Subtotal coronoid ostectomy (SCO) is a surgical treatment option for medial coronoid disease (MCD). The objective is to remove portions of the coronoid that are visibly diseased as determined by arthroscopic or CT scan interrogation and an additional portion which may have suboptimal subchondral architecture on physical palpation or direct observation. There is a significant body of evidence, based on analysis of diseased coronoid samples by histology, histomorphometry and micro-CT that subchondral pathology exists both within visibly diseased regions of the medial coronoid process and in adjacent areas. This pathology has been attributed to fatigue microdamage with a mechanical overload aetiopathogenesis, though intrinsic biologic defects of the cartilage and subchondral bone have not been definitively precluded. Current evidence intimates that the physical response of the cartilage and bone of the medial coronoid process to disparate patterns of mechanical overload may explain observed cartilage and bone pathology, even in the absence of a definitive biologic defect. Microcracking of subchondral bone precedes gross fibrillation, fissuring and fragmentation of articular cartilage. Furthermore, in some clinical cases of MCD, fragmentation per se is not observed but rather a general erosion and eburnation of the surfaces of the medial coronoid process and the medial aspect of the humeral condyle in a mirror-image striatory fashion, ascribed the term “kissing lesions” and mechanically attributable to humero-ulnar conflict (HUC).

In an abstract presented at this meeting, the author proposes, based on micro-CT of excised diseased coronoid fragments that there may be a fundamental difference between tip and radial incisure (RI) fissure-fragmentation patterns. There seems little doubt that genetic factors contribute significantly, but whether this is mediated by conformational anomaly, mechanical misfit of the humerus, radius and ulna, soft-tissue-bone mismatch or unknown biologic effects on cartilage and bone is unproven and the subject of intense debate. In some cases the radial articular surface is definitively and measurably subjacent to the surface of the coronoid process of the ulna; in some cases there is a definitive and measurable incongruity between the distal humerus and the ulnar notch; however, potential incongruity between the radial head and the RI of the coronoid process is also possible, which could result in torsional incongruity and could predicate certain patterns of subchondral fatigue and cartilage pathology. Furthermore a torsional force scenario leading to HUC could be theorized whereby the medial coronoid process could be forced into the recess between the intercondylar isthmus and the radial head. The author has drawn parallels between the phenomenon of the RI of the medial coronoid process moving relative to the radial head and the motion of tectonic plates in geophysics, with ensuing shear planes and sub-surface damage. At this time these theories remain speculative based on observation of disease patterns and analysis of excised coronoid tissue.

It has also been proposed by this author and others that the action of musculo-tendinous forces, most notably the biceps-brachialis complex and the flexor tendons of the antebrauchium may produce long lever arms on poorly fitting joint surfaces much like poorly fitting cogs in a machine being driven together in an undesirable fashion. In this scenario, the lever arm itself may not be diseased, but the mechanical effect of the lever arm could exacerbate and manifest incongruity in physically observable overload fissure-fragmentation-wear phenomena. In this respect, the therapeutic intervention of Biceps ulnar release procedure (BURP), which involves cutting the insertion of the biceps-brachialis on the medial coronoid process, may have a clinical effect through diminution of the forces acting on incongruent osseous elements. Whether BURP in conjunction with either fragment removal
(FR) or SCO, yields clinical outcomes superior to FR or SCO alone, is the subject of ongoing investigation. The author does not advocate BURP as a sole treatment for full thickness modified Outerbridge grade IV cartilage disease of the medial compartment, having not experienced positive outcomes for application in this scenario.

Kinematic analysis of dogs affected by confirmed MCD and normal dogs has been performed at the author’s facility to track gait patterns in all three planes of motion (sagittal, frontal and transverse). Early findings intimate that dynamic radioulnar incongruity could increase medial coronoid pressures and contribute from a conformational perspective to mechanical overload. CT scan and arthroscopic evaluation of all clinically-affected elbows is the standard of care at the author’s facility. A retrospective review of more than 500 cases presented for treatment at the author’s facility revealed that whilst CT scan is more sensitive than radiography regarding perception of incongruity, as has been shown in previous studies, the majority of cases affected by MCD do not manifest observable incongruity on CT scan or arthroscopy.

In a study of 263 dogs affected by MCD performed by the author, the medial coronoid process was grossly intact in 17.6%, fissured in 18.3% and fragmented in 64.1%. Therefore there were a significant proportion of cases in which FR wasn’t possible as a surgical treatment option. If fissure or fragmentation is not apparent on CT scan or arthroscopic examination, but medial coronoid cartilage disease graded modified Outerbridge I to III is apparent, the most appropriate surgical intervention has not been clearly defined by outcome measures to date. It is unclear whether SCO can influence the short or longer term outcome for such cases. Other recent work suggested little difference between FR alone and conservative medical management. However, long term outcomes for medical management alone versus either FR or SCO have not been published for treatment of well described and documented MCD scenarios. Additionally, prospective comparisons are difficult to achieve for diseased animals because of ethical issues and the fact that some owners insist on surgical management ab initio whilst some request surgical management if medical management isn’t controlling clinical signs to an extent that provides adequate quality of life from their perspective.

Case selection criteria for different treatment modalities have been poorly defined and the portion of coronoid process removed in SCO varies between surgeons and existing descriptions in the literature. In fact, in the author’s hands, SCO performed by arthroscopic manual or motorized means or by a mini-medial arthrotomy in the fashion he has described (1.5cm incision caudal to medial collateral ligament), subjectively show no discernable medium term outcome difference. In fact, the author has observed that in some instances arthroscopic portals have been as large as the skin incision created for mini-medial arthrotomy. Extent of surgical approach for either arthrotomy or arthroscopy must be clearly defined in addition to the extent of intervention for the MCD. In reports to date, this has not been reported in a standardized fashion. However, effect of intervention may be more related to the inciting cause of HUC than by the technique of SCO application.

There has been some debate over how much resection of the medial coronoid process constitutes too much. The author defines SCO as removal of a portion of the medial coronoid process with the lateral extent of that portion being no more than ¾ of the distance between the tip of the medial coronoid and the junction of the RI of the medial coronoid process and the sagittal ridge of the ulnar trochlear notch (obviously patient size dependant). In patients affected by RI fragmentation, the lateral border of the excised segment is generally at the most caudal extent of the arcuate fissure line. In some cases, what individual surgeons have described as FR or abrasion arthroplasty, may in fact constitute what could also be described as SCO. More stringent definition of intervention is warranted in scientific publications striving for well-founded evidence based medicine.
Furthermore, as there is possibly a different inciting force pattern for tip versus RI fissuring and fragmentation, SCO may have different effects in different patients. Though the author has reported that owner and veterinary-assessed short and medium term outcomes following SCO were favorable, long term follow-up data has been lacking, as has kinetically validated improvements. Anecdotally, the author has seen both favorable 3-8 year outcomes following SCO and significant debilitation after 3-8 years due to progressive painful elbow arthrosis. The factors influencing whether an individual dog responds well or poorly to SCO have not been defined. Subjectively, patients with existing humeral erosive lesions have performed less well in the longer term than dogs where the medial aspect of the humeral condyle was intact at initial surgery; but there have been notable exceptions where an apparently unaffected medial humeral condyle becomes progressively eroded following FR or SCO and others where minor initial humeral erosion becomes full-thickness modified Outerbridge Grade IV cartilage disease due to HUC of the cut edge of the SCO within a few months as assessed by second-look arthroscopy. In some cases, erosion progresses to the medial margin of the radial head. The mechanical drivers of these disparate outcomes are poorly understood. In the author’s view, SCO has different outcomes for the same degree of arthroscopically discerned pathology in different patients and ascribing outcomes measures without defining age, breed, imaging findings, arthroscopic findings, body weight, time of intervention relative to humeral and coronoid pathology and activity level of the patient, is misleading.

It is intuitive that the assessment of long term outcome of SCO would require strict inclusion and exclusion criteria, but these have been poorly defined in relation to developmental elbow disease generally, with some published reports grouping elbows affected by osteochondritis dissecans with those affected by “kissing lesions” of the humeral condyle and MCD. Even in the author’s own study of 263 dogs, it would have been preferable to group dogs according to salient disease criteria for MCD such as whether overt elbow incongruity was evident, what type of incongruity, and whether tip or RI fissuring or fragmentation was apparent or just cartilage disease without overt fissuring. In an effort to ascertain the effect of different types of MCD on long term outcome, this data is currently being collated for all of these cases 3-8 years postoperatively and all owners are asked to attend for force-plate assessment and clinical examination. If geographic distance or reluctance to attend precludes kinetic evaluation, a telephone questionnaire has been performed. Some patients have died and some owners have moved or are un-contactable. For dogs assessed to date, 41% are lameness-free after 6 years without medication and 43% of cases on medication are being provided non-steroidal anti-inflammatory treatment. No case contacted to date has undergone another elbow surgery.

Kinetic results on cases examined to date have revealed good symmetry indices of thoracic limb gait, even where a unilateral SCO was initially performed (an average of 5% of difference has been calculated between the left and right thoracic limb using the ground reaction force percentages). Additionally, peak vertical forces measured are within 15% of values published for normal dogs. Clinical examination revealed that 55% did not resent pressure application to the medial aspect of the operated elbow, 60% displayed some manifestation of mild pain (turning or pulling on the limb) when the elbow was supinated, 55% did not manifest pain during elbow flexion and 70% didn’t manifest pain on elbow extension. The maximal flexion angle of dogs previously operated by SCO is less than for elbows not operated, but this difference is not statistically significant. An attempt to correlate degree of periarticular osteophytosis at the time of initial presentation and at times of follow-up with degree of intra-articular pathology at the time of surgery and the type of surgery performed is also ongoing.
In the absence of significant medial humeral condylar pathology identified arthroscopically, local surgical treatment of MCD remains the mainstay of surgical intervention. Whether there is a difference in the short or longer term between FR alone or SCO remains to be established. The author, like others, has observed short term improvement following FR alone in overtly fragmented cases, but whether this improvement is maintained or not in the longer term is not documented in the literature to date and no kinetic or kinematic data is available regarding longer term outcomes of FR. Furthermore, whether there is a difference in outcome following FR alone in tip versus RI fragment location is not yet elucidated. Subjectively, the author’s experience is that tip fragmentation responds more favorably to FR alone than does RI fragmentation.

The author has experienced similar outcomes for SCO employed for both tip and RI fragmentation scenarios with similar degrees of cartilage disease at the time of intervention. This may be related to reduction in HUC with RI pathology removed by SCO rather than FR alone for this condition, though this remains to be objectively validated. There is histomorphometric and micro-CT evidence that micro-crack pattern predating radial incisure fragmentation radiates out medially from the RI and diffuse subchondral bone damage is present, albeit to a lesser extent, in the medial and mid aspects of the medial coronoid process, as well as the lateral incisure region. Tip fragments adopt a different micro-crack pattern of gradual “cumbling” caudal to the fragmentation plane, as shown in an abstract presented by the author at this meeting. The author has observed that in many cases of tip fragmentation, the SCO cut is parallel to and not much further caudally disposed than the actual plane of fragmentation itself, meaning that FR of large tip fragments and SCO per se are not dissimilar procedures by definition. Subjectively, the author further submits that FR alone in a specific subgroup of older patients (≥ 2 years) with sudden fragmentation (“jump-down syndrome”) and in the absence of overt humeral cartilage pathology, results in satisfactory clinical outcomes in the short and long term, but we have shown histologically that this sudden fragmentation is not an acute fracture of un-diseased bone but rather an acute overload of diseased subchondral bone which hitherto had been submitted to chronic fatigue. In the author’s experience the majority of these fractures constitute tip fragments.

It has been questioned whether SCO may actually adversely affect the joint mechanically and perpetuate medial compartment wear and collapse. This has never been proven. Specifically it’s unknown whether elbows which suffer inexorable medial compartment erosion after SCO would have progressed to end stage disease and medial compartment collapse in any case or whether SCO contributed to this demise. Our kinematic data in diseased versus undiseased dogs suggests that there may be an intrinsic conformational malalignment in diseased dogs ab initio.

Interestingly, in an abstract presented at this meeting the author has demonstrated using kinetic and clinical outcome data that when load on the medial compartment is reduced using sliding humeral osteotomy (SHO), there is no difference in outcome whether a loose fragment is removed or not. In fact such loose fragments are generally covered with thickened cartilage and the author submits that this may be due to separation of these fragments at an earlier date before mechanical overload and subsequent erosion of the remaining surface of the medial coronoid process; hence the un-remodelled and thickened cartilage on the surface of the fragment, sometimes inferred as a lesion of osteochondrosis. Histological data of this cartilage-capped fragment does not share characteristic features associated with the disturbance of endochondral ossification typical of osteochondritis dissecans.

In addition to SHO, other surgical salvage options for dogs affected by chronic medial compartment collapse following failure of SCO have included various ulnar osteotomies (proximal and distal, with or without custom plates and with or without arthroscopic guidance) and more recently unicompartamental elbow replacement and total elbow

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replacement. In an abstract presented at this meeting, positive outcomes are documented after application of SHO as a salvage procedure, with currently a zero percent major complication rate in the author’s hands.

In the presence of significant humeral erosive pathology at initial inspection, there may be an argument for ulnar, radial or humeral osteotomy techniques to attempt unloading and in abstracts presented at this meeting, the author documents the effect of bi-oblique dynamic proximal ulnar osteotomy (BODPUO). If overt radio-ulnar incongruence is identified, then the author submits that BODPUO is the favored surgical intervention but it is unclear if there are additional benefits from concomitant SCO and if so, which grades or types of pathology warrant SCO, by comparison with BODPUO alone or a less invasive procedure such as BURP. The author will employ BODPUO in addition to SCO in cases of coronoid fragmentation where the edge of the medial coronoid process caudal to the fragment is producing abrasion of the medial aspect of the humeral condyle. If full thickness modified Outerbridge Grade IV lesions of the medial aspect of the humeral condyle are present then it is deemed unlikely that SCO or BODPUO will result in a positive outcome, and the author generally performs SHO for these cases.

The author contends that in order to provide useful long term data regarding outcome following any treatment for MCD, and especially SCO, strict protocols, inclusion and exclusion criteria, technique and approach standardization and cohort studies are essential. Then future treatment recommendations can be based on clinical evidence rather than anecdote, habituation, opinion or bias. Clearly SCO has a role to play in treatment of MCD in dogs, but definitive indications and objective outcome measures require further investigation. Many dogs have experienced long term benefit from SCO surgery but it is not a rational basis for progress if we continue to compare outcomes of dogs affected by MCD caused by disparate mechanisms and draw generalized conclusions that SCO is or is not successful by comparison with FR or conservative medical management unless our sample populations are more clearly defined and more ardently followed for longer time periods.

References