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Research Article

Clinical and radiological evaluation of metacarpal fractures in calves: A retrospective study: 72 cases

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ABSTRACT

Metacarpal fractures are frequently encountered in calves, especially as a result of dystocia. This study, it was aimed to evaluate metacarpus fractures in calves from multiple aspects, especially the fracture's causes, location and classification, and to determine the most appropriate treatment option. Seventy two calves diagnosed with a metacarpus fracture, aged between 1 and 15 days, regardless of gender or breed, were included in the study. Calves were classified according to fracture type and treatment method. In the treatment, external fixation with Steinman pins and polyvinylchloride-fiberglass plaster supported closed or windowed bandage methods were preferred. According to the findings of the radiological examination, the fractures were determined to be distal diaphyseal in 40 (55%) cases, epiphyseal in 20 (27%) cases, and middle diaphyseal in 12 (18%) cases. It was discovered that 46 of 51 cases with closed fractures and bandages healed without complications, while 5 patients died due to comorbidities (calf diarrhea, aspiration pneumonia). Five of seven patients who had external fixation using Steinmann pins recovered without complications, meanwhile 2 patients succumbed to infection. Full recovery was observed in 12 of 14 patients who underwent window bandage, and it was discovered that 2 patients died due to secondary infection. As a result, substantial data that will contribute to clinical practice and literature knowledge regarding the causes, location, classification and treatment of metacarpal fractures, which are commonly encountered in calves and cause both economic and productivity loss, have been uncovered.

INTRODUCTION

Extremity fractures are prevalent in calves. Dystocia, crushing of calf by a cow, trauma from other animals, and faulty manipulations during childbirth are among the most common causes of limb fractures. (Aksoy et al, 2009, Nuss et al, 2011, Arıcan et al, 2014, Belge et al, 2016). Metacarpus fractures constitute approximately half (50%) of all extremity fractures in calves (Nichols et al, 2010, Rodrigues et al, 2012, Arıcan et al, 2014, Öztaş & Avki 2015). Calves exhibit behaviors such as reluctance to move, inability to stand on their feet, and inability to walk, as well as moving in a lying position. Radiograpic views taken from different angles (e.g. dorsopalmar/plantar, mediolateral and anteroposterior) in conjunction with clinical findings are helpful in the diagnosis of fracture (Ewoldt et al, 2003, Mulon, 2014).

Many factors such as the shape of the fracture, its localization, duration, and the economic and breeding value of the animal influence the effectiveness of fracture treatment (Görgül et al, 2004, Aksoy et al, 2009, Öztaş & Avki 2015, Yurtal et al, 2020). External and internal methods could be employed to reduce and stabilize the broken bone. In farm animals, the bandage technique supported by materials such as polyvinylchloride (PVC) and aluminum, alone or in combination with a bandage such as Thomas Splint, has been frequently used as a treatment option for external fixation of closed fractures (Auer et al, 1993, Nuss et al, 2011, Mulon, et al. 2014, Belge et al, 2016). Internal fixation techniques require general anesthesia, expertise, special tools, and equipment. In addition, some issues such as nonunion, angular deformity, and osteomyelitis in comminuted, open or infected fractures reduce the likelihood of success (Arıcan et al, 2014).

The current study was aimed to determine the causes of

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metacarpus fractures in calves, radiological findings, the success of the treatment options, and the most appropriate treatment option in light of this data.

MATERIAL and METHODS

Case Selection

Seventy-two calves with different breeds and genders, aged between 1 and 15 days, were brought to the Kafkas University Veterinary Medicine Faculty Animal Hospital with the complaint of lameness due to dystocia or trauma and diagnosed with metacarpus fracture were included in this study. Systematic and inspection-palpation examinations for fractures were performed on patients who presented with complaints of lameness in the front leg due to dystocia or trauma. Subsequently, mediolateral and anteroposterior radiographs of the corresponding extremity of each calf were performed for a definitive diagnosis. Following the determination of the anatomical location and shape of the fracture, the preparations were planned for the necessary interventions.

Equipments

Considering the different fracture types, the closed fixation technique was preferred for closed fractures and open fractures suited for windowed bandage application. To provide fixation, 2-4 pieces of 10 cm x 10 m roll bandage, 1 - 2 pieces of 250 g hydrophilic cotton, 1 - 2 pieces of polyvinyl chloride (PVC) prepared in appropriate sizes, 2 - 3 pieces of number 3 and/or number 4 fiberglass plasters were used. In infected fractures that are not suitable for open and windowed bandages, 4 Steinman pins (Safir®, Antalya/Turkey) with a diameter of Ø3-5 mm were preferred as external fixation material for placing transversal for 2 pieces of each fracture fragment.

Surgical Procedure

Two hours prior to the surgery, antibiotic (Cefazolin, 30 mg/kg, IM, Cezol, Deva®, Istanbul) was administered to each calf with fractures that were to be externally treated with transversal pinning. Following the shaving and cleaning of the related extremity, the area was prepared for aseptic surgery. The operation was performed with sedation with 0.05 mg/kg IM xylazine HCl (Rompun 2%, Bayer®, İstanbul) and general anesthesia with 4 mg/kg IM ketamine HCl (Ketakontrol®, Doğa İlaç, İstanbul). Following anesthesia, Steinmann pins prepared in appropriate diameters were placed transversally (Bilateral-Uniplanar) as 2 pins each for the proximal and distal fragments. Then, the outsider pin ends were fixed using fiberglass plaster, the pins' roots were cleaned with 10% povidone-iodine and the operation was completed (Figure 1).

Figure 1. Postoperative clinical view of a case that had external fixation with transfixation pinning

In closed fractures, or open fractures suitable for a windowed bandage, xylazine HCl (0.2 mg/kg IM) sedation was followed by fracture fixation using previously prepared supported bandage materials (Figure 2).

In addition to the use of antibiotics on open fractures where a windowed bandage is applied, for wound care; Antibiotic ointment (Furacin, 2% Nitrofurazon, Zentiva, Çorlu) and cicatrizant pomade (Madecassol®%1, Centella asiatica, Bayer, İstanbul) were used locally. After the preparation of bandage materials, the calves were sedated with xylazine HCl (0.2 mg/kg IM), the fragments were corrected by traction, control radiographs were acquired for appropriate reduction, and the extremities were wrapped with hydrophilic cotton, roll bandage, PVC, and fiberglass casts. Rigid stabilization and fixation were obtained (Figure 3).

Postoperative Care and Follow-up Periods

In this study, hospitalization was not performed on the pa-

Figure 2. Post-treatment clinical image of a case in which a PVC-reinforced fiberglass plaster and window bandage was applied

Figure 3. Stages of the bandage technique applied with double PVC reinforced fiberglass plaster in the treatment of metacarpus fractures in calves. A: Placing a lateral and medial PVC B: Completing the bandage process by wrapping the entire leg with fiberglass plaster C: Standing of the calf immediately after the bandaging process is completed

tients. In cases where external fixation with Steinmann pinning was performed, patient owners were instructed to confine the patients in a small area prior to discharge and daily cleaning of the pin holes with povidone-iodine (10%). In addition, postoperatively, antibiotics (Cefazolin, 30 mg/kg, IM, Cezol®, Deva, Istanbul) were administered for 7 days and meloxicam for 3 days to reduce pain (0.2 mg/kg/day, SC, Bavet Meloxicam, Bavet®, Istanbul). Moreover, patient owners were informed that open wound care should be done daily, calves should be kept in a small area, antibiotics and painkillers should be given to patients who have applied a bandage with a window to their fractures. No medical treatment was applied in cases of closed fractures, the owners were instructed to confine patients in a small area. No medical treatment was administered in the cases of closed fractures, and the owners were instructed to confine the patients in a small area. Clinical and radiological evaluations were performed by calling the patients for a follow-up at intervals of 2 or 3 weeks postoperatively.

The bandage material was removed in an average of 4-6 weeks in cases where a windowed bandage was applied, and in 4-5 weeks in cases where a bandage was applied for closed fractures.

RESULTS

Of the patients included in the study, 48 (66%) were aged 1-5 days, and 24 (34%) were aged 5-15 days. 55 (76%) of the cases belonged to the Simmental breed, 12 (16%) to the

Crossbreed Simmental, and 5 (8%) to the Brown Swiss breed. In addition, 56 (77%) of the cases were male and 16 (23%) were female. In light of the anamnesis information obtained during the clinical examination of each case, it was determined that the fracture was caused by excessive strain due to excessive traction during dystocia, traumas from the cows or other calves. In the examination performed by inspection, it was observed that 51 (71%) of the cases had closed fractures

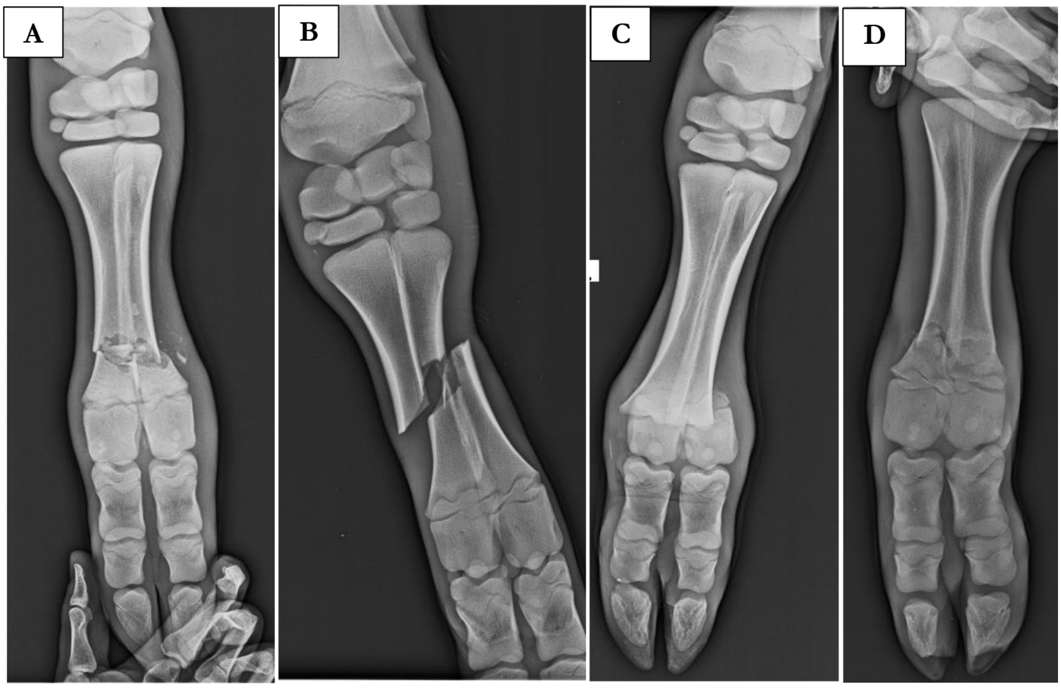

Figure 4. Classification of fractures according to radiological examination findings A: Distal diaphyseal fracture B: Middle diaphyseal fracture C: Distal epiphyseal fracture (Salther Harris Type I) D: Distal epiphyseal fracture (Salther Harris Type II)

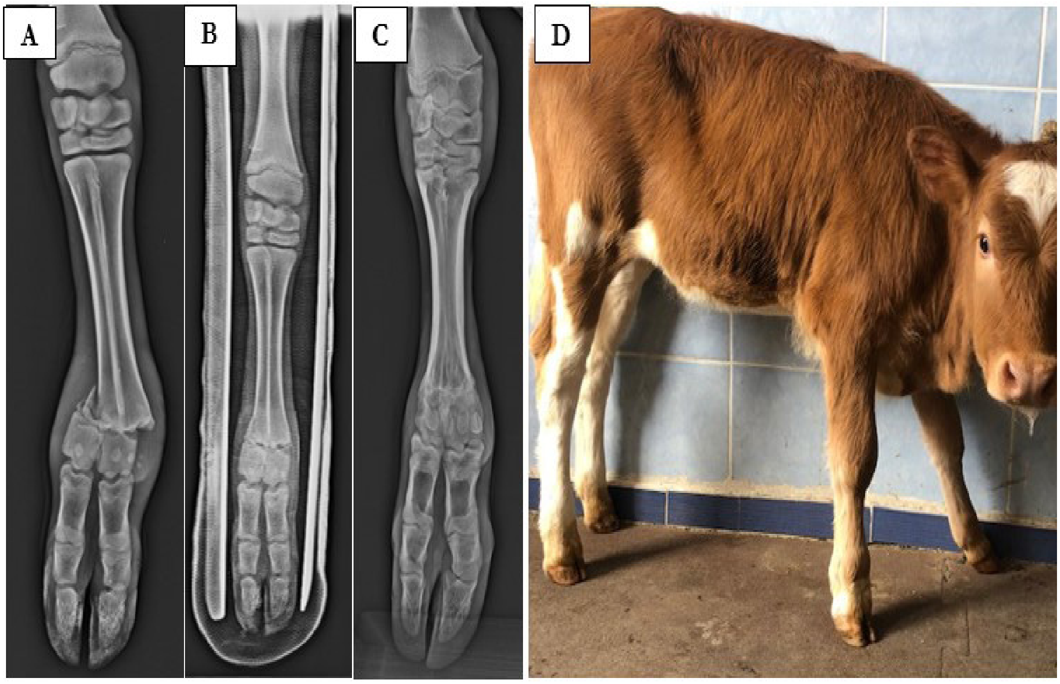

Figure 5. Treatment stages of a distal epiphyseal Salther Harris Type II fracture of a case A: Radiographic image of the fracture before treatment B: Radiograph of the fracture on day 0 after bandage with double PVC reinforced fiberglass plaster C: Radiograph of the fracture on day 35 after treatment D: Post-treatment of the calf 90 days clinical picture

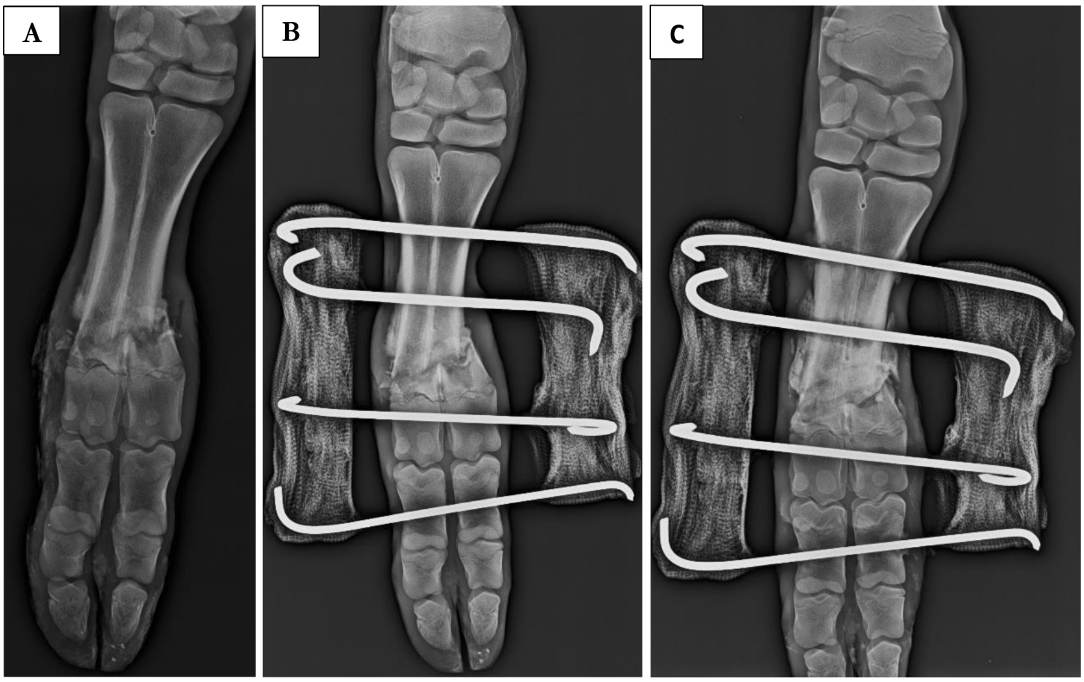

Figure 6. Treatment stages of an infected open distal diaphyseal metacarpus fracture of a case A: Preoperative radiographic image of the fracture B: Postoperative day 0 radiograph C: Postoperative 28th day radiograph

and 21 (29%) had open or infected fractures. Upon palpation examination, routine fracture findings such as crepitation and abnormal mobility were observed in all cases. According to the findings of the radiological examination performed to determine the location and shape of the fracture and to make a definitive diagnosis, it was determined that fractures were located at distal diaphyseal in 40 (55%), epiphyseal in 20 (27%) and mid-diaphyseal in 12 (18%) of the cases. In addition, when epiphyseal fractures were classified within themselves, it was observed that 12 (60%) of 20 cases were Salter-Harris Type I and 8 (40%) were Type II (Figure 4).

In the treatment, external fixation was performed using Steinmann pins in 7 of 21 cases of open fractures, and in the other 14 cases, a windowed bandage was performed with PVC and fiberglass plaster. In closed fractures, while stabilization was provided by using a fiberglass cast and caudally placed PVC in 22 of the 51 cases, fixation was achieved by using two PVC and fiberglass plasters placed medially and laterally in 29 cases. It was observed that all cases, both bandaged and operative, were able to use the related extremity without any problems immediately following the completion of the procedures. In the follow-ups of the patients with closed fractures that were bandaged, it was observed that 43 of 51 patients healed without any complications, recovery was achieved in 3 patients after the bandage was renewed due to wetting, and 5 patients died due to comorbidities (calf diarrhea, aspiration pneumonia) (Figure 5).

Five of seven patients who underwent external fixation using a Steinmann pin recovered successfully, meanwhile, two patients succumbed to infection. Full recovery was observed in 12 of 14 patients who underwent windowed bandage, and 2 patients died due to secondary infection (Figure 6).

DISCUSSION

Metacarpus fractures, which are frequently encountered in calves, are usually the result of excessive traction and incorrect manipulations during birth, and postnatal trauma. Postpartum fractures in calves usually occur within 1-10 days following the birth (Fessler & Adams, 1996, Görgül et al. 2004, Aksoy et al. 2009, Arıcan et al. 2014, Yurdakul, 2018). Male, gigantic, and have a relatively high birth weight calves are at the high-risk group for the second stage of birth (Akın, 2017). Similar to the literature, the metacarpus fractures in our cases occurred from dystocia, incorrect interventions during birth, and postnatal trauma. The calves ranged in age from 1 to 15 days, and all of them were culture breeds (Simmental, Simmental cross, and Brown Swiss). We can attribute the frequent occurrence of metacarpus fractures to the large size of the calves of especially large culture breeds, the lack of selection of seeds suitable for the breed of the animal in artificial insemination, and the larger size of male calves. In addition, the fact that these features make birth more difficult, and the resulting difficulty can be explained by the excessive force applied during the tether or manual pulling on the distal part of the metacarpus during birth.

Metacarpus fractures in calves can be in the form of open or closed fractures (Tulleners, 1986, Aksoy et al. 2009). Studies have reported that metacarpus fractures are generally localized in the distal diaphysis, metaphysis, distal epiphysis, and diaphyseal regions (Elma, 1988, Tulleners, 1986, Görgül et al, 2004, Aksoy et al, 2009, Belge et al, 2016). Metacarpus fractures in calves occur most frequently in the distal epiphysis and metaphysis (Aithal et al 2007). In their study, Sevil and Öcal (2006) reported that the weakest part of the metacarpus is the distal part. Metacarpus fractures in calves can be in the form of open or closed fractures (Tulleners, 1986, Aksoy et al. 2009). Salter-Harris Type I is the most common type of fracture in calves with distal epiphysis and metaphyseal fractures (Tullers, 1986). Elma (1988) radiologically evaluated a total of 69 metacarpal fractures and reported that there were diaphyseal fractures in 42 of the cases, metaphyseal fractures in 20 cases, distal epiphyseal fractures in 4 cases, and epiphyseal fractures with metaphyseal fracture (Salter-Harris Type II) in 3 cases. In the clinical and radiological evaluation of 72 calves with metacarpus fractures in our study, it was revealed that 51 (71%) were closed and 21 (29%) were open fractures. It was determined that the location and type of the fracture was consistent with some of the literature and inconsistent with others. In our study, distal diaphyseal fractures comprised the majority of cases with 40, epiphyseal fractures accounted for 20 cases and middle diaphyseal fractures for 12 cases. In addition, when epiphyseal fractures were classified within themselves, it was observed that 12 (60%) of 20 cases were Salter-Harris Type I, and 8 (40%) were Type II. In our cases, we can associate the formation of the majority of fractures in the distal region of the bone with the weaker structure of the bone in the transition region from the diaphysis to the metaphysis compared to other regions. Moreover, this region is often affected when owners attempt to assist in birth with a rope and use excessive traction, resulting in fractures.

The age and general health of the animal, its genetic potential, location and type of fracture, fracture site, severity of soft tissue injury, presence of bacterial contamination, and degree of movement of the fracture should be considered in the selection of a treatment technique. In addition, fracture characteristics influence the fracture's healing process (Görgül et al, 2004, Aithal et al. et al, 2004, Gangl et al, 2006). Open fractures with severely traumatized soft tissues commonly become infected, making repair significantly more difficult. If contamination occurs at the fracture site and persistent infection develops, the treatment is probably to fail (Desrochers et al, 2004, Arıcan et al, 2014). Many internal and external methods have been described in the literature for the treatment of metacarpus fractures (Arıcan et al, 2014, Mulon, 2014, Belge, 2016). Bandage (PVC, fiberglass, and Thomas splints) applications are generally preferred in closed metacarpus fractures with good outcomes. On the other hand, some open metacarpus fractures can be treated with windowed bandages if suitable and necessary, whereas some open fractures that are not suitable for a windowed bandage can be treated via many methods such as plate osteosynthesis, intramedullary pinning, and external fixation with transfixation pins (Ferguson, 1982, Mulon 2014, Arıcan et al, 2014, Salcı et al, 2016, Gillespie et al, 2018, Yadav et al, 2020, Yurtal et al. et al, 2020). In our study, while determining the treatment options, the most appropriate treatment option was determined by considering the fracture's location, shape, connection with the external environment (open and closed fracture), the presence of contamination, the economic value of the animal, and the time of fracture. Infection occurred in all 21 cases of open fractures in the current study, external fixation with transfixation pins was applied in 7 of these cases, while a windowed bandage with PVC+fiberglass plaster was applied in the 14 cases. No infection was detected in any of the 51 cases of closed fractures, and in 22 of these cases, a PVC+fiberglass plaster bandage was placed on palmar side, while PVC was placed on both lateral and medial sides of the metacarpus in 29 cases. After obtaining reduction and stabilization of the fracture with a wrap of materials, fiberglass plaster was applied to strengthen the fixation. The uneventful recovery of 46 out of 51 cases in which bandages were applied in closed fractures, 12 out of 14 cases in which a windowed bandage was applied in open fractures, and 5 out of 7 cases in which external fixation was applied with transfixation pins revealed the suitability of the selected treatment options. We may attribute the absence of any adverse events in the cases treated with a bandage with the high recovery rate, to the fact that bandage treatment is more convenient for the treatment of metacarpus fractures. Furthermore, this can be associated with the two PVCs placed on the lateral and medial of the fractured metacarpus. In the cases which resulted in death, it was understood in the controls that the causes of death were not due to the treatment, but rather the result of the negligence of the patients' owners. In open metacarpus fractures, the risk of infection is quite high, which reduces the likelihood of treatment. For this reason, patient owners must be made aware of this matter.

CONCLUSION

Numerous treatment options exist for metacarpus fractures, which are prevalent in calves and cause significant economic and productivity losses if left untreated. When determining the treatment option, the condition of the fracture (closed or open fracture), shape, location, presence of infection, cost of treatment, the economic value of the animal, and care conditions during the recovery period should be considered. Even if post-operative care are carefully monitored, infection becomes inevitable as the calves are housed in a barn environment. For this reason, it has been concluded that non-invasive bandage techniques are less costly and have a higher recovery rate than invasive methods, particularly for the treatment of distal metacarpus fractures.

DECLARATIONS

Ethics Approval

This study was conducted with the approval of Kafkas University Animal Experiments Local Ethics Committee (Approval no: KAÜ-HADYEK/2022-048).

Conflict of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of paper.

Consent for Publication

Not applicable

Author contribution

Idea, concept and design: UA, İÖ, ÖA and ET

Data collection and analysis: UA, İÖ, ÖA, CŞE, EK, UY, ET, MT and AY

Drafting of the manuscript: UA, UY and ET

Critical review: UA, İÖ, ÖA, CŞE, EK, UY, ET, MT and AY

Data Availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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