Surgical treatment of shoulder instability
A retrospective study on 76 cases (1993–2007)

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**Summary**
This study evaluates 76 cases of shoulder instability in dogs, functional outcome after treatment, and the effectiveness of medial biceps tendon transposition using a metallic staple. Clinical examinations of the shoulder were performed and radiographs were taken. Conservative treatment or surgery (biceps tendon transposition or arthrodesis) was then opted for on the basis of type of instability, associated lesions and dog (age, weight, behaviour). Long-term functional outcome was categorized as ‘excellent’, ‘good’, ‘average’ or ‘poor’. In our series, the most frequently affected breed was the Poodle (13%). Humeral head intermittent displacement was either medial (80%), lateral (19%) or cranial (1%). On clinical examination, 97% of the animals experienced pain. In anaesthetised dogs, shoulder instability was observed in 90% of the population. Muscle atrophy (33%) and associated radiographic lesions (34%) were less frequent. Ninety-five percent of the dogs were treated surgically, either by bicipital tendon transposition (81%) or by shoulder arthrodesis (19%). Results were ‘good’ to ‘excellent’ in 25% of the animals treated conservatively, and in 84.5% and 87.5%, respectively, in those treated by tendon transposition and arthrodesis. Complications did not arise from the use of a metallic staple to anchor the tendon during medial transposition. Tendon transposition or arthrodesis resulted in a good functional outcome in more than 80% of the dogs with shoulder instability. During the medial transposition, the biceps tendon was easily and effectively stabilized using a metallic staple.

**Keywords**
Shoulder, instability, tendon transposition

**Introduction**
Although shoulder instability has been classically described as a frequent cause of forelimb lameness in dogs (1, 2), its diagnosis and treatment always represents a challenge for the surgeon. A clinical examination is essential in order to diagnose the disorder and involves not only direct manipulation of the shoulder (3, 4) but also measurement of the angle of abduction, which has recently been reported by Cook (5) to be significantly greater in dogs with medial instability. In a study involving small dogs, Puglisi (6) attempted to establish objective, radiographic criteria for diagnosing shoulder instability, but despite evidence of an increase in the joint space in a stressed position, a consensus has not yet been reached regarding such criteria. Yet radiographic techniques permit the diagnosis of secondary degenerative lesions, which have been reported to exist in 57% of all cases of instability (1). Finally, arthroscopy (7–11) and magnetic resonance imaging (12), which permit direct observation of damaged structures, represent important advances for the early diagnosis of shoulder instability. In a study involving 33 dogs with luxations of the shoulder, Vasseur (13) reported that 64% of the luxations were medial and 30% were lateral. This predominance of medial instability has been confirmed by several authors, who have found it to be associated with traumatic lesions of the medial glenohumeral ligament and/or, in cases of congenital instability, dysplastic lesions of the glenoid cavity (1). Lateral instability, which occurs more frequently in large dogs, is more often traumatic in origin (14). The choice of treatment depends on the orientation and degree of instability, associated lesions, the age and weight of the subject, and the intensity of physical activity. In cases of instability which are traumatic in origin, and in which reduction and immobilization is possible, conservative forms of treatment may be considered. Of the various surgical procedures used for stabilization, biceps tendon transposition techniques have often been mentioned but few studies have evaluated the functional outcome of such techniques. Moreover, these techniques are sometimes quite difficult to perform, particularly medial transpositions in small dogs. Vasseur reported on a series of 10 cases of instability in which a clinical improvement was systematically observed following biceps tendon transposition (13). The treatment of medial instability by thermal capsulorrhaphy (15, 16) also seems to give good results since a clinical improvement was observed by Cook in 93% of the cases. Finally, when confronted with severe dysplastic or degenerative lesions, or when the previously mentioned techniques fail, the only remaining option is arthrodesis (17, 18). Thus, in this retrospective study of 76 cases, we sought to evaluate the functional outcome of each type of treatment, in particular the procedure involving the medial transposition of the biceps tendon in which an original method of anchoring the latter using a surgical staple was used.

**Materials and method**

**Inclusion criteria**
This retrospective study (1993–2006) involved 76 dogs that were admitted with forelimb lameness associated with shoulder instability. The dogs with a concomitant orthopaedic pathology which could potentially bias clinical evaluations were excluded from the study, as were the dogs that had not been followed up for at least four months. For each animal, the weight, breed and age, as well as side, nature, cause and
treatment of instability were recorded. The cause of lameness was categorized as ‘traumatic’ when a specific traumatic event was mentioned by the owner, and as ‘unknown’ in all other cases.

**Diagnosis**

The clinical examination began with the observation of the waking animal, first while it was inactive and then during activity. Symptoms sought included lameness or evidence of pain (yelping, refusal to move). The shoulder was then carefully manipulated, particularly in extension, flexion, adduction and abduction, in order to check for signs of pain. Evidence of pain on palpation of the biceps tendon was often indicative of a more general sensation of pain in the shoulder (1).

Atrophy of the pectoral and infra- and supraspinatus muscles was occasionally observed. It was sometimes possible to evaluate amplitude of movement and instability during the waking state, but since this was often painful, all of the animals were sedated with a combination of intravenous xylazine (0.2 mg/kg), morphine chlorhydrate (0.5 mg/kg), and atropine (0.02 mg/kg). The animals were examined for two types of instability by comparing the affected shoulder with the contralateral one. For the first type of instability the shoulder was manipulated to test for cranial, caudal, lateral and medial translocations of the humeral head. Translocation was categorized into four grades (19): grade 1 (none): no instability; grade 2 (mild): translocation of the humeral head without the latter rising on to the rim of the glenoid cavity; grade 3 (moderate): translocation of the humeral head on to the rim of the glenoid cavity; grade 4 (severe): dislocation of the humeral head. Testing for the second type of instability involved placing the two forelimbs into abduction and then checking for any differences in angulation. An increase in the angle of abduction was suggestive of a slackening in the medial compartment of the shoulder. Differences in angulation were evaluated subjectively by the surgeon by comparing the two shoulders. This sometimes proved to be difficult in cases of minor instability or bilateral instability. The experience of the surgeon was a crucial factor in the diagnosis. Diagnosing lateral instability was often more delicate. In this case, since the thorax prevented the limb from being placed in a position of maximum adduction, it was practically impossible to evaluate this angle. Mediolateral and craniocaudal radiographs were systematically taken with the forelimb in extension. The latter was maintained in a stressed position by applying traction to the distal end of the limb. Mediolateral views of an unstable shoulder can reveal an increase in joint space (Fig. 1A). Other associated lesions of the scapula neck and the humeral head (osteophytes along the edges of the glenoid cavity and the humeral head; formation of bone spurs and ossicles; radio-dense appearance at the biceps tendon insertion site) are sometimes observed but are not specific to instability since they are also observed in other pathologies that cause degenerative joint disease (Fig. 2). Craniocaudal views can confirm the direction of the displacement in lateral and medial luxations (Figs. 1B, 3) by revealing abnormal angulations and can show erosion of the medial edge of the glenoid cavity. Yet the depth of the glenoid is difficult to quantify precisely.

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a Rompun®, Bayer Pharma, Puteaux, France.
b Morphine®, Cooper, Melun, France.
c Atropine®, Augeuttant, Lyon, France.

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**Fig. 1** Preoperative medio-lateral (A) and craniocaudal (B) radiographs of a dog with a subluxation of the shoulder. An abnormal joint space (white arrow) is observed between glenoid cavity (a) and humeral head (b).

**Fig. 2** Medio-lateral radiograph of a shoulder with degenerative lesions and osteophytes (white arrows).

**Fig. 3** Crano-caudal radiograph of a dog with a genuine luxation of the shoulder. (a) glenoid cavity; (b) humeral head.
because it depends on the position of the shoulder, i.e. on the reproducibility of the radiographic technique. Craniocaudal views also permit the detection of lesions that are generally associated with joint instability, such as enthesiophyte production at the insertion of the medial capsule along the glenoid and the lesser tubercle, and wedge-shaped abrasions of the medial part of the glenoid.

**Treatment**

The purpose of the treatment was to reduce instability, limit recurrence and to obtain pain free movement. In our study, we considered conservative treatment for cases which were recent, non congenital, and which could be reduced and immobilized. The animal’s behaviour and its readiness to withstand having a limb immobilized were also taken into account. With such methods of treatment, the limb is immobilized in a non weight-bearing position for two to three weeks. In cases of lateral instability, a spica splint is used to maintain the limb in an extended position. In cases of medial instability, a Velpeau sling is used to maintain the carpus, elbow and shoulder in hyperflexion. If such treatment fails, or when the luxated joint cannot be reduced or immobilized, surgical treatment, either corrective or palliative, is prescribed. In this case, surgical treatment of lateral or medial instability involves the transposition of the biceps tendon. Medial transposition entails transposing the biceps tendon into a medial position, behind the lesser tubercle, so that it provides medial support for the joint by acting as a collateral ligament. After approaching the joint craniomedially, the transverse humeral ligament is sectioned and the biceps tendon is withdrawn from the intertubercular groove. The tendon is then secured in place using a U-shaped surgical staple which is implanted in such a way so that the tendon is not compressed (Figs. 4, 5, 6). A Kirschner wire (0.8 mm to 1.5 mm depending on the size of the dog) is cut to the required length and bent into a U-shape, spanning a width 1.0 mm wider than the width of the biceps tendon. One advantage of this fixation technique is that it does not completely immobilize the tendon. After transposition, the tendon is held in place and the staple is maintained perpendicular to the surface of the bone as it is driven into the bone using a mallet. The staple is driven into the bone until its edge is 1.0 mm from the biceps tendon. The mobility of the tendon is verified by manipulating the limb. Another advantage of this technique is that it is easy to perform. After plication of the capsule, the deep pectoral muscle is sutured to the superficial pectoral, the subscapularis to the deep pectoral, and the superficial pectoral to the acromial part of the deltoid. After closure of the incision, the limb is immobilized for two weeks with a Velpeau sling. The treatment of cases of lateral instability involves transposing the biceps tendon laterally with respect to the greater tubercle, the latter being resected beforehand. The joint is approached cranially, the transverse humeral ligament sectioned and the biceps tendon released. The greater tubercle is transected using a chisel which is struck at an angle of 30° to the longitudinal axis of the humerus. A groove is cut laterally to the osteotomized tubercle and the biceps tendon is fitted into the groove. The greater tubercle is then reattached using two Kirschner pins and a tension band wire (Fig. 7). Joint plication is performed and the superficial pectoral muscles are sutured to the aponevrosis of the deltoid and the biceps brachii. Postoperatively, the limb is immobilized in extension for two weeks.

In cases of recurrent surgical luxations, major degenerative damage, dysplasia of the glenoid cavity or major instability, shoulder arthrodesis using a plate is performed (Fig. 8). In uncontrollable dogs with severe instability, the risk of recurrence following tendon transposition is high once the dressing...
has been removed. In this case, arthrodesis is often the best option.

In all cases, activity is restricted for six weeks and is limited to leash walks.

**Perioperative care**

Preoperatively, all of the animals received an injection of carprofen (4 mg/kg, intra-muscularly) and an injection of morphine chlorhydrate (0.25 mg/kg subcutaneously) at the moment of induction. Postoperatively, morphine chlorhydrate was readministered every six hours for 24 hours. Carprofen was readministered orally every 24 hours for five days.

**Results**

**Populations**

The most frequently affected breed in the study population was the Poodle, accounting for 13% (10/76) of the cases. Of the 76 dogs, 80% (61/76) presented with medial instability, 18% (14/76) with lateral instability and 1% (1/76) with cranial instability. The average weight of the animals with medial instability was 19.3 kg, as opposed to 31.9 kg for animals with lateral instability. The average age of the dogs with medial instability was 4.6 years old, as opposed to 5.5 years old for dogs with lateral instability. Instability was characterized by a genuine luxation in 13% (10/76) of the cases, and by a subluxation in the remaining 87% (66/76). A traumatic origin was reported in 49% (30/61) of the animals with medial instability and in 100% (14/14) of those with lateral instability. The only case of cranial instability was associated with severe congenital dysplasia of the shoulder (Fig. 9).

**Diagnosis**

Pain was experienced in 97% (74/76) of the cases and was often elicited on hyperexten-

sion of the shoulder joint or abduction of the limb. Instability was observed on manipulation of the animals in 90% (68/76) of the cases, and was demonstrated by a positive drawer test (66/76) and/or an increase in the abduction angle of the limb (40/61 in the case of medial instability). Medial instability was diagnosed in 55 animals, with 36% (20/55) of the cases evaluated as grade 2, 51% (28/55) as grade 3, and 13% (7/55) as grade 4. In the 10 animals with lateral instability, 80% (8/10) of the cases were evaluated as grade 3 and 20% (2/10) as grade 4. When there was a lack of direct evidence of instability (8/76), the diagnosis was made on the basis of clinical presentation and the presence of radiographic anomalies indicative of instability, after excluding other possible causes of shoulder lameness. Muscle atrophy was observed in 33% (25/76) of the cases. Associated radiographic lesions were observed in 34% (26/76) of the cases.

**Postoperative follow-up**

All of the animals were followed-up clinically for at least four months and also up to four years (mean=16.5 months). Follow-up examinations were performed either by the surgeon (74% of the cases) or by the owner when the latter could not bring the animal in. When the examination was performed by the surgeon (55 dogs), the degree of instability was evaluated under sedation and always by the same surgeon who had conducted the

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4 Rimadyl®. Pfizer, Kingsway, West Dundee, UK.
preoperative evaluation. On the basis of the follow-up examinations the animals were divided into four functional-outcome categories: ‘excellent’ (not lame); ‘good’ (intermittent post-exercise lameness, disappearing following the administration of anti-inflammatory drugs); ‘average’ (frequent lameness after rest, requiring regular administration of anti-inflammatory drugs); and ‘poor’ (permanent lameness).

Treatment and follow-up examination

Four of the dogs were not treated by surgery. Functional outcome was ‘average’ in three of the dogs and ‘excellent’ in one. Surgical treatment involved tendon transposition and arthrodesis in 81% (58/72) and 19% (14/72) of the cases, respectively. Arthrodesis was opted for in animals with degenerative lesions (8/14 cases) and in cases of major instability associated with agitation (6/14 cases). The results were ‘good’ to ‘excellent’ in 84% (42/50) of the cases of medial transposition, and in 87.5% (7/8) of the cases of lateral transposition. Complications that arose as a result of the surgical intervention included one case of instability of the biceps-tendon staple, which was observed radiographically. As the functional outcome was excellent, follow-up operation was not required. One case of persistent shoulder instability, leading to a relapse to lameness, was observed and required arthrodesis two years after the first intervention. Following tendon transposition, functional outcome was ‘average’ to ‘poor’ in eight of the dogs, all of which had been reevaluated by the surgeon. In five of the eight animals the degree of instability was similar to that measured prior to surgery. Significant arthrosis was observed in three of the patients. Of the dogs on which medial transposition was performed, 67% (29/43) showed an increase in the angle of abduction prior to surgery as opposed to 23% (10/43) after surgery. Of those on which lateral or medial transposition was performed, 67% (31/46) showed a decrease in grade on direct manipulation of the shoulder.

Results were ‘good’ to ‘excellent’ in 85.7% (12/14) of the cases in which arthrodesis was performed. Of the two cases with an ‘average’ or ‘poor’ functional outcome, only one had been reevaluated by the surgeon, whose evaluation was based on the obesity of the animal.

Discussion

As borne out by the literature (1–3), our study demonstrates that medial instability occurs more frequently than lateral instability, and that it seems to be more prevalent in smaller breeds of dogs. In dogs, during movement, the scapulohumeral joint is not subjected to the same forces in every direction. Indeed, regardless of the gait, the greatest range of motion is obtained during movements of flexion and extension (20). The static stability of the shoulder is essentially afforded by the medial and lateral glenohumeral ligaments associated with the joint capsule (1, 21–23). The intracapsular mechanisms of ‘limited joint volume’ and ‘adhesion-cohesion’ observed in humans seem to be of minor significance in the static stabilization of the shoulder in dogs (24, 25). Dynamic stability is provided by the perarticular muscles, the contraction or relaxation of which accompanies changes in position. These muscles also contribute to the mechanism of concavity-compression (1, 21, 25), which reinforces the stability of the shoulder. These so-called ‘cuff muscles’ are the biceps brachii (cranial stability), the supraspinatus (craniolateral stability), the infraspinatus (lateral stability), the Teres minor (caudolateral stability) and the subscapularis (medial stability). The origin of instability is classically described as either congenital or traumatic (2). In congenital instability, the absence of a centre of secondary ossification in the coracoid, at the age of eight weeks, results in an anomaly in the development of the shoulder. Thus, ultrasonography enables the detection of effusions and synovial proliferation within the bicipital bursa, inflammatory lesions of the biceps and supraspinatus muscles, and dystrophic calcifications (26, 27). Arthroscopy permits the examination of all the intra-articular structures, i.e. the humeral head, the glenoid labrum, the glenohumeral ligaments, the biceps and subscapularis tendons (1, 7–11, 28). More re-
cently, magnetic resonance tomography has been used to conduct a comprehensive evaluation of all of the periarticular stabilizing structures (12).

The choice of surgical procedure depends on the direction and degree of instability, the age, size and level of activity of the patient, the severity of any degenerative lesions, and the presence of dysplastic lesions in the glenoid cavity (2). Conservative treatment is limited to cases of traumatic instability which can be reduced and immobilized. In the four cases of conservative treatment identified in our study, surgical stabilization had been recommended by the surgeon but the owners’ decisions were strictly based on financial considerations. This could possibly explain the average results that were observed in three of these four cases. Of the available stabilization techniques (13–16, 29–34), transposition of the biceps brachii or the suprascapular tendons was often recommended but few studies have evaluated the clinical results of these techniques (13). In our study, we elected to transpose the biceps brachii, either laterally using the standard technique described by Hohn (32), or medially using a modified version of the original technique. When performing the latter technique, the tendon is lodged in a preformed groove created in the lesser tubercle after elevation of a flap of bone. The flap is then reattached with two Kirschner wires, thereby securing the tendon to the medial aspect of the joint. This technique is difficult to perform, especially in small animals, in which there is a high risk of fracture of the flap. As such, we chose to stabilize the tendon with a metallic staple made by bending a Kirschner wire and cutting it to the required length. This was carefully driven into the bone, making sure that it did not compress the biceps tendon. Not only is this technique simple to perform but it also permits the back and forth movement of the tendon, which reduces the risk of classically described secondary lesions (36–41). In one case of persistent medial instability, shoulder arthrodesis was performed two years after medial transposition, thus permitting a macroscopic evaluation of the transposed biceps tendon. Signs of inflammation were not observed; however the tendon fibres were found to be elongated. Regarding the biomechanical consequences of tendon transposition, a study has shown that the relative incongruence observed in the immediate postoperative period diminishes as weight is brought to bear on the limb, permitting a gradual extension of the tendon (42). The functional outcomes we obtained were ‘good’ to ‘excellent’ in 84.5% of the cases of tendon transposition. These results can be compared with those obtained with thermal capsulorrhaphy as described by Cook (16), who reported improved clinical function in 93% of the cases and an ‘excellent’ outcome in 79% of the cases. While these results may be comparable to ours, Cook’s study presents a more objective evaluation of shoulder instability than ours insofar that the angles of abduction were actually measured. In our study, the essentially clinical nature of the evaluation, based to a large extent on the surgeon’s experience, diminished the objectivity of the diagnosis and constitutes an important limitation of our study. Thermal capsulorrhaphy is also much less invasive and is therefore probably less painful, and permits systematic arthroscopic evaluations of the shoulder. The technique does, however, require specific equipment and calls for more experience than that required for surgical transposition. Serious complications arising directly from the use of the surgical technique were not observed. ‘Average’ to ‘poor’ outcomes were often accounted for by persisting instability or the appearance of major degenerative lesions. It would be interesting to carry out a post-mortem histological study of the transposed tendons in order to evaluate any possible lesions resulting from the friction between the tendon and the surgical staple.

Conclusion

The surgical treatment of shoulder instability by transposition of the biceps tendon or by arthrodesis produces ‘good’ to ‘excellent’ results in more than 80% of all cases. During the medial transposition of the biceps tendon, the attachment of the latter using a metallic staple has the advantage of being simple to perform while limiting the risk of secondary damage to the tendon.

References


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