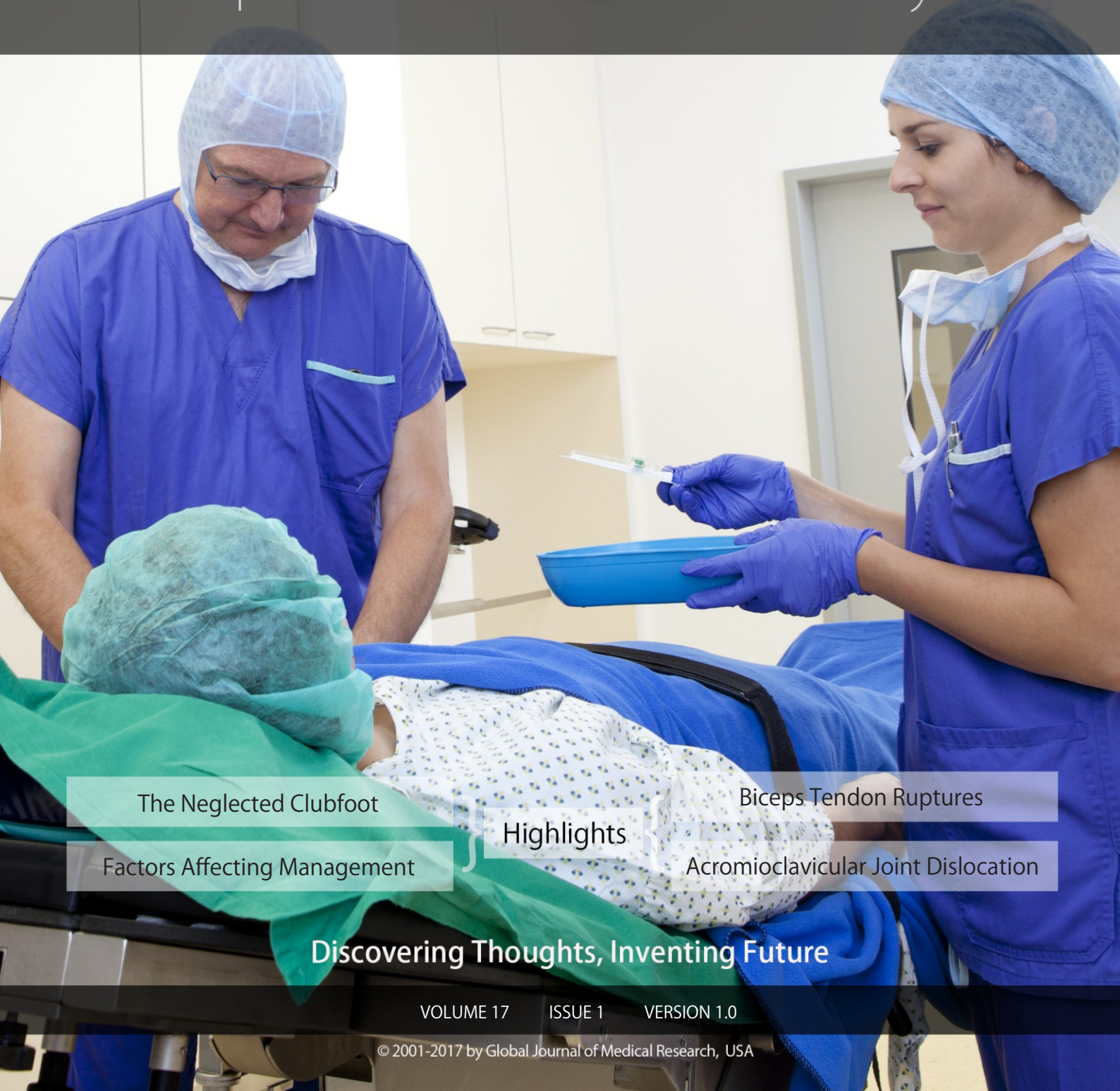


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Prognostic Factors Affecting Management of Liposarcoma

Cary Fletcher

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Abstract- Soft tissue sarcomas account for 1% of all neoplasms, with the second commonest being liposarcomas. Liposarcomas in the popliteal fossa often grows to a large size, as neither the patient nor the clinician will initially be able to palpate the tumour due to its depth in the tissues and the fact that the tumour is often low grade. Its size often does not facilitate the ability to resect the mass with wide margins. The following article discusses prognostic factors for liposarcomas with regards to histological subtype, anatomical distribution, resection margins and neoadjuvant therapy.

Keywords: *liposarcoma, prognostic factors, management.*

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Prognostic Factors Affecting Management of Liposarcoma

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Abstract- Soft tissue sarcomas account for 1% of all neoplasms, with the second commonest being liposarcomas. Liposarcomas in the popliteal fossa often grows to a large size, as neither the patient nor the clinician will initially be able to palpate the tumour due to its depth in the tissues and the fact that the tumour is often low grade. Its size often does not facilitate the ability to resect the mass with wide margins. The following article discusses prognostic factors for liposarcomas with regards to histological subtype, anatomical distribution, resection margins and neoadjuvant therapy.

Keywords: liposarcoma, prognostic factors, management.

I. INTRODUCTION

Liposarcoma is the most common histology of soft tissue sarcomas accounting for approximately 20 to 30% of all sarcomas in adults [1, 2]. Despite soft tissue and skeletal tissue being the most abundant tissue in the body, soft tissue sarcomas accounts for 1% of neoplasms [3, 4]. Prognostic features and subsequent clinical behaviour of soft tissue sarcoma are said to be associated with histology and anatomical distribution [3]. These tumours often grow to large sizes, thus their management presents major challenges [4]. The following case is presented to discuss the prognostic factors affecting the clinical behaviour of liposarcoma post limb sparing surgery.

II. CASE PRESENTATION

A 48 year old male presented to the Orthopaedic outpatient clinic with a one year history of a painless mass in the back of the right knee. This mass gradually increased in size. There was no history of numbness or weakness in the right lower limb. He denied having constitutional symptoms.

On examination, mucous membranes were pink, moist and anicteric. There was no lymphadenopathy. Significant findings were confined to the right lower limb where there was a large ill defined mass centred over the popliteal fossa. The mass was approximately 14cm by 7cm. The mass was firm, nontender, nonpulsatile, normal temperature, not attached to skin or muscle. There were no distal neurovascular deficits. CT of the chest, abdomen and pelvis were normal. MRI showed a large heterogeneous fatty mass surrounded by, but not arising from muscle measuring 24 cm by 12 cm by 8 cm. The mass was

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confined to the posterior compartment of the thigh and popliteal fossa but did not invade the knee joint. Two open biopsies returned an inconclusive result. In consultation with the patient, a wide local excision of the mass was performed (see Figures 1 and 2).



Fig. 1

Fig. 2

Histology of the excision revealed a well differentiated liposarcoma with microscopic involvement of one of the surgical margins. The Oncologists deemed it unnecessary to offer chemotherapy. The offer of radiotherapy was turned down by the patient because he was unwilling to face the potential complications of this treatment. At two years follow-up, he had shown no clinical evidence of recurrence locally or by metastasis. He was however unable to afford an MRI or CT to allow for radiological assessment of recurrence.

III. DISCUSSION

Soft tissue sarcomas are heterogeneous, malignant tumours [5, 6]. In relation to other types of cancer they are relatively rare where 5000 new cases are diagnosed yearly [7], representing about 1% of all newly diagnosed neoplasms [8, 9]. Liposarcoma constitutes about 9 to 18% of all soft tissue sarcomas, second only to malignant fibrous histiocytoma [10, 11, 12]. Liposarcomas may be defined as malignant mesenchymal tumours consisting of lipoblasts [11]. They originate in the connective tissue and their name reflects the fact that variable amounts of adipose tissue are found within the tumour [13]. Since sarcomas, in general, are very rare, there is not much literature on the prognostic factors and optimal treatment of liposarcomas [3]. Compared to other malignant tumours in the extremity, it is uncommon [14].

Liposarcomas occur mainly in adults [15, 16] with its incidence peaking between 40 and 60 years with a slight predominance towards men [11, 13]. It is much more commonly seen in Caucasians than blacks [17].

Although it occurs at any age, and at any site [8], there is a paucity of data in children due to the rarity in this group [18]. In both age groups, the thigh is the most frequent location [13, 14, 18, 19, 20], however they may also arise in the inguinal area and popliteal fossa [13, 14]. Tumours in the popliteal fossa, such as the index case, are likely to be malignant [21]. Other factors suggesting malignancy in the index case was a mass greater than 5 cm and a deep seated mass [7]. Attachments to other structures also suggest malignancy. A mass is commonly the only symptom which may grow intermittently (index case) or progress steadily [5, 20]. In comparison to other soft tissue sarcomas, liposarcomas tend to be large partially because the patient tends not to have other symptoms and they often have a deep location which may not allow the patient to appreciate the mass earlier [5, 13, 20]. Both are possible reasons why the patient's mass grew to be large.

Diagnosis of liposarcoma is now less common because of stricter diagnostic criteria. Tumours such as atypical lipoma, spindle cell lipomas and pleomorphic lipomas were all once previously categorised as liposarcoma [15]. Early diagnosis and referral to specialist centres are necessary for optimal outcome [5].

Many different typing systems have been described [1, 19, 22, 23]. The most commonly used system is Enzinger and Weiss [19, 24]. The system recognises four variants of liposarcoma: well differentiated, myxoid, round cell and pleomorphic. The importance of the histological subtypes cannot be understated in terms of being a prognostic factor [15, 24, 25, 26]. Well differentiated is the most common subtype [11, 27, 28]. They tend to arise in the limbs or retro-peritoneum in the middle aged or elderly population accounting for greater than 50% of reported cases [3, 11]. This subtype is low grade and often is grossly very large, that is, greater than 20 cm [28]. This was the subtype in the index case. Histologically it is characterised by proliferation of mature appearing adipocytes with variable numbers of atypical hyperchromatic cells either between the adipocytes or within dense fibrous septae [17].

The second most common groups are the myxoid and round cells (30-40% of all liposarcomas) which are seen in a younger population [11, 29]. Asano 2012 reviewed information on 58 patients with myxoid and round cell tumours. The median age at presentation was 46 years old (range; 18-80 years). It is felt that the myxoid and round cells types are a continuum of a single subtype [19, 24, 27, 28]. The higher the proportion of the round cell component is the worse the

outcome [19, 27], with higher rates of metastasis [24, 29]. There are two forms of myxoid tumour: The first is a well differentiated liposarcoma subtype which is similar to the well differentiated histological group, and the second form is characterised by distinctive genetic reciprocal translocation of two genes.

De-differentiation of a well differentiated subtype may be due to a clonal evolution in which local foci of other cells are found such as malignant fibrous histiocytoma [14, 28]. De-differentiated and pleomorphic subtypes accounts for approximately 5%, occurring in older patients and presenting in the limbs or retroperitoneum [11, 29]. The pleomorphic subtype is most commonly seen in patients in their fourth decade [19]. It has the worst prognosis based on disease free survival rates of 39% at ten years [24, 30], and recurs in a third of cases [24].

The lung is the commonest site of early metastasis [20, 22, 30] in all subtypes except the myxoid subtype which has a strong propensity for extrapulmonary metastasis, for example, spine, retroperitoneum and axilla [30]. Patients with the myxoid subtype require a more careful follow-up including assessment of the thorax, retroperitoneum and abdomen [30]. Dedifferentiation is associated with a 15-30% rate of metastasis and an increase risk of local recurrence and increased death risk [13, 28]. Radical excision is thus required to achieve local control plus or minus adjuvant radiotherapy [28]. The pleomorphic type is also associated with an increased risk of local and distant spread [11, 29]. The overall metastatic potential of liposarcoma therefore varies widely from 20-70% [11, 14, 24]. Comparison between studies is difficult because of small numbers of patients and the wide variety of the subtypes [30].

Histology affects subsequent clinical behaviour where low grade lesions (well differentiated) are associated with high local recurrence rates but have almost no propensity to metastasize. Poorly differentiated or high grade tumours are often clinically aggressive with a high incidence of local recurrence as well as distant metastasis [3, 12, 31]. Although the different subgroups have different clinical courses in terms of clinical features and survival outcome, current clinical practice has not been optimised according to different histological subtypes and clinical protocols [3]. Specific treatment protocols are lacking in the literature for liposarcoma other than treatment with wide resection [17]. Treatment decisions and prognosis are based on a classification system that depends on morphological and genetic features of the tumour [5, 32]. Kim et al [3] looked at defining the distinctive clinical features by assessing prognostic factors in 94 liposarcoma patients. His multivariate analysis demonstrated that histological subtype was an index prognostic factor for survival. Higher grade tumours (de-differentiated, round cell, pleomorphic) were associated with a fivefold increase in

mortality rates compared with the well differentiated subtype. Zagars et al [24] found that the most important factor influencing outcome in terms of local control, metastasis or survival rates was histological subtype. Berlin et al [33] and Lietman et al [17] found a strong association between disease specific survivorships and grade.

Despite there being the same universal guidelines in managing extremity sarcomas, management must be individualised [34]. Management however remains controversial [4]. A multidisciplinary team approach allows for streamlining the complexities and intricacies of treatment and thus providing optimal treatment [4, 34]. Goals include eradicating local disease, control of metastasis and salvaging a functional limb without compromising survival [4, 5]. Prior to the use of radiotherapy, amputation was a standard therapeutic treatment [5, 35].

Radiation has been proven to facilitate local control and when used in combination with limb sparing surgery has decreased the need for amputation [5, 6, 24]. Patients such as the index case with inadequate margins may benefit from adjuvant therapy [6]. In cases where a marginally resectable tumour is present, neoadjuvant therapy may increase the likelihood of a margin negative resection with subsequent preservation of function [34]. The potential wound complications [34] and the potential for radiation induced sarcoma which is typically seen two to three years post treatment [11] dissuaded the patient from opting for radiotherapy.

Grossly positive margins have a significantly worse prognosis compared with negative or microscopic positive margins [36]. Conversely when adequate surgical margins are achieved, local recurrence is unlikely even in high grade tumours, making radiotherapy unnecessary in these cases [33, 37]. The likelihood of local recurrence is partially related to whether the excision is marginal, wide or radical [37]. Although many studies recommended a margin of at least 2cm of gross margins around the tumour, this is usually limited by a normal critical structure [37]. Most liposarcomas in the extremity cannot be excised with a wide margin, but one should aim for at least a marginal resection [13]. Despite positive margins being a risk factor for local recurrence, overall survival is unaffected [5, 37]. This was the rationale for performing a marginal resection in some areas of the tumour in the index case. Leaving close margins near vital structures are acceptable for a limb salvage procedure [5]. Baldini et al [37] in their study of 74 sarcoma patients, 23 of which had liposarcoma, were all treated with excision alone. Six patients had positive margins. None of the six patients had local recurrence. The four patients with recurrence had histological evidence of tumour involvement less than 1cm within the resection margins. He found no relationship between recurrence and tumour grade, stage and depth, on further analysis

though the study had limited statistical power. Ribuffo et al [38] in reviewing liposarcoma in the thigh found no correlation between histological grade, surgical treatment and progression of disease. Conversely, Orson et al [31] looked at 211 cases with a mean age of 52.9 years and found a 45% variation in survival rates due to differences in histological grade, Enneking stage and tumour size. Various soft tissue reconstructive procedures have allowed for more aggressive resection leading to a lower likelihood of an intralesional resection [4, 5]. Incompletely excised tumour may be subsequently re-excised inclusive of the prior incision followed by radiation therapy [6, 14, 24]. With the index case refusing radiation therapy, he had been counselled on the need for re-excision once there is future evidence of recurrence. In the index case's favour, is the fact that no patient had demised solely to local disease in Linehan et al [12] study as microscopic margins were not a predictor of local recurrence when managed with adjuvant radiotherapy.

Sarcomas in general often appear grossly to be contained in a well-defined capsule but microscopic disease is often beyond the pseudocapsule, reactive zone, prior biopsy site scar and a cuff normal tissue via a longitudinal incision [5, 34].

Although limb sparing surgery plus or minus radiotherapy have shown good results, the role of chemotherapy remains controversial [14]. Adjuvant chemotherapy is meant to eradicate micrometastasis with the ultimate goal of prolonging time to recurrence and overall survival [17]. Lietman et al [17] performed a thorough literature search and found no randomised prospective studies analysing the effectiveness of various chemotherapy regimes, protocols or indications in the treatment of liposarcoma. Chemotherapy sensitivity varies significantly between liposarcoma subtypes with a higher response rate in the myxoid and round cell subtypes compared with the well differentiated subtype [32]. Eilber et al [39] found that ifosfamide based treatment in liposarcoma patients improved disease free survival states in patients with tumours greater than 10 cm (such as the index case) however there is little data to support use of chemotherapy in low grade liposarcoma because of their low metastatic spread potential [13].

In a 20 year retrospective review of 63 patients with liposarcoma; age, gender and tumour size were not shown to be statistically significant in terms of patient survivorship however, it was felt that the sample size was too small to make a definitive conclusion [17]. Older age was a poor prognostic factor in some studies [23, 33].

Location has been found to be an independent prognostic factor, since liposarcomas in the extremity has a better prognosis than retroperitoneal liposarcoma [12, 17, 23] despite there being a lower percentage of low grade tumours in the extremity [17].

In most soft tissue sarcomas, recurrence occurs within two years. Follow up every three months with clinical and radiological imaging via MRI or ultrasound is recommended to identify local recurrence and chest CT for pulmonary metastasis [5, 37]. If no lesion is identified, review may be six monthly after 2 to 3 years. There is as yet no clinical evidence of local recurrence in the index case. Since the adjuvant radiotherapy has been refused by the patient, he will be monitored clinically and radiologically and if recurrence occurs, re-excision will hopefully treat recurrence in this margin positive patient. Based on the well differentiated subtype, the index case is unlikely to have metastasis or mortality even if recurrence does occur. With improved understanding of patterns of recurrence in extremity liposarcoma, there will be earlier identification of subclinical metastatic disease thus allowing aggressive salvage treatment and improved overall survival [30]. Dalal et al [23] have published subtype specific liposarcoma prognostic nomograms that can efficiently integrate multiple prognostic variables which allow one to predict the probability of recurrence and death. This information is useful in counselling patients and in some cases to reassure [23]. This also allows high risk patients to be identified and undergo intense surveillance and be considered for adjuvant or neoadjuvant therapy [23].

In a very recent study, Knebel et al [40] conducted a retrospective study on 133 patients with a diagnosis of liposarcoma. The median age was 55.1 years (14-86 years). Upon analysing the data he concluded that the histological subtype, tumour size, presence of metastasis, local recurrence post resection and negative resection margins were all independent factors which determined disease specific survival.

IV. CONCLUSION

The histological subtype and resection margin status have been found to be independently associated with disease specific survival. Adjuvant radiotherapy has been found to have a bigger impact on overall survival rates as well as disease free survival, in low grade sarcomas than high grade ones.

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Surgical Management of Type III Acromioclavicular Joint Dislocation – The Biomechanical basis for Reconstruction

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Abstract- The acromioclavicular joint (ACJ) is a diarthrodial joint which is stabilized by static and dynamic stabilizers. Acromioclavicular (AC) ligaments and the coracoclavicular (CC) ligaments (trapezoid and conoid) and the coracoacromial ligament make up the static stabilizers. The dynamic stabilizers are the deltoid and trapezius muscles. The principles of various surgical techniques involve reduction of the AC joint and were historically classified into two groups: those that focus on primary healing of the CC ligaments and those meant to reconstruct the CC ligaments. Ligament reconstruction must have sufficient immediate stability to prevent acute redisplacement or be protected temporarily until the region heals. The biomechanical basis for reconstructing the CC ligaments in the management of acromioclavicular type 3 injuries is discussed.

Keywords: *acromioclavicular, dislocation, type III.*

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I. INTRODUCTION

The acromioclavicular joint (ACJ) is a robust articulation between the clavicle and the scapula. This articulation serves as a pivot point, as opposed to the sternoclavicular joint which acts as a strut. Due to the design and anatomy of the joint, it can resist a significant amount of the force prior to disruption. Numerous protocols have been devised to treat these injuries and as such, an understanding of the anatomy and biomechanics of the ACJ is important in order to choose the appropriate option for treatment [1]. The following case is presented in order to discuss the biomechanical basis for reconstruction of the coracoclavicular (CC) ligaments for type III ACJ dislocations in patients with an appropriate surgical indication.

II. CASE REPORT

A 60 year old male was riding a bicycle on an asphalted road when the front wheel got trapped in a fissure on the road. He was thrown forwards and landed directly onto his left shoulder. He experienced immediate pain, swelling, and deformity of his left shoulder. Medical attention was sought the same day. He was diagnosed as having a Type III left ACJ dislocation and managed conservatively. He was unhappy with the appearance of the shoulder and complained of an inability to perform overhead activities

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on the job. His occupation at the time of injury was a construction worker. After five weeks of conservative management, he was referred for operative management.

On examination of the left shoulder, there was an obvious deformity, no tenderness, no distal neurovascular deficits or pain during range of motion (ROM) (see figure 1).



Fig. 1

The ROM was decreased in all directions secondary to weakness. He had grade 4 power in all directions. Radiographs confirmed a Type III ACJ dislocation (see figure 2).



Fig. 2

He was taken to the operating theatre seven weeks post injury. A bra strap incision was made and the ACJ was exposed followed by the coracoid process.

The meniscus was excised. Semitendinosus graft was harvested from the ipsilateral lower limb (see figure 3).



Fig. 3

Two drill holes were placed in the clavicle directly superior to the coracoid process. The semitendinosus autograft was wrapped around the coracoid process and passed through the drill holes in a figure eight configuration post reduction. The graft was sutured onto itself and reinforced with 1.0 vicryl suture which acted as a biological fixation (see figure 4).

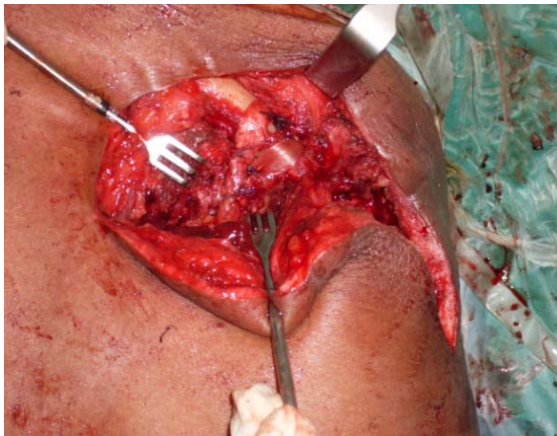


Fig. 4

Postoperatively he was placed in a broad arm sling for six weeks. Pendulum exercises were commenced at two weeks followed by light activities of daily living at four weeks. At eight weeks, active ROM exercises were commenced. He had no pain, and no difficulty performing overhead activities or performing activities of daily living when he was evaluated 18 months after surgery. Ironically, his radiographs revealed a partially reduced ACJ at that time. (See figure 5).



Fig. 5

III. DISCUSSION

The ACJ is a diarthrodial joint, formed by the medial aspect of the acromion and the lateral end of the clavicle. The joint is surrounded by a capsule with synovium and an articular surface made up of hyaline cartilage containing an intra-articular meniscus type structure [1, 2].

ACJ injuries account for approximately nine percent of all shoulder injuries. About 43.5% of the cases occurs in adults in their twenties and are five times more common in males [1]. The incidence is approximately three to four per 100,000 [3].

Transmissions of forces from the appendicular skeleton to the axial skeleton as well as suspending the upper extremity are the primary functions of the ACJ [2]. The ACJ is stabilized by static and dynamic stabilizers. The superior, inferior, anterior and posterior acromioclavicular (AC) ligaments, the CC ligaments (trapezoid and conoid) and the coracoacromial ligament make up the static stabilizers. The dynamic stabilizers are the deltoid and trapezius muscles [1]. The AC ligaments form a strong complex which reinforces the capsule [2]. Serial sectioning of the ACJ ligaments demonstrates that the superior ligament contributes 56% and the posterior ligament contributes 25% of the resistance to posterior displacement of the clavicle [1]. The inferior AC ligament is the major restraint to anterior translation [4]. The CC ligaments perform two major functions. Their attachments between the clavicle and the scapula allow these ligaments to guide synchronous scapulohumeral motion. The other major function is to strengthen the AC articulation [1].

AC joint injuries were classified into three types by Tossy et al [5]. This was later expanded by Rockwood [6] in 1984, to include type IV to VI. Type I is an AC ligament sprain with an intact joint. In type II, AC ligaments are torn but CC ligaments are intact. Type III which the index case suffered, represents torn AC and CC ligaments with 100% superior ACJ dislocation. In type IV, there is complete dislocation with posterior displacement of the distal clavicle into or through the trapezius muscle. Type V is an exaggerated superior



dislocation of the AC joint between 100% and 300% in which the deltotracheal fascia is disrupted. Type VI is a displaced distal clavicle into a subacromial or subcoracoid position [6].

Lee et al [4] suggested that the CC and AC ligaments should be considered for reconstruction to restore normal joint function. The AC ligaments are the primary restraints to posterior and superior translation of the clavicle initially [7]. The conoid ligament is the primary restraint to superior translation (62%), though the AC ligaments remain the primary restraint to posterior displacement [7]. The primary restraint to compression of the AC joint is the trapezoid ligament [7]. Fukuda [7] stated “if maximum strength of healing after an injury to the AC joint is the goal, all ligaments should be allowed to participate in the healing process.” That statement was the basis for some authors to perform reconstruction as their primary surgical treatment [1].

The shoulder suspensory complex is composed of the superior glenohumeral ligament, coracoid process, CC ligaments, the distal clavicle, AC joint and the acromion. Damage to part of this complex must also produce disruption of another portion of the osteoligamentous ring. Types III to VI fall in this category of double disruption [8].

Dislocation of the AC joint usually results from direct trauma (such as the index case), but may occur with indirect trauma. The usual mechanism is a force applied to the shoulder with the arm adducted [2]. Chronic symptoms may occur after minor or severe injuries to the AC joint but more commonly in association with higher levels of disruption [9].

The management of Type III AC joint dislocation remains controversial, with a trend towards non-operative management [2, 9, 10, 11, 12, 13, 14]. The natural history of untreated AC joint dislocations Type III suggests that the majority of patients do well without formal treatment; however a small percentage such as the index case, require delayed surgical intervention [11]. The index case had reduced function as evidenced by an inability to perform overhead activities on the job as well as he was unhappy about the shoulder deformity. Bannister [12] noted that patients treated non-operatively had earlier return to work or sports and regained motion faster. Some authors reserve operative management for high level pitchers, open injuries, brachial plexopathy or severe Type III dislocations [2]. Surgery also has a role in patients with failed non-operative management such as the index case [2, 9, 15]. Schlegel et al [11] noted weakness during bench press and questioned this influence on patients who are manual labourers or weight lifters. Guy et al [16] noted that manual labourers often had residual chronic aching and shoulder weakness. Some authors therefore advocate that patients with high functional demands such as the index case should be treated surgically [16].

In contrast to this, Fremerey et al [14] concluded that being a labourer was not a surgical indication because there was no difference in pain and weakness between their surgical and non-surgical groups, but their numbers were small. The patient being a manual worker was one of the considerations taken into account when surgery was offered to him.

The choice of the best operative technique is controversial [17]. The multiplicity of procedures and lack of a generally accepted method of operative treatment suggests the various techniques carry a substantial risk of resubluxation [17]. The aim of treatment is to return the patient to the level of function before injury, with a pain-free, strong and mobile shoulder [9]. This was achieved in our index case despite not achieving a perfect radiological result.

The principles of the various surgical techniques involve accurate reduction of the AC joint [9]. Operative treatments were broadly classified into two groups: those that focus on primary healing of CC ligaments and those meant to reconstruct the CC ligaments [18]. Reconstruction is performed to mimic normal joint restraints and must have sufficient immediate stability to prevent acute redisplacement [9].

Older surgical techniques include the standard Weaver-Dunn, modified Weaver-Dunn, coracoclavicular suture, AC ligament repair, cerclage slings, screw fixation and free graft reconstruction of the coracoclavicular ligament complex with or without distal clavicular resection (1). The hook plate was subsequently developed to avoid using native tissue for reconstruction [19]. Repair is technically difficult in terms of the surgical access and the structural integrity of the repaired ligament alone is questionable [9].

The standard Weaver-Dunn technique which involves transferring the coracoacromial ligament to reconstruct the coracoclavicular ligaments was initially the most popular procedure, however it has been associated with residual symptoms and unacceptable resubluxation rates. This led to the development of research in evaluating this procedure and the development of newer reconstructive techniques (1). Costic et al (4) performed cyclic loading followed by a load to failure protocol of the normal CC ligament complex in cadavers. This was repeated for an anatomic reconstruction in the same specimen, consisting of ST tendon which replicated the direction and orientation of the trapezoid and conoid ligaments. He noted that although the ST anatomic reconstruction demonstrated a significantly inferior stiffness and ultimate load to failure compared with intact CC ligaments, the stiffness characteristics were much better than the standard Weaver-Dunn procedure (4). The role of the coracoacromial ligament includes prevention of superior migration of the humeral head as well as anterior and inferior instability [20]. Transfer of this ligament may take away its native function to perform another function and

Lee et al [18] felt that transfer should not be done indiscriminately. Coracoacromial transfer is said to fail at small loads during cyclical loading [17].

Modified Weaver-Dunn techniques which augmented the coracoacromial transfer was found to be biomechanically superior to the standard Weaver-Dunn in terms of stability and pullout strength, but none of the techniques restored the AC joint back to normal [21]. In the modified Weaver-Dunn technique, suture, tape, or a screw is used to keep the acromioclavicular joint reduced while the transferred ligament heals [22]. Numerous complications including hardware migration, coracoid or clavicular fractures, infection and fixation failure have been reported [22]. The modified Weaver-Dunn procedure also placed the clavicle in a non anatomic position [22]. Aseptic foreign body reaction or infection has been associated with the use of synthetic suture and implants [23]. The hook plate may be used to augment soft tissue reconstruction or may be used in isolation. Unfortunately, it has also been associated with infection, plate dislocation and becoming bent [19]. When an autologous graft is used, there is no risk of foreign body tissue reaction to synthetic materials. Potential complications of implants are avoided and a second operation for removal of hardware is unnecessary [24].

The search for stable and anatomic CC reconstruction techniques has resulted in using free tendon grafts [25].

Reconstruction of the injured ligaments offers a biological option by getting incorporated into living tissue [17]. If an auto graft is selected, donor site morbidity may occur [17, 18]. Donor site morbidity is uncommon however [25, 26]. Allograft has been used in acute and chronic cases with excellent functional results [27]. Anatomic reconstruction with semitendinosus allograft has been shown in a cadaver study to be biomechanically superior to non anatomic allograft reconstruction, anatomic suture fixation, graftrope reconstruction and the modified Weaver-Dunn techniques [26]. If allograft is used however, disease transmission may occur [17].

Lee et al [18] found that reconstruction with semitendinosus (ST), gracilis or long toe extensor grafts had superior initial biomechanical properties compared with coracoacromial ligament transfer during non-cyclical loading. There were no differences in strength and stiffness noted between the three graft choices [18].

Semitendinosus reconstruction does not require the use of the coracoacromial ligament allowing it to maintain its function as a humeral head stabiliser. It does not rely on native ligaments to heal and may promote earlier aggressive rehabilitation and earlier return to work [17]. The strength of the reconstruction plus the primary healing of the torn native CC ligaments may yield a higher strength than any of the repairs that rely on primary healing alone [18].

Lizaur [28] emphasized that repair of CC ligaments had no bearing on the final stability of the clavicle. He deemed that repair of the deltotrapioid muscle complex is an important surgical adjunct.

Ceccarelli [10] performed an extensive literature search on the management of Type III injuries. He found that there were an inadequate number of randomised controlled trials or complete systematic reviews. Studies lacked validated outcome measures and comparison between the few randomised controlled trials was not possible. He felt that there was no overwhelming evidence to offer surgery as first line treatment of these injuries (10). It is difficult to analyse the numerous studies over the past three decades which lack prospective designs and compare multiple treatments [11]. The decision to use a given method of treatment is often based on dogma and anecdotal experience [11].

Stiffness of the CC suspension is the determining factor for good functional outcome. The ST graft offers more stability with significantly less amount of CC displacement under stress loading, resulting in better clinical outcome [26]. The expanding body of biomechanical studies to date supports individual reconstruction of the CC and AC ligaments [26].

Domos et al (29) in a 2017 study conducted a survey amongst UK Orthopaedic surgeons collecting 137 responses in 3 months. They all opted for initial conservative management with 86% of the responders ordered commencing of routine physiotherapy. Pre injury demands, current pain and disability were considerations for converting to surgical management. The lockdown technique was the most common technique used. For acute cases, the next commonest procedure was ligament augmentation and reconstruction system, the hook plate, then the arthroscopic tightrope technique. These techniques which uses a foreign body, allow for an accurate reduction of the ACJ, without the donor site morbidity associated with using autogenous grafts.

Korsten et al (30) underwent a critical appraisal of eight articles after doing a systematic literature review. Subjective and objective shoulder function was superior in the operative group, especially in young adults, but the complication rates in conjunction with radiographic abnormalities were higher. The rehabilitation time was shorter in the conservative group; but there were inferior cosmetic results. Korstens' conclusion was that there were no major differences in outcome between operative and nonoperative cases.

IV. CONCLUSION

The literature remains ambiguous as to the superiority of surgical management over conservative management for Type III ACJ dislocations. However, reconstruction may provide excellent function and patient satisfaction with appropriate patient selection.

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Management of Distal Biceps Tendon Ruptures

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Abstract- Distal biceps tendon rupture is a fairly uncommon injury but the incidence has risen with the associated increase in recreational activities in the 40 to 60 year old age group. The injury usually occurs from a single traumatic event whereby there is a forceful eccentric contraction of the biceps in the flexed elbow. Management considerations include conservative versus surgical management, and if surgery is chosen, the surgical approach: one-incision versus two-incision, and the choice of fixation technique which includes: suture anchors, bone tunnels or the endobutton. Surgery is indicated in patients who require maximum flexion and supination strength for vocational and recreational activities. The following article discusses the evolution of surgical management and the complications associated with the one and two incision approaches.

Keywords: *distal bicep, rupture, tendon.*

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I. INTRODUCTION

Surgical repair is the treatment of choice for younger, more active individuals who have rupture of the distal biceps tendon. Surgery allows for restoration of anatomy, which gives the best chances of regaining full elbow flexion and forearm supination (1). Surgery has evolved from a non-anatomic approach to an extensile single incision to a two-incision technique to a modified one-incision technique (2, 3).

II. DISCUSSION

Rupture of the distal biceps brachii tendon is an uncommon injury (4, 5, 6, 7). The incidence of the injury has been calculated at an average of 1.24 per 100, 000 people (8). As populations get older, with an increasingly active lifestyle, this incidence is likely to increase (9). It occurs mainly in the 40 to 60 age group (5, 6, 10) and its occurrence in females is very rare (4, 5, 8).

Injury tends to occur during intentional lifting or reaching activities (6, 8). It has been speculated that an individual is more likely to use their stronger dominant extremity for strength or support which accounts for the higher incidence in the dominant arm (8, 10). The classic mechanism of injury involves a single traumatic event to a flexed arm causing forceful eccentric contraction (4, 5, 10, 11) The patient then experiences an acute episode of sharp pain, followed by a dull aching pain. Ecchymosis and change in the muscle contour are often present and there is a hollow in the antecubital fossa compared with the contra-lateral elbow (4, 5, 10, 11, 12). Elbow flexion weakness may be

subtle, but forearm supination may be more dramatic (4, 5, 10).

Most complete ruptures occur at the radial osseous insertion of the tendon. A few cases involve the musculotendinous interval (10). A detailed understanding of the distal biceps anatomy is necessary to anatomically repair tendon ruptures and re-establish normal tendon kinematics (10). The long and short head of the biceps are innervated by the musculocutaneous nerve, the distal biceps tendon spirals in a predictable manner. The twisting is said to aid in supination. The posterolateral fibres insert superiorly on the bicipital tuberosity and the anteromedial fibres insert inferiorly (13). Thus, the short head attaches inferiorly on the tuberosity and the long head attaches superiorly (10, 13). Kulshreshtha et al (13) proposed that the significant factor responsible for deficits in strength and range of motion is the failure to reproduce the complex arrangements of the tendon fibres.

Areas of interest with regards to managing these injuries include:

1. Conservative versus surgical management.
2. The surgical approach: one-incision versus two-incision.
3. Choice of fixation technique: suture anchors, bone tunnels or endobutton (14).

Operative treatment is indicated in the active patient, especially in light of the inferior results yielded with conservative treatment (12, 15, 16) including the decreased ability to use a screwdriver or baseball bat (5, 16). Some patients do achieve acceptable function, if they are low demand. These patients do not notice functional deficiencies such as an inability to perform repetitive elbow flexion and forearm supination activities as well as loss of endurance (4, 5). Contra-indications to surgery include: patient unwilling or unable to comply with rehabilitation, unwilling to undergo reconstruction, medical illness which preclude surgery and injuries which limit function of reconstructed upper extremity (4). Surgery is indicated in patients who require maximum flexion and supination strength for vocational and recreational activities (11, 17).

The original description of the surgical repair of a distal biceps tendon rupture was in 1898 (18). Numerous modifications have evolved with the goal of minimizing incision length and number of incisions, while minimizing complications (18). Historically non-anatomic repairs (where the biceps tendon is not reattached to the radial tuberosity) have been described, in which the biceps tendon was tenodesed

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to the brachialis. The procedure provided relief in terms of antecubital fossa pain and is technically easy to perform (4). Tenodesis to the brachialis was developed to avoid nerve injury (18, 19). It has been found to be a suboptimal procedure in the majority of patients who require supination strength and endurance (4, 6, 16). Surgical techniques have evolved from a nonanatomic approach to a two-incision approach to newer one-incision techniques including suture anchors, cortical buttons and interface screws (3, 20). The ideal biceps tendon repair ought to have high fixation strength, allow minimal gap formation and maintain mechanical stability until solid healing occurs (19, 21). Ideally the procedure should be easy, have a low complication rate, and allow for immediate elbow flexion and extension and forearm pronation and supination (21). Currently, the two most commonly used techniques involve anatomic attachment of the biceps tendon onto the radial tuberosity using either a one or two incision approach (18, 19). The clinical decision as to whether to perform a single or double incision has evolved over time (10). The surgeon now must choose between a single anterior incision and a modified two-incision technique (10). Reinsertion of the bicipital tendon in the radial tuberosity has been shown to give the patient the best functional outcome when compared to other treatment options (16, 15, 21, 22). Despite the description of several repair methods, using one or two-incisions, each technique has been associated with complications (18, 19, 23).

Earliest anatomic repairs were performed using a single extensive volar incision (9, 12, 20, 24). Extensive dissection was required to perform fixation techniques using mersilene tape, sutures or screws with plastic washers (5). This wide exposure of the radial tuberosity caused an increased risk of iatrogenic injury to the radial nerve (9). The most dreaded complication of distal biceps tendon repair is injury to the posterior interosseus nerve, where loss of function results in an inability to extend the digits (23). Luckily most are neuropraxias which resolve in less than eight weeks. To reduce this complication rate, the dissection to the tuberosity should be done with the forearm in supination, to get the nerve lateral to the plane of dissection (23).

The two-incision technique described by Boyd and Anderson (20) was introduced in order to reduce the incidence of neurological injury which was associated with the extensile volar approaches. In this technique, the tendon which is identified via the volar incision is reattached to the radial tuberosity which is exposed via the dorsal approach (20). Silk is sutured into the tendon and passed through drill holes and tied (20). The Boyd technique and its subsequent modifications have been found to be effective in restoring ROM and strength thus allowing return to premorbid function (9). Moosmayer et al (22) however

stated that in using the Boyd technique, they endorsed the procedure, but stated that one should expect a slight decrease in strength and ROM. Although Boyd's technique had decreased the incidence of nerve injury, an increased rate of heterotopic ossification (HO) and radioulnar synostosis (25, 26) was associated with this surgery.

Heterotopic ossification is one of the most feared complications of repair of distal biceps tendon rupture as it may result in complete loss of forearm rotation in severe cases (23). Heterotopic ossification is much more common following 2-incision techniques than 1-techniques (23). Kelly et al (26) stated that radioulnar synostosis is the most frequently expressed concern of the 2-incision approach. Motion limiting HO may be caused by damage to the proximal portion of the interosseus membrane, haematoma formation between the ulna and the radius, bone debris in the surgical area and stimulation of the ulna periosteum (25). In an attempt to reduce HO rates associated with Boyd's technique, Morrey et al (15) modified this technique by avoiding subperiosteal dissection of the ulna. They instead used an extensor muscle splitting approach. Other recommendations included wound drainage to reduce haematoma formation and to avoid spreading of bone dust (15). Kelly et al (26) adopted these recommendations and had no cases of synostosis. Exposure of the ulnar periosteum may contribute to radioulnar synostosis (5, 14, 26). Austin et al (14) noted that patients with synostosis tended to have scars near the ulnar crest and thus must be avoided. Cil et al (27) had two out of twenty one patients with HO and no cases of proximal radioulnar synostosis which he attributed to minimal posterior dissection and the use of two mini incisions. Following Morrey et al (15), Bourne further modified the two-incision technique by using a blunt, curved haemostat to pass the tendon down the original tunnel to the posterolateral surface (28). Once the haemostat is palpated, the second incision is made over the instrument tip. Bourne (28) felt that his modification also reduced the rate of HO. Despite various modifications to the original two-incision technique, HO still occurs in muscle splitting techniques and in rare cases, after single incision which suggests a multifactorial aetiology (23).

The two-incision technique was introduced in an attempt to avoid neural injury has not totally eliminated this problem (23, 26). Kelly et al (26) had an eight percent rate of neural injury, where the lateral antebrachial cutaneous and superficial radial nerves were the most frequently injured. Both are at risk laterally when a long Henry incision is used anteriorly (26). All surgical techniques require an anterior incision in the antecubital flexion crease to retrieve the distal biceps tendon (23). Dissection through soft tissue requires identification and protection of both nerves. The repaired tendon sheath must pass deep to the nerve. Inadvertent

injury or excessive retraction may cause painful neuroma or paresthesias down the anterolateral aspect of the forearm (23). Kelly et al (26) also noted that no nerve injuries occurred with a small anterior incision and recommended the anterior incision to be 2.5 – 4.0 cm to avoid nerve injury. Moosmayer et al (22) using the conventional Boyd technique had two out of nine cases with deep branch of the radial nerve palsy. They theorized that this was due to compression of the nerve between the Homan retractor and the radius in the dorsal incision and advised that no soft tissue should be interposed.

Austin et al. (14) concluded that the two-incision technique has a low complication rate with the majority of complications resolving early and completely. He felt patient specific variables do not appear to be associated with the rate or type of complications. D'Arco et al. (17) controlled for hand dominance and found no difference in return to pre-morbid activity levels and radiographic findings when comparing conventional with the modified Boyd-Anderson technique, thus deeming both techniques as efficacious for repair of distal biceps tendon ruptures.

Kelly et al (26) found that when repair was performed greater than ten days post injury, overall complications increased from 22% to 41%. This is attributed to the increased anterior dissection needed to identify the bicipital tunnel and to mobilize the retracted tendon. Kelly et al (26) concluded that the two-incision technique is safe when done early with limited anterior dissection. Austin et al. (14) noted a 24% complication rate in 84 patients who underwent a modified Boyd approach with the vast majority resolving spontaneously. There was one re-rupture in this series and they found one other case in his literature review. Cil et al (27) noted no re-ruptures despite early active ROM following a modified mini two-incision distal biceps repair. Both methods are strong enough to withstand current rehabilitation protocols (21).

Recently the more favoured surgical approaches to repair distal biceps tendon rupture are the two-incision modified Boyd-Anderson technique or the limited single anterior incision using suture anchor fixation (18).

The increased popularity of suture anchors have coincided with several new technique for repair, all of which have been found to provide adequate fixation while ensuring excellent outcomes with minimal complications (9, 12, 28). These newer techniques have simplified the single incision volar approach (12). Of the single incision techniques, suture anchors are the most widely used (9).

Chronic cases have tissue atrophy, scar formation and tendon retraction which may limit direct repair and necessitate graft use e.g. free tendon autografts such as semitendinosus, flexor carpi radialis, palmaris longus, fascia lata or allograft Achilles tendon

(4, 6, 7). The presence of an intact laceratus fibrosus is more important than chronicity as there is little tendon retraction if this is intact (4). Despite these factors, the surgical approach to a chronic distal biceps tendon rupture is similar to that of an acute injury (4). The lateral cutaneous nerve may become entrapped within reactive inflammatory tissue, thus special care during dissection is mandatory (23). Despite this risk, Rantanen & Orava (6) advocated anatomic repair in chronic cases because they had only one nerve injury, which had caused lengthy deficit, in 147 cases in their review which included both single and two-incision techniques.

With increasing demands of middle aged patients, surgical techniques continue to be refined to optimize outcome with the shortest return to activity (3). The recent literature focuses on new techniques along with biomechanical studies comparing these methods (3). The introduction of suture anchors for distal biceps rupture has led to the Orthopaedic community coming full circle with there being a renewed interest in the anterior single incision approach over the past few decades (10, 12, 24). Use of suture anchors may obviate the need for a second incision and has limited the need for extensive dissection, but still requires meticulous preparation of the tissues and sound anatomical knowledge (6, 12, 19). Although the approach does not dictate the fixation method used, transosseous suture fixation is typically combined with the two-incision techniques, whereas alternative fixation methods such as the suture anchor or the endobutton technique are combined with the one-incision technique (18).

Suture anchors are an attractive alternative to bone tunnels via the two-incision approach for surgeons who prefer the one-incision technique and are uncomfortable doing a single incision bone tunnel. Although biomechanical studies, in general, have not favoured suture anchors, they do not disprove their clinical usefulness (9). The goal is limited dissection and avoidance of complications seen with the two-incision techniques (9). Despite this apparent biomechanical disadvantage, Limpisvasti & Singer (29) via a five cm anterior approach utilizing three suture anchors (or two if the tendon is small) in their primary repairs and four flexor carpi radialis reconstructions, found no clinical signs of residual weakness nor functional impairment. The most common complication was transient neuropraxia of the lateral antebrachial cutaneous nerve.

In literature reviews of biomechanical studies, they found that the endobutton considerably performed better than other repair methods, but the minimum load and stiffness necessary for a satisfactory outcome are not known (21). In the clinical portion of their review, most patients had suture anchors or transosseous repairs and their conclusion was that it allows for a more cosmetic result, decreased blood loss and decreased surgical time. Those who favours the modified two-

incision approach argue that exposure of the radial tuberosity are safer and easier and gave better functional outcome (24). Numerous studies have reported success with using single incision and double incision techniques (24). Only one study prospectively reviewed both techniques (30). Nine patients underwent a single incision; ten underwent the modified Boyd and Anderson technique. At one year follow-up the one-incision group gained more flexion (142.8 versus 131.1°). There were 44% complications with one-incision, as compared with ten percent complication rate with a two-incision technique, however most were transient paraesthesias. The differences between the groups were relatively minor with the two-incision group showing more rapid recovery of the flexion strength. Chavan et al (21) in his literature review found no difference in overall complications between the two-techniques but found a significantly higher incidence of forearm rotational loss with the two-incision approach and a significantly greater number of unsatisfactory results with the two-incision technique. Frequently authors fail to state in their description of either the one or two-incision technique, the difficulty in attaining exposure of the operative site while maintaining correct forearm and elbow position. The surgeon may need one or two dedicated assistants to carry out these procedures successfully (11).

Boyd and Anderson's approach have almost eliminated HO and radio ulnar synostosis whereas suture anchors significantly decreased the risk of iatrogenic nerve injury during a single incision approach (10). There is no clinical evidence indicating superiority between the various fixation methods (10, 14, 24). A randomized prospective study is required to demonstrate superiority of one technique versus the other (24). Regardless of the type of incision or fixation used, the aim of anatomical surgery is to promote tendon ingrowths into the bone. However, it is not known if early active or passive range of motion delays or facilitates tendon reattachment to bone at the repair site (27). There is little consensus on the rehabilitation guidelines after distal biceps tendon repair (27, 31). Commonly used rehabilitation protocols in the post operative period including protecting the repaired tendon, preventing elbow stiffness and adaptation to one handed activities of daily living. The period of immobilization varies between one and six weeks with most authors emphasizing immobilization for two to three weeks followed by passive ROM especially during elbow flexion and forearm supination (27). Cil et al (27) did the first clinical study to examine the ability of a two-incision suture repair to withstand early active motion. Although full elbow flexion strength is fully achieved, full supination strength is often not achieved after single or double incision techniques. This may be due to difficulty in achieving anatomic restoration of a more pronated foot print using a single incision.

A two-incision technique offers good visualisation but evaluation of the trough for the tendon reinsertion limits the pulley or cam effect of the bicipital tuberosity, thus reducing supination moment arm (27). Amin et al in a study published in 2016, conducted an extensive systematic meta-analysis of the complications following the single-incision versus the double- incision approach. Eighty-seven articles were included, and it was noted that the lateral antebrachial cutaneous nerve neuropraxia was the most common complication in the single-incision group (9.8%) and heterotopic ossification was the most common complication in the double-incision group (7.2%). They found that rerupture rates were higher in the single-incision group in addition to the expected higher rates of nerve injury.

III. CONCLUSION

When reviewing the clinical evidence in the literature, the data demonstrates good to excellent results with both procedures. The literature is leaning towards more favourable results in the double-incision technique however surgeon preference, training and comfort level with the approaches will influence the surgeons' decision as to which technique to use.

Declaration of conflict of interest

There are no financial, institutional and personal relations that could potentially bias the information presented above.

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The Neglected Clubfoot

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Abstract- The neglected clubfoot is an uncommon condition in the developed world that has not been clearly defined in the literature. The condition is more common in the developing nations as a result of lower detection rates early in life for various economic and cultural reasons. In addition to the physical, social and financial burden which often occurs, there is a psychological component that must be addressed prior to commencing orthopaedic management. When left untreated beyond walking age, the weight bearing on the side of the foot worsens the deformity in addition to the worsened contractures due to increased contractile elements in the soft tissues. Treatment traditionally started with casting utilising the Ponseti technique followed by extensive open surgery which may entail soft tissue procedures plus or minus bony correction. Bony procedures involving osteotomies often result in an obviously shortened foot and may be associated with skin necrosis, psuedoarthrosis, infection and vascular damage. These procedures are also not uncommonly associated with pain, weakness, and stiffness of the foot and ankle postoperatively.

Keywords: clubfoot, neglected.

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The Neglected Clubfoot

Cary Fletcher

Abstract- The neglected clubfoot is an uncommon condition in the developed world that has not been clearly defined in the literature. The condition is more common in the developing nations as a result of lower detection rates early in life for various economic and cultural reasons. In addition to the physical, social and financial burden which often occurs, there is a psychological component that must be addressed prior to commencing orthopaedic management. When left untreated beyond walking age, the weight bearing on the side of the foot worsens the deformity in addition to the worsened contractures due to increased contractile elements in the soft tissues. Treatment traditionally started with casting utilising the Ponseti technique followed by extensive open surgery which may entail soft tissue procedures plus or minus bony correction. Bony procedures involving osteotomies often result in an obviously shortened foot and may be associated with skin necrosis, psuedoarthrosis, infection and vascular damage. These procedures are also not uncommonly associated with pain, weakness, and stiffness of the foot and ankle postoperatively. The trend is now moving towards more minimally invasive distraction in order to minimise the morbidity mentioned previously, and to achieve a painless plantigrade functional foot. The following article discusses the evolution of the management of the neglected clubfoot.

Keywords: clubfoot, neglected.

I. INTRODUCTION

Congenital idiopathic club foot is a complex deformity occurring in a child that is otherwise normal [1]. There are four components to this deformity: forefoot adductus, cavus, hindfoot varus and ankle equinus [2]. The literature lacks of a formal definition for the neglected clubfoot, however it may be considered in any patient presenting for treatment after 3 years of age [3].

Patients often undergo extensive corrective surgery which results in complications and disturbing failures [2]. Revisions are required more commonly in this population [2]. Despite the foot improving cosmetically post surgery; it is commonly stiff, weak and painful especially after adolescence [2].

II. DISCUSSION

Congenital equinovarus (CTEV) or clubfoot is the commonest congenital anomaly which presents to a paediatric orthopaedic surgeon, and is the commonest congenital condition resulting in loco motor disability [3]. Clubfoot is a complex foot deformity which requires dedicated efforts from both the parents (of younger patients) and the surgeon to achieve correction [2]. The

anomaly occurs in the 3rd month of intrauterine life and is characterised by dysfunction of the posterior and medial aspects of the lower leg, ankle and foot [4]. The muscles are smaller and there is increased collagen synthesis resulting in fibrosis in the posteromedial tarsal ligaments, deep fascia, Achilles tendon and tibialis posterior tendon [4]. Treatment is ideally commenced as early as possible and the patient followed closely [2, 5].

Untreated CTEV beyond early childhood is rarely seen in developed countries [6, 7, 8], but is a common occurrence in developing nations [9, 10]. There are a number of reasons for its high prevalence in the third world. Delayed presentation may be due to a failure of detection in the first two years of life because of lack of Orthopaedic surgeons and technicians in the country [11, 12]. Shortage of materials during management and ethno cultural beliefs are other factors [11]. In these countries, patients often come from rural areas where they present late to the hospitals which are located in the city due to travelling distance [12, 13]. In this setting, patient disability may lead to worsening of poverty to the entire family, because the mother has less time to look after siblings and has less time for economic activities or domestic activities [14]. Lourenco and Morcuende [1] stated that in Brazil, many of these children are unable to socialise because of stigmatisation. He also noted very long waiting lists for elective surgery due to a limited health care budget hence causing several children to have this untreated beyond walking age.

In addition to the physical, social and financial burden, there is a psychological component which should be addressed prior to commencing orthopaedic management [10]. This includes a comprehensive discussion about the treatment and the expected results with the patient and family [10] as both parents and the patient are prone to psychological trauma [9].

In the normal foot and ankle, the tibiotalar joint is a hinge whereby the talar dome rotates in the sagittal plane within the mortise [7]. Talar movement is dependent on ligamentous attachments to the calcaneous and navicular as there are no muscular attachments [7].

In a cadaveric study, Windisch et al [15] found that external tibial torsion was less in this population. The anterior and middle facets of the calcaneus are normal; however the posterior facet is in an anterolateral position in severe cases. The posterior facet is under severe biomechanical forces in that position [15]. The

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talar head becomes conical; the neck is angulated medially, while the medial aspect of the head articulates with the navicular [6]. There is also medial subluxation of the calcaneocuboid joint [6]. The abnormal articulations of the talonavicular and calcaneocuboid joints are partially due to the abnormal talus head/shaft angle of less than 45° [6]. Tension in the triceps surae and absence of the close packed position of the subtalar joint allows the calcaneus to move laterally under the talus which changes the length of the calcaneofibular ligament [15]. Primary contractile forces acting on the soft tissues cause progressive worsening of bony deformities. The medial tissues in particular will undergo significant contraction and as the deformity progresses, there is decreased remodelling potential [6].

Beyond age two years, foot contractures tend to appreciably worsen [11]. The deformities of CTEV worsen when the child commences walking because weight bearing occurs on the side of the foot [6]. Herold and Torok [10] found that prolonged weight bearing accentuated mainly forefoot adduction and tibial torsion. Thickened callous and large bursa eventually develop over the prominent weight bearing talar head dorsolaterally which is often associated with deep fissures which are prone to breakdown and infection [6]. Walking on the dorsum of stiff deformed feet will also lead to chronic pain [11] and difficulty fitting shoes is often problematic [9]. Pain occurs in the skin and subcutaneous tissue on the dorsum of the foot [6]. Neglected CTEV in older children poses special challenges due to the rigidity of the deformities and a fixed altered gait pattern. After years of accommodation and joint adaptation, the skewed anatomy and the rigidity of the tissues make correction more difficult and a perfect foot is unlikely [1, 16]. Grill and Franke [8] stated that the limited ROM in the tarsometatarsal and midtarsal joints were characteristic of neglected CTEV and prevents perfect surgical correction.

Since CTEV is a complex deformity combining several components, treatment must be individualised [10, 17]. Thus in open treatment, structures to be lengthened and released must be determined intraoperatively [17].

Correction of various deformities may require individual variations in technique and a supplementary operation however; there is usually one dominant deformity [10].

Treatment of CTEV has evolved over the past few decades where there has been an increased interest in the minimally invasive Ponseti technique. The technique decreases the rates of stiffness and residual or recurrent deformities associated with extensive soft tissue release [12]. It has been used as the sole means of correcting neglected CTEV [3]. Serial manipulation and casting relies on the viscoelastic properties of connective tissue to achieve plastic deformation via stress relaxation [18]. During gentle stretching,

shortened tissues are placed under tension however the tension lessens over time which then allows for more correction [18]. Lourenco [1] retrospectively reviewed 17 patients (24 feet) ages 1.2 to nine years with neglected CTEV who were treated via a modification of the Ponseti technique. In anticipation of these patients having soft tissue which have decreased elasticity, the manipulations lasted five to ten minutes and the cast changed every two weeks to allow more time for remodelling. All wore shoes, did activities of daily living, had no pain and all were satisfied. Khan and Kumar [9] looked at 21 patients (25 neglected feet) with a mean age of 8.9 years, whereby 18 feet had full correction and six feet had recurrent deformity at four year follow up. Spiegel et al [12] avoided extensive soft tissue releases in 94% of his patients aged six years and less. The Ponseti technique is thus a cost effective, safe modality [9].

In contrast to Khan and Kumar [9], Spiegel et al [12], Lourenco and Morcuende [1], and Hassan et al [19] felt that the neglected CTEV deformity had no further potential for manipulative correction and that soft tissue release was required to achieve manipulation. He performed surgery in two stages for 24 patients (35 feet) with neglected CTEV where the 1st stage was an extensive posteromedial releases including Achilles tendon lengthening, posterior capsulotomies of the ankle and subtalar joints and calcaneofibular ligament release. The 2nd stage was a triple arthrodesis followed by 16 weeks in plaster where the last eight weeks was in a walking plaster. Herold and Torok [10] who also utilised a similar two staged procedure treated 44 patients age 6-62 years. Manipulations and casting was performed between the two operations which allowed for skin closure without tension [10]. Hassan et al [19] slightly under corrected after stage 1 to decrease wound complications, then went for full correction after stage 2. Khan and Chinoy [20] proposed double zigzag incisions over the medial aspect of the foot and over the Achilles tendon in 21 feet with severe neglected clubfoot and found that this single operation allowed for full correction with no wound complications. Soft tissue release and Achilles tendon lengthening prior to triple arthrodesis has been advocated because bony resection alone increases the incidence of osteonecrosis of the talus, persistence of deformity and poor bony contact of midtarsal bones with subsequent psuedoarthrosis [19, 21]. Triple arthrodesis has been considered salvage [16] and intended to improve function [10]. It is recommended beyond age 12 [11].

In more resistant cases, soft tissue releases include complete release of posterior and medial subtalar joint capsule, talonavicular capsulotomy (including spring ligament and bifurcate y ligament), medial calcaneocuboid joint capsulotomy, knot of Henry and Abductor hallucis as well as tibial posterior lengthening [6].

Relapse rates especially in older children with neglected CTEV are higher because of the tendency of bones to revert to their deformed position [6]. Other factors include tight, thickened ligaments, and a significantly retracted tibialis posterior tendon [9]. Ponseti [4] stated CTEV had a strong tendency to relapse regardless of the mode of treatment, but stiff severe clubfoot with a small diameter calf are more prone to relapse. The components of clubfoot equinus and heel varus are most important relapses [4]. Although relapse of a deformity may be treated with manipulation and casting there are situations in which surgery is offered because of unreliability of follow up, that is, compliance with repeated sessions will be questionable [10]. Inadequate postoperative care, indelicate surgery and improper choice of technique are other reasons for high recurrence rates [2, 17].

Residual equinus is common in young children post full soft tissue releases [6]. Scott et al [22] found that a lateral tether including the posterolateral subtalar joint capsule, peroneal tendon sheath and the calcaneofibular ligament may prevent dorsiflexion and needs to be released in the presence of residual equinus. Posterior releases are favoured in patients older than three years whereas tenotomy (open or percutaneous) is favoured in the less than three year old patient in treating residual equinus [12].

Stabile and Giorgini [16] have advocated a closing calcaneocuboid wedge osteotomy with a talonavicular joint fusion as a procedure which gives consistently good results. Operations utilising closing wedge osteotomies and triple arthrodesis, results in a noticeably shortened foot [8]. Although bony procedures allow for a near normal foot correction, the results are often poor in terms of chronic pain and stiffness [11]. The Ilizarov method has been used to avoid the need to perform bony resection or arthrodesis while achieving a balance in the discrepancy in length between the medial and lateral sides of the foot via medial side lengthening in the form of continuous distraction by an external fixator [8]. The Ilizarov external fixator decreases the likelihood of skin necrosis, psuedoarthrosis, infection and vascular damage associated with osteotomies [8].

Ferreira et al [23] used the Ilizarov fixator in 30 patients (38 feet) with a mean age of 19 years. 78.9% of patients had complete correction with no pain, while 23.7% required arthrodesis for symptomatic arthritis; however minimal bone resection was required, due to correction of severe deformities [23].

Similar to the Ilizarov fixator the Joshi external stabilisation system (JESS) also avoids scarring, skin complications and neurovascular injuries associated with open techniques [24].

III. CONCLUSION

Many surgeons are now moving away from the Ponseti technique as well as soft tissue releases in favour of distraction techniques because of its ability to achieve deformity correction and produce a cosmetic foot with a near normal foot size.

Declaration of Conflict of Interest

There are no financial, institutional and personal relations that could potentially bias the information presented above.

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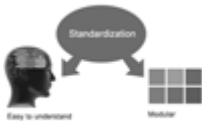


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It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

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Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art. A few tips for deciding as strategically as possible about keyword search:



- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
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Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

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Acknowledgements: Please make these as concise as possible.

References

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<i>Abstract</i>	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
<i>Introduction</i>	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
<i>Methods and Procedures</i>	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
<i>Result</i>	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
<i>Discussion</i>	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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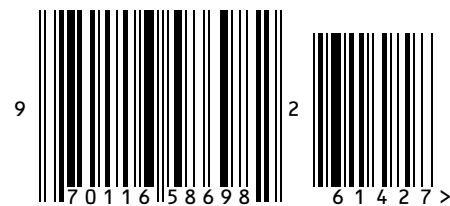
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