*Original Article*

# The Study of the Radiographic Positionings of the Canine Elbow for Identifying the Medial Coronoid Process

**Suwicha Chuthatep[1*] Kongkiat Srisuwatanasagul[2] Chalika Wangdee[1]**
**Kumpanart Sunthornwipart[1] Surassanan Angkana[1]**

## Abstract

**Twenty cadaver canine forelimbs, 9 right and 11 left, were used to evaluate the most effective radiographic position that can enhance the cranial aspect of the medial coronoid process (MCP) of the ulna. A lead pellet (1 mm) was buried to represent the area representing the cartilegenous fragment in the canine patient in the fragmented medial coronoid process (FMCP). The distance between the pellet and the radial surface and the superimposition of the humeral condyle silhouette on the pellet were used as parameters for analysis. The results showed that the disto45 medial-proximolateral oblique (Di45M-PrLO) position with a 40 flexed elbow had not only the least distance between the pellet and the radial surface but also the least superimposition of the humeral condyle silhouette on the pellet. In conclusion, the Di45M-PrLO position with a 40 flexed elbow is the best position for viewing MCP radiography in a dog with suspected FMCP.**

**Keywords :** Medial coronoid process (MCP), canine, radiographic position.

[1]Department of Surgery, [2]Department of Anatomy, Faculty of Veterinary Sciences, Chulalongkorn University, Bangkok 10330.
*Corresponding author, E-mail : Suwicha.chuthatep@gmail.com

## บทคัดย่อ


## การศึกษาการจัดท่าทางรังสีวิทยาของข้อศอกสุนัขเพื่อตรวจ medial coronoid process


สุวิชา จุฑาเทพ[1*] ก้องเกียรติ ศรีสุวัฒนาสกุล[2] ชาลิกา หวังดี[1] กัมปนาท สุนทรวิภาต[1] สุรัสนันท์ อังคะนา[1]

**การศึกษาหาการจัดท่าทางรังสีวิทยาที่เหมาะสมที่สุดที่สามารถทำให้บริเวณขอบด้านหน้าของ medial coronoid process (MCP) ของกระดูก ulna ปรากฏชัดเจนที่สุดในภาพถ่ายทางรังสี ได้ทำในซากขาหน้าของสุนัขจำนวน 20 ขา ประกอบด้วยขาขวาจำนวน 9 ขา และขาซ้ายจำนวน 11 ขา โดยนำเอาเม็ดตะกั่วมาฝังเพื่อระบุตำแหน่ง และเป็นตัวแทนของบริเวณชิ้นกระดูกอ่อนนี้ ซึ่งพบชิ้นส่วนของชิ้นกระดูกอ่อนบริเวณนี้แตกได้ในสุนัขที่มีสภาวะของ fragmented medial coronoid process (FMCP) โดยวิเคราะห์ระยะห่างระหว่างเม็ดตะกั่ว กับผิวกระดูก radius และการซ้อนทับของ humeral condyle กับเม็ดตะกั่ว พบว่าการจัดข้อศอกของสุนัขในท่า disto45 medial-proximolateral oblique พร้อมกับการงอข้อศอกเป็นมุม 40 องศา ให้ภาพรังสีที่มีค่าของระยะห่างระหว่างเม็ดตะกั่วกับผิวกระดูก radius น้อยที่สุด อีกทั้งยังมีการซ้อนทับของ humeral condyle กับเม็ดตะกั่วน้อยที่สุดอีกด้วย โดยสรุปการจัดท่าทางรังสี disto45 medial-proximolateral oblique ควรเป็นท่าที่ดีที่สุด ในการถ่ายรังสี นอกเหนือจากท่าทางรังสีมาตราฐาน เพื่อใช้ในการวินิจฉัยทางรังสีวิทยาในสุนัข ที่ถูกสงสัยว่ามีสภาวะของ FMCP**

**คำสำคัญ:** Medial coronoid process (MCP) สุนัข การจัดท่าทางรังสีวิทยา

**[1]ภาควิชาศัลยศาสตร์ [2]ภาควิชากายวิภาคศาสตร์ คณะสัตวแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย กรุงเทพฯ 10330**
***ผู้รับผิดชอบบทความ**

## Introduction

Elbow dysplasia is a most common developmental abnormality and causes clinical lameness in young, large-breed dogs (Henry, 1984; Carpenter et al., 1993; Miyabayashi et al., 1995; Boulay, 1998; Wosar et al., 1999; Kunzel et al., 2004). Elbow dysplasia includes fragmented medial coronoid process (FMCP), ununited anconeal process (UAP), incongruity of the joint surfaces, and osteochondritis dissecans (OCD). Of these 4 developmental abnormalities, FMCP is the most common (Grondalen and Grondalen, 1981; Fox and Bloomberg, 1983; Lewis et al., 1989; Boulay, 1998). In the radiographic findings of UAP, the joint incongruity and OCD are usually distinct, whereas in the findings of FMCP it is mostly impossible because the cartilagenous fragment indicating the FMCP is always obscured by the superimposition of the radial head. Therefore, the diagnosis of FMCP is often based on the presence of osteoarthritic characteristic changes including osteophyte formation on the dorsal aspect of the anconeal process, on the medial aspect of the medial coronoid process, along the medial humeral condyle or cranial to the radial head; subchondral sclerosis adjacent to the medial coronoid process; and indistinct outlines of the medial coronoid process (Henry, 1984; Carpenter et al., 1993; Haudiquet et al., 2002).

Although the finding of radiography are equivocal, FMCP is still the suspected origin of lameness. Therefore, a repeated radiographic examination 6 weeks later is recommended (Olsson, 1983). During this observation period, further progression of osteoarthritis sometimes allows a diagnosis to be made with greater confidence. Unfortunately, this waiting period may be detrimental to the affected dogs because early diagnosis and surgical intervention appear to give the best favorable outcome (Grondalen and Grondalen, 1981; Henry, 1984; Carpenter et al., 1993). Because an early diagnosis is necessary to provide optimal treatment before the development of degenerative joint disease, several imaging diagnostic modalities have been used such as computed tomography, linear tomography, plain-film radiography, or arthrography (Robins, 1980; Fox and Bloomberg, 1983; Carpenter et al., 1993; Miyabayashi et al., 1995; Boulay, 1998). Computed tomography has the highest accuracy (86.7%) and sensitivity (88.2%) (Carpenter et al., 1993), however this diagnostic method is not widely use in small animal practices. Consequently, the radiographic method is still necessary for FMCP diagnosis.

The sensitivity of the conventional radiographic projections in imaging the MCP is suboptimal and has been estimated to range from 10 to 62% at a specificity of 100% (Carpenter et al., 1993; Wosar et al., 1999). The latest study reported that the disto35medial-proximolateral oblique (Di35M-PrLO) view was found to be the best position that could enhance the identification of FMCP, compared with the alternative radiographic positions (Haudiquet et al., 2002). However, diagnostic results from this radiographic position involved subjective evaluation. Therefore, further objective evalution has to be investigated.

The purpose of the study was to determine the radiographic enhancement ability of the different positions to view the cranial aspect of the MCP in 20 canine cadaver forelimbs. The findings compared routine radiographic positions (craniocaudal, flexed 45 mediolateral and extended 120 mediolateral) and alternative positions (Di25M-PrLO, Di35M-PrLO and Di45M-PrLO with 11 angles varied from 40 flexed to 140 extended).

## Materials and Methods

### *Elbow joints*

Twenty cadaver forelimbs, 9 right and 11 left, from 20 dogs euthanatized for reasons unrelated to our study were included. The criteria for the specimens inclusion were a body weight of more than 15 kg and an absence of current orthopedic problems in or adjacent to the elbow joints. A medial intermuscular approach to the elbow joint was performed by dissecting the fascia between the pronator teres and the extensor carpi radialis muscles. The annular ligament was transected to view the cranial aspect of the MCP. When additional exposure was necessary, the medial collateral ligament was also transected. A one-millimeter-diameter hole was drilled at the cranial aspect of the MCP. A one-millimeter-diameter lead pellet was buried in the hole to represent the cranial aspect of the MCP. The dissected ligaments and muscular tissues were sutured using an interrupted pattern with 3-0 nylon. After radiographic studies, the elbow joints were reapproached to check for pellet migration.

### *Radiographic positioning and acquisition*

Anatomical and radiographic studies were made of 3 standard radiographic positions including craniocaudal, mediolateral (extended 120 mediolateral) and flexed mediolateral (at an elbow angle of 45 ) (Morgan 1993; Hornof et al., 2000; Haudiquet et al., 2002) and 33 different angles of distomedial-proximolateral oblique (DiM-PrLO) radiographic positions. The DiM-PrLO radiographic positions were composed of 25 (Di25M-PrLO), 35 (Di35M-PrLO) and 45 (Di45M-PrLO). Each of them consisted of 11 angles (flexed/ extended) of the elbow at 40 , 50 , 60 , 70 , 80 , 90 , 100 , 110 , 120 ,130 and 140 . A radio-translucent instrument was used to make the positions of the different angles as shown in Figs. 1A and 1B. All radiographs were made using a high detail film (T-MAT S/RA Film, Kodak). The intensity ranged from 1 to 2 mAs and the penetrability ranged from 60 to 70 kVp. All radiographs were made by centering the radiographic beam over the elbow as shown in Figs. 2A, 2B, 2C, 2D, and 2E.

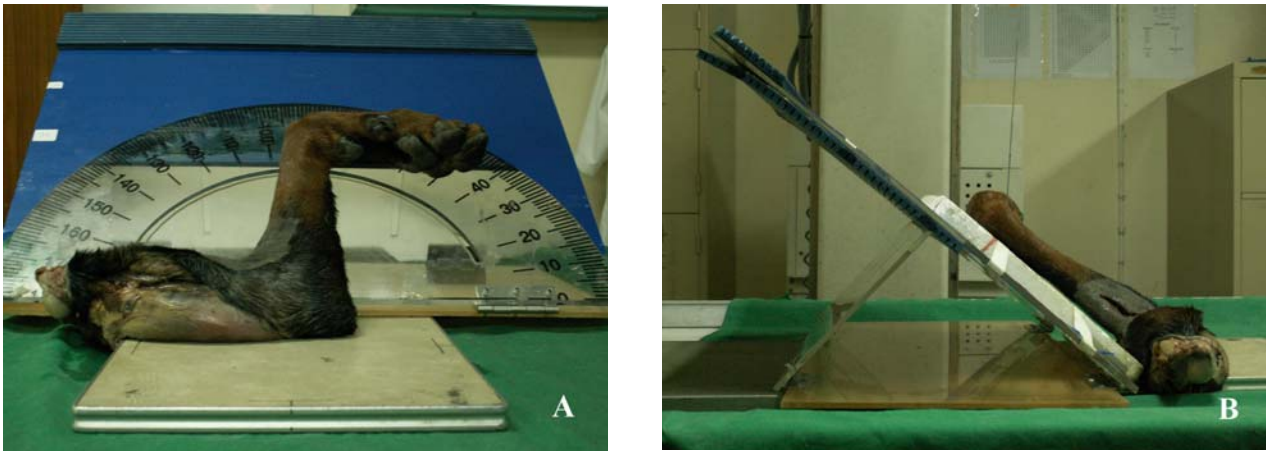


**Figure 1A, B** The DiM-PrLO position is made by placing the canine cadaver on a radio-translucent instrument. The radiographic beam is centered over the elbow joint.


**Figure 2** The position of the MCP in radiographs can be clearly seen by the placed lead pellets at the cranial aspect of the MCP.

**A** Craniocaudal radiographic view; placing the radius and ulna parallel to the casssette but the humerus remain at an angle to the cassette.

**B** Mediolateral radiographic view; placing the elbow joint in a 120 extended position on the cassette.

**C** Flexed mediolateral radiographic view; placing the elbow joint in a 45 flexed position on the cassette.

**D** Di45M-PrLO with 40 flexed radiographic view; placing the elbow in a 40 flexed position with 45 elevated from the cassette.

**E** Di25M-PrLO with 140 extended radiographic view; placing the elbow in a 140 extended position with 25 elevated from the cassette.

### Radiographic evaluation

In order to evaluate the projection differences among all the radiographs, the distance between the edge of the lead pellet and the radial surface was measured and the superimposition of the humeral condyle silhouette on the pallet was recorded. The distance was recorded in millimeters by using a digital caliper (0.01 mm resolution) and the superimposition was recorded as "yes" for superimposition and "no" for non-superimposition.

### Statistical analysis

The distance between the edge of the lead pellet and the radial surface in all radiographic views was analyzed to find the position that exhibited the shortest distance by using Analysis of Variance and Tukey-kramer HSD method (JMP version 5, SAS Institute Inc., Cary, NC) which $p$ values ≤ 0.05 were accepted as significant difference. The proportions of the superimposition of the humeral condyle silhouette on the pallet from all radiographic positions were also determined by contingency analysis.

## Results

### The distance between the pellet and the radial surface

The radiograph of the Di45M-PrLO position with 40 flexed elbow significantly revealed the shortest distance between the pellet and the radial surface, compared with other oblique and the conventional positions ($p$ < 0.05) as shown in Table 1.

| Position | | | | | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A35B140 | A | | | | | | | | | | | | | | | 8.6 475 |
| A45B140 | A | | | | | | | | | | | | | | | 8.4540 |
| A35B130 | A | B | | | | | | | | | | | | | | 8.2800 |
| A45B130 | A | B | | | | | | | | | | | | | | 8.2270 |
| A25B140 | A | B | | | | | | | | | | | | | | 8.0415 |
| A35B120 | A | B | C | | | | | | | | | | | | | 7.8990 |
| A45B120 | A | B | C | | | | | | | | | | | | | 7.8560 |
| A25B130 | A | B | C | | | | | | | | | | | | | 7.7550 |
| A35B110 | A | B | C | | | | | | | | | | | | | 7.5160 |
| A45B110 | A | B | C | D | | | | | | | | | | | | 7.3845 |
| A25B120 | A | B | C | D | | | | | | | | | | | | 7.3725 |
| A35B100 | A | B | C | D | E | | | | | | | | | | | 6.9840 |
| A25B110 | A | B | C | D | E | | | | | | | | | | | 6.9335 |
| A45B100 | A | B | C | D | E | F | | | | | | | | | | 6.8235 |
| A25B100 | | B | C | D | E | F | G | | | | | | | | | 6.5745 |
| ML120 | | | C | D | E | F | G | H | | | | | | | | 6.1760 |
| A35B90 | | | C | D | E | F | G | H | | | | | | | | 6.1475 |
| A25B90 | | | C | D | E | F | G | H | | | | | | | | 6.1380 |
| A45B90 | | | C | D | E | F | G | H | I | | | | | | | 6.0765 |
| A25B80 | | | | D | E | F | G | H | I | J | | | | | | 5.6420 |
| ML45 | | | | D | E | F | G | H | I | J | | | | | | 5.6160 |
| A35B80 | | | | D | E | F | G | H | I | J | K | | | | | 5.5620 |
| A45B80 | | | | | E | F | G | H | I | J | K | L | | | | 5.4690 |
| A25B70 | | | | | E | F | G | H | I | J | K | L | M | | | 5.1795 |
| A35B70 | | | | | | F | G | H | I | J | K | L | M | N | | 5.0465 |
| A45B70 | | | | | | | G | H | I | J | K | L | M | N | | 4.8990 |
| A25B60 | | | | | | | | H | I | J | K | L | M | N | O | 4.7305 |
| A35B60 | | | | | | | | H | I | J | K | L | M | N | O | 4.3540 |
| A25B50 | | | | | | | | | I | J | K | L | M | N | O | 4.2880 |
| A45B60 | | | | | | | | | | J | K | L | M | N | O | 4.2125 |
| A35B50 | | | | | | | | | | J | K | L | M | N | O | 3.8695 |
| A25B40 | | | | | | | | | | | K | L | M | N | O | 3.7395 |
| cra-cau | | | | | | | | | | | | L | M | N | O | 3.6500 |
| A45B50 | | | | | | | | | | | | | M | N | O | 3.5400 |
| A35B40 | | | | | | | | | | | | | | N | O | 3.3205 |
| A45B40 | | | | | | | | | | | | | | | O | 2.9170 |

**Table 1** Statistical analysis shows the mean comparison of the distance between the pellet and the radial surface from all position. **A** Angle of the proximal-distal elevation. **B** Angle of the flexed-extended elbow. (Different letters in the same category are significantly different).

On the DiM-PrLO radiograph, when the obliquity of the disto-proximal dimension was increased from 25 to 45 , the distance between the pellet and the radial surface was decreased. In addition, when the elbow angles were increased from 40 to 140 , the distance between the pellet and the radial surface was also increased as shown in Fig. 3.

On the standard radiographs, craniocaudal radiographs showed the shortest distance between the pellet and the radial surface. In addition, the distance between the pellet and the radial surface on the flexed 45 mediolateral position was less than on the extended 120 mediolateral position as shown in Fig. 3.

***The superimposition of the humeral condyle silhouette on the pellet***

On the DiM-PrLO radiographs, Di45M-PrLO with 40 flexed elbow position showed the least proportion of superimposition. The proportion of superimposition was increased in accordance with the increased elbow angles. However, there was an exception when the elbow angle was extended more than 130 in the DiM-PrLO position.

On the standard radiographs, no radiographs showed any superimposition of the humeral condyle silhouette on the pallet as shown in Fig. 4.

**Figure 3** Mean comparisons of the pellet-radial surface distance (mm) among the radiographic positions.
A Angle of the proximal/ distal elevated elbow.
B Angle of the flexed/ extended elbow.

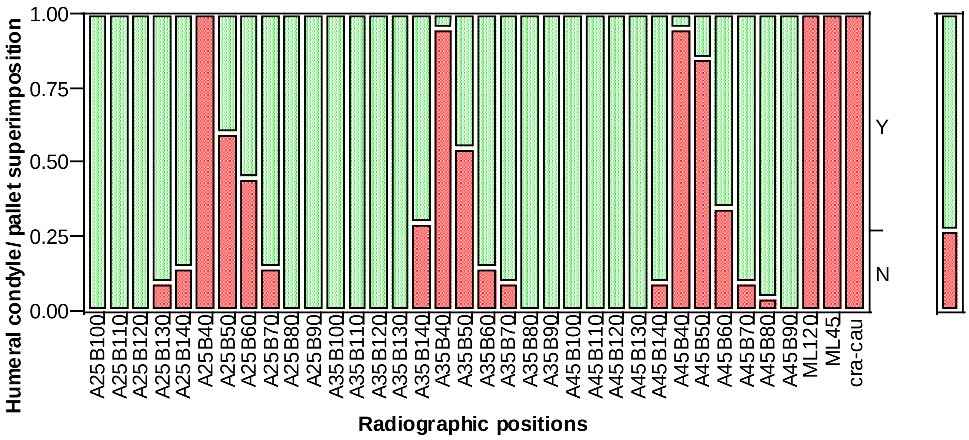


**Figure 4** The proportions of the superimposition in the different radiographic positions.
**Y** Yes; appearance of the superimposition of the humeral condyle silhouette on the pellet.
**N** No; non-appearance the superimposition of the humeral condyle silhouette on the pellet.

## Discussion

In this study, the cranial aspect of the MCP was easy to approach and the identification of this area with lead pellets could be made accurately in the canine cadavers. In addition, the radiographic imaging by the using a radio-translucent instrument, depicted the precise angle of the elbow without any interference in the radiographic viewing and quality.

A previous study has suggested that the degree of superimposition of the proximal radius on the cranial aspect of the MCP has an effect on the evaluation of the FMCP. In this case, the decrease in superimposition of the proximal radius on the cranial aspect of the MCP will increase the detectability of FMCP (Miyabayashi et al., 1995). Therefore, evaluation of the distance between the pellet and the radial surface as a parameter in this study reflected the detectability of FMCP. It was shown that the distance between the pellet and the radial surface on the DiM-PrLO positions with flexed elbow was shorter than those on the standard mediolateral position (extended 120 mediolateral position) indicating that oblique positions could improve the detectability of FMCP. It partially agreed with a previous study which reported that the sensitivity of FMCP detection on the Di35M-PrLO position with 90 flexed elbow was higher than those on the flexed 45 mediolateral and extended 120 mediolateral positions (Haudiquet et al., 2002). In contrast with this study, the sensitivity of FMCP detection on the flexed 45 mediolateral position was higher than on the Di35M-PrLO position with 90 flexed elbow. However, the DiM-PrLO positions with hyperflexed elbow (the angle smaller than 70 ) still had a higher level of sensitivity in detecting FMCP than the Di35M-PrLO position with 90 flexed elbow.

The study of Haudiquet (2002) remarked that the Di35M-PrLO radiograph showed the superimposition of the humeral condyle on the cranial aspect of the MCP. For this reason, the superimposition of the humeral condyle silhouette on the pellet was also considered in this study to find the position that had the least humeral condyle superimposition on the cranial aspect of the MCP. Radiologically, the cranial aspect of the MCP moved away from the humeral condyle when elbow was placed in overflexed and overextended angles because we found that the pellet moved from proximally above humeral condyle in an overflexed elbow to distally below humeral condyle in an overextended elbow.

Considering the distance between the pellet and the radial surface and the superimposition from our study, the Di45M-PrLO position with 40 flexed elbow and the craniocaudal positions are probably the most effective positions. Unfortunately, the craniocaudal position exhibited obscurity of the cranial aspect of MCP by the proximal of the ulna which supports the Boulay study (1998).

In clinical situations, the Di45M-PrLO position with 40 flexed elbow is simple to arrange because it can be made by flexing the elbow with less abduction of the forelimb in the dorsal recumbency. However, the dog should be sedated and radiographic positioning instruments such as sand bags or tape should be used.

## Conclusion

The Di45M-PrLO with 40 flexed elbow radiographic position proves to be the most efficient position to enhance viewing of the cranial aspect of MCP, compared with other radiographic positions. In addition, this position is easy to perform and can be used for screening the dogs potentially affected with FMCP.

## Acknowledgement

This work was supported by a research grant from the Faculty of Veterinary Sciences, Chulalongkorn University, Bangkok, Thailand. The authors would like to thank Dr. Gedsara Chumponkulwong for providing the canine cadavers and Dr. Dachrit Nilubol for assistance in statistical analyses.

## References

Boulay, J. P. 1998. Fragmented medial coronoid process of the ulna in the dog. Vet. Clin. North Am. Small Anim. Pract. 28(1): 51-74.

Carpenter, L. G., Schwarz, P. D., Lowry, J. E., Park, R. D. and Steyn, P. F. 1993. Comparison of radiologic imaging techniques for diagnosis of fragmented medial coronoid process of the cubital joint in dogs. J. Am. Vet. Med. Assoc. 203(1): 78-83.

Fox, S. and Bloomberg, M. 1983. Developmental anomalies of the canine elbow. J. Am. Vet. Med. Assoc. 19: 605-615.

Grondalen, J. and Grondalen, T. 1981. Arthrosis in the elbow joint of young rapidly growing dogs. V. A. pathoanatomical investigation. Nord. Vet. Med. 33(1): 1-16.

Haudiquet, P. R., Marcellin-Little, D. J. and Stebbins, M. E. 2002. Use of the distomedial-proximolateral oblique radiographic view of the elbow joint for examination of the medial coronoid process in dogs. Am. J. Vet. Res. 63(7): 1000-1005.

Henry, W. B., Jr. 1984. Radiographic diagnosis and surgical management of fragmented medial coronoid process in dogs. J. Am. Vet. Med. Assoc. 184(7): 799-805.

Hornof, W. J., Wind, A. P., Wallack, S. T. and Schulz, K. S. 2000. Canine elbow dysplasia. The early radiographic detection of fragmentation of the coronoid process. Vet. Clin. North. Am. Small Anim. Pract. 30(2): 257-266.

Kunzel, W., Breit, S. and Probst, A. 2004. The subchondral split line patterns of the medial coronoid process in canine ulnae. Anat. Histol. Embryol. 33(6): 339-343.

Lewis, P., Parker, R. and Hager, D. 1989. Fragmented medial coronoid process of the canine elbow. Compend Cont. Edu. Pract Vet. 11: 703-716.

Miyabayashi, T., Takiguchi, M., Schrader, S. C. and Biller, D. S. 1995. Radiographic anatomy of the medial coronoid process of dogs. J. Am. Anim. Hosp. Assoc. 31(2): 125-132.

Morgan, J. P. 1993. Elbow joint. In: Radiography of the Forelimb. From Techniques of Veterinary Radiography. 5th ed. Ames: Iowa State University Press. 152-153.

Olsson, S. E. 1983. The early diagnosis of fragmented coronoid process and osteochondritis dissecans of the canine elbow joint. J. Am. Anim. Hosp. Assoc. 19: 616-626.

Robins, G. M. 1980. Some aspects of the radiographical examination of the canine elbow joint. J. Small Anim. Pract. 21(8): 417-428.

Wosar, M. A., Lewis, D. D., Neuwirth, L., Parker, R. B., Spencer, C. P., Kubilis, P. S., Stubbs, W. P., Murphy, S. T., Shiroma, J. T., Stallings, J. T. and Bertrand, S. G. 1999. Radiographic evaluation of elbow joints before and after surgery in dogs with possible fragmented medial coronoid process. J. Am. Vet. Med. Assoc. 214(1): 52-58.