data (Yurtal et al 2022). Based on these data, it is

Table 3. Treatment distribution of 224 pelvic fracture cats

	Ilium Plate Osteosynthesis	Sacroiliac Screw Fixation	Spinal Surgery	Acetabular Fracture Fixation	Caudectomy	Limb orthopaedic surgery	Bandaging and Splinting	Abdominal Surgery	Conservative treatment
61A	-	-	-	-	1	-	-	-	3
61B	-	-	1	0	-	1	-	-	5
61C	0	0	0	0	0	1	1	0	3
62A	1	3	0	0	0	13	8	0	21
62B	7	0	0	0	0	4	0	0	3
62C	0	0	0	0	0	3	0	0	3
63A	0	14	0	0	1	9	3	3	17
63B	15	1	0	1	0	3	0	2	15
63C	0	0	0	0	0	0	0	0	2
63CX	1	1	1	1	1	1	0	0	2
Total	24	19	1	2	3	35	12	5	76

not acceptable to say that male cats are more prone to pelvic trauma than females. The differences in results may be related to the cat population in the region where the study was conducted, or to the fact that male cats are more likely to be present in the clinics and hospitals where the studies were conducted.

According to international studies, the majority of traumatized cats admitted to veterinary hospitals and clinics are reported to be neutered ([Hernon et al 2018](#), [Gregory et al 2023](#)). However, these findings contrast with the data from our study, in which most cats were intact males and no females were spayed (Table 1). We hypothesize that this discrepancy may be attributed to the high population of stray cats in our region, as well as a lack of awareness among pet owners regarding this issue.

Our pelvic fracture classification showed that sacroiliac luxations had the highest incidence rate (46.9%), followed by iliac fractures (33.5%) and fractures involving the pelvic rim and ischium (8.9%). Acetabular fractures accounted for 5.4% and fractures involving all three weight-bearing regions (sacroiliac joint, ilium, acetabulum) also accounted for 5.4%. These findings are consistent with previous studies ([Hammer et al 2019](#), [Bouabdallah et al 2020](#), [Antonov 2022](#)). The prevalence of unilateral (23.2%) and bilateral (23.7%) sacroiliac luxations differed significantly from the higher prevalence of unilateral sacroiliac luxations reported in studies by [Hammer et al \(2019\)](#), [Bouabdallah et al \(2020\)](#), [Çatalkaya et al \(2024\)](#) and [Antonov \(2022\)](#). In these cases, the pelvic bone was displaced cranially and a haematoma was observed in the pelvic region.

The findings regarding iliac fractures (25%) were consistent with those reported by [Messmer and Montavon \(2004\)](#). We also observed that the majority of bilateral weight-bearing trauma-specifically 64.3% of bilateral iliac fractures and 47.2% of bilateral sacroiliac luxations -were attributed to road traffic accidents. This may be due to the severe impact and crushing injuries typically experienced by cats involved in road traffic accidents, as opposed to injuries resulting from high-rise syndrome.

A very high proportion (91.2%) of pelvic fractures were located in the weight-bearing region of the pelvis (35.3% unilateral, 55.9% bilateral) ([Hammer et al 2019](#)). At the same time, the mortality rate increased in correlation with the incidence of injuries to the bilateral weight-bearing areas of the pelvis, as well as associated thoracic (%68.8), skeletal (%15.3), and neurological injuries (%6.8). This increase accounted for 72.7% of the total mortality rate of 26.8%. The fact that 78.3% of the 60 dead cats had lesions in the bilateral weight-bearing regions of the pelvis is consistent with the findings of [Hammer et al \(2019\)](#) and confirms the association between multiple trauma and mortality.

The ilium is one of the weight-bearing parts of the pelvis and is the most commonly fractured hip bone in pelvic injuries. Due to the weight-bearing nature of the ilium and the displacement of fracture fragments into the pelvic canal and subsequent narrowing of the pelvic canal, surgical treatment is usually recommended. According to the literature, pelvic fractures are generally oblique, while transverse and multiple fractures are rare. For iliac fixation, lag screws, cerclage wire and plate osteosynthesis

are recommended (Zamirbekova et al 2020, Arican et al 2022). In our study, we performed a total of 24 iliac plate osteosynthesis procedures. Surgery was performed in 7 of 19 patients with unilateral and 16 of 56 patients with bilateral iliac fractures. Although iliac fractures typically require surgery, the low number of surgeries is generally attributed to the economic status of pet owners and the high mortality rate in patients with bilateral iliac fractures. However, the prognosis was excellent in 15 of 19 cats with unilateral iliac fractures, good in 2 and poor in the remaining 2 cats. Although the short-term prognosis for the eight non-surgically treated cats was favorable, the long-term outcome remains uncertain. As previous studies indicate, ilium fractures can cause pelvic canal narrowing and lead to significant complications over time (Meeson and Corr 2011, DeGroot et al 2016, Costa et al 2018). While many of these cases showed favourable short-term outcomes, the lack of long-term follow-up means it is not possible to draw definitive conclusions about functional recovery and late-onset sequelae in patients managed conservatively. The mortality rate for cats with bilateral iliac fractures was 38.3% of all cats with the worst prognosis. Most of these patients died before they could be stabilised for surgery due to severe pulmonary contusion, pneumothorax, multiple fractures in the hind and forelimbs, paraplegia, and urinary incontinence.

Due to the anatomical location of the sciatic nerve, this nerve is often injured following iliac fractures. In our study, sciatic nerve injury was reported in one patient with unilateral sacroiliac luxation and one patient with bilateral iliac fractures, both of which had a worse prognosis (Antonov 2022, Çatalkaya et al 2024). As the sacroiliac joint is a weight-bearing point of the pelvis, the treatment of sacroiliac luxations varies depending on the presence of bone dislocation and whether the luxation is unilateral or bilateral, which determines whether surgical or conservative measures are appropriate. Surgical fixation methods generally include a lag screw inserted into the sacrum at a 90 degree angle to the ilium or transiliac pin applications (Meeson and Corr 2011, Çatalkaya et al 2024).

Conservative treatment typically involves restricting the patient's movements for 4-6 weeks. Clinical and retrospective studies have reported a high success rate with conservative treatment in such cases (Frances and Felipe 2020). In our study, sacroiliac luxations were the most common type of injury, accounting for 46.9% of cases of pelvic trauma in cats. Of the 74 cats treated conservatively, 51.3% belonged to this category. Only 18% of sacroiliac luxations were treated surgically. Among 52 cats diagnosed with unilateral sacroiliac luxation, the majority of which were treated conservatively, 69.2% had an excellent prognosis, 17.3% had a good prognosis, and

11.5% had a poor prognosis. In cats with bilateral sacroiliac luxations, the mortality rate was 32% in 53 cats, which was twice as high as in unilateral luxations (Hammer et al 2019). Acetabular fractures are the most difficult type of pelvic fracture to treat. Anatomic plate osteosynthesis of the "C" type is usually the preferred method of treatment. If this method is not suitable for the injury, osteotomy of the caput femoris and collum femoris is used to relieve joint tension. In our study, "C" plates were used in only two out of twelve identified acetabular fractures (Çatalkaya et al 2024). The remaining patients usually underwent osteotomy of the caput femoris and collum femoris. Of the eight cats with unilateral acetabular fractures, the prognosis was excellent in three cases and good in three others.

As fractures of the pelvic rim, pubic bone, pubic symphysis, ischial symphysis and ischial corpus are classified as non-weight-bearing hip fractures, they are frequently treated conservatively. In our study, 17 out of 20 cats in this category were treated conservatively. The prognosis was considered excellent in 11 cases, good in three patients, with one cat suffering permanent lameness due to a symphysis pubis fracture and three cases classified as "poor".

At least one injury associated with pelvic fractures was detected in 92.8% of cases (Antonov 2022). According to our analyses, thoracic lesions were the most common injury associated with pelvic fractures, with a rate of 62.1%. When comparing thoracic injuries with causes of trauma, we found that thoracic lesions (53.1%), particularly pneumothorax (37.9%) and pulmonary contusion (19.4%), were common injuries in cats with high-rise syndrome, consistent with previous studies (Vnuk et al 2004, Lefman and Prittie 2022).

Urinary tract injuries are an inevitable consequence of pelvic fractures (Hammer et al 2019). Unfortunately, damage to both upper and lower motor neurons during trauma increases the incidence of urinary incontinence and bladder paralysis. According to previous studies, the majority of cases of urinary incontinence improve between 2 and 30 days after treatment. Cases that do not improve within this time are considered to be permanent (Meeson and Corr 2011, Couper and Decker 2020). In our study, urinary incontinence was found in 24 of 224 cats with pelvic fractures. Of these cats, 79.2% recovered and survived, while the remaining 20.8% died. In addition, 14 cats with urinary incontinence had sacrococcygeal injuries and flaccid paralysis of the tail as a result of these injuries. Hind limb fractures showed a significantly higher rate of concomitant injury, being three times more common than forelimb fractures (forelimb fractures 7.1%, hind limb fractures 21.8%). Extremity fractures were also one of the injuries that required the most surgical intervention (17.8%) (Hammer et al 2019).

CONCLUSION

In conclusion, of the pelvic injuries we analysed, sacroiliac luxations and iliac fractures were the most common. In addition, mortality rates were high for bilateral sacroiliac luxations and bilateral iliac fractures. The rates of high-rise syndrome and road traffic accidents were closely matched among the causes of trauma. Injuries to the non-weight-bearing and unilateral weight-bearing parts of the pelvis generally showed a favourable course. However, as the number of bilateral fractures and associated injuries to the weight-bearing parts of the pelvis has increased, so has the mortality rate.

DECLARATIONS

Competing Interests

The authors did not report any conflict of interest or financial support.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author.

Ethical Statement

Selcuk University Experimental Research and Application Center, 28.03.2024 2024/03 Number Ethics Committee Decision.

Author Contributions


Motivation/Concept:NZ,MA;Design:NZ,MA;Control/Supervision:NZ, MA; Data Collection and Processing: NZ, IS, HC, IO; Analysis and Interpretation: HZ, IS, HC; Literature Review: NZ, MA, IS, HC, IO; Writing the Article: NZ, MA, IS; Critical Review: NZ, MA

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