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Neglected Lateral Condyle Humerus Fractures: Current Concepts and Practices

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Abstract

Neglected lateral condyle fractures present varied and difficult challenges to the treating orthopaedic surgeon. They have the potential to cause long term problems like deformities, stiffness, instability and tardy ulnar nerve palsy. The treatment of lateral condyle non-unions depend on the presence or absence of deformity, the duration of non-union, skeletal maturity of the child and the presence or absence of ulnar nerve palsy. Accordingly the treatment ranges from conservative management in neglected fractures with no deformity and no ulnar nerve palsy at one end, Open/mini-open or closed in-situ fixation for established non-unions with instability and corrective osteotomy with fixation of non-union and ulnar nerve transposition at the other end.

In this article, the authors have endeavoured to go through the various aspects of clinical presentations and treatment modalities for this difficult fracture.

Keywords: Neglected lateral condyle fractures, Cubitus valgus, Tardy ulnar nerve palsy, Instability

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Introduction

Lateral condyle humerus (LCH) fractures are common fractures around the elbow and have the potential to cause long term problems of deformities, restricted range of motion, instability and tardy ulnar nerve palsy [1, 2]. In systemic review of LCH fractures by Tan et al [3], it was found that most LCH fractures had union, with 0.9% delayed union, 1.6% non-union and 1.5% malunion. Common complications following LCH fracture include valgus deformities (6.1%), varus deformities (7.8%), flexion loss (9.7%), extension loss (11.5%), prominent lateral condyle (27.3%), fishtail deformity (14.3%), avascular necrosis (1.7%), premature epiphyseal closure (5.4%) and neurological deficits (10.6%) [3].

The first report of nonunion of LCH was described by Moorhead in 1919 [4]; the patient was seen seventeen years after injury; due to acceptable elbow movements without pain, the non-union was not treated [5] In order to prevent these complications, it is prudent to treat these fractures well early with stable fixation whenever indicated. However, especially in the developing world, orthopedists do get fractures which are neglected or "mis"-treated [6].

Though the treatment of fresh LCH fractures is fairly standardized, management of neglected LCH fractures still remains controversial. Recently Song classification has improved our understanding of the LCH fracture and their treatment guidelines which have been effective as seen by a few studies in the recent times [7, 8]. Tan et al in their systematic review recommended that non-displaced extra-articular fractures on all radiographic views could be managed conservatively, while displaced or intra-articular fractures (with broken cartilage

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hinge) with > 2 mm displacement require surgical intervention [3].

This described treatment of neglected LCH ranges from conservative management and allowing the fracture to mal-unite/ cause a deformity, at one extreme [9, 10], to immediate surgical exploration, recreation of the fracture, anatomical reduction and rigid internal fixation at the other extreme [1, 11]. There have been a plethora of articles describing these various treatment modalities for the treatment of neglected lateral condyle fractures associated with or without deformities.

In this article, we will attempt to address the problems associated with these difficult fractures and discuss merits of various treatments suggested for neglected LCH fractures. In the process we will put forth a protocol for the management of the same.

Definition of "neglected" fractures and associated problems

Various observers have defined "neglected" fractures in different manners. Jakob and Fontanetta stated that open reduction should not be performed more than three weeks after the injury, as the blood supply of the fragment is easily disturbed, leading to avascular necrosis of the fragment [10]. While Agarwal in their study considered LCH neglected if presented after 4 weeks [12, 13]. Dhillon et al, suggested changing the definition of "neglected" to beyond 6 weeks of injury and theorized that fractures beyond 6 weeks of trauma should not be treated by open reduction and internal fixation [14]. Aggarwal et al [12] and Prakash et al [6] have kept the working definition of "neglected" to be more than 3 months after injury. One may safely state that when LCH fracture does not show expected signs of union following conservative or improperly stabilized fracture it may be labelled neglected as early as 2-3 weeks. Regardless of the duration of neglect, all authors do feel that these neglected fractures need to be treated with utmost caution and have put forth their own protocols for the same.

The reason for this delay is multi-factorial. Flynn noted that the most common causes of LCH nonunion is inadequate treatment of the fresh fracture, with the patient not seeking medical advice or orthopedist not being able to appreciate the fracture [15]. In developing world, the reasons for LCH nonunion include parental lack of awareness, financial constraint and non-availability of health care facilities [12, 14, 16]. Fracture management by osteopaths is seen in developing world as well as affluent societies [12, 14, 17, 18]. Roy noted that LCH nonunion may result from wide separation of fracture surfaces, missed fractures, failed closed or open reduction, and separation of undisplaced fracture in follow up. Moreover, there is considerable debate about the management of this fracture after 3 weeks of injury and that adds to the problems which the child faces as an aftermath of this fracture.

The problems of neglected lateral condyle fractures are related to its unique vascular and muscular anatomy. Lagrange and Rigault in their famous study showed that the blood supply of the lateral condylar fragment enters posteriorly near the common extensor attachment, and disruption of this blood supply due to the injury or the surgical procedure can lead to ischemia of the fragment [19]. Once the fracture displacement occurs, the fragment is completely separated from the proximal fragment and then continues to enlarge. It becomes irregular in shape and gets covered on all sides with articular cartilage that it may sometimes be impossible to distinguish the normal articular surface from the newly formed articular surface [20]. The metaphyseal fragment also undergoes hypertrophy, becomes enlarged and misshapen and does not conform to the shape of the reciprocal surface on the proximal side [12]). Masada found olecranon fossa was markedly smaller than normal and major part of the trochlear groove had disappeared; in some patients radial head became convex [5]. In such circumstances, trying to recreate the anatomy during surgery, leads to significant dissection, with subsequent damage to the vascularity, avascular necrosis of the fragment and stiffness. Satoshi et al noted that in patients with nonunion following Milch type 1 injury, the lateral condyle fragment was small and radial head was rounded and capitellum was concave while in nonunion following Milch type 2 injury lateral condyle fragment was large with almost normal relation of the radiocapitellar joint [2, 18].

Jeffery in late fifties noted that radiological union of displaced lateral condyle must be established unequivocally [3, 10, 21]. If delayed union is recognized in time, steps can be taken to achieve union, thereby preventing further displacement and deformity and described treatment of delayed LCH fracture with minimal displacement by drilling a channel and filling it by bone-grafting [21]. Flynn described two prerequisites for successful treatment of lateral condyle nonunion, 1. fragment in acceptable position, 2. Physis of fragment open, but finally concluded that that providing stability even without growth potential may be helpful. He treated LCH nonunion by freshening metaphyseal side of the fracture, fixing with Hagie pin, and did peg bone grafting preserving physis. He also recommended early treatment of nonunion "without procrastination" and noted that nonunion treated in time will allow the condylar fragment to grow with the elbow to maturity, producing a satisfactory functional and cosmetic result [15]. Wilkins et al. stated: "If we believe that we can obtain fracture union without loss of elbow motion and avoid avascular necrosis of the lateral condyle, then we recommend surgery for selected patients". Shimada et al reported that in children after osteosynthesis of LCH nonunion, union is achieved easily,

elbow motion is maintained, the ulnar nerve function returns and the articular surface remodels [22, 23]. Many authors recommended osteosynthesis of nonunion of LCH in children not only with pain but even with less symptoms [11, 23]. They noted that osteosythesis prevents progression of a cubitus valgus deformity with subsequent ulnar nerve dysfunction and fairly good remodeling of the elbow joint with improvement in of motion over a several years [11, 22].

Presentation

Children with nonunion of lateral condyle tend to have pain in the elbow, apprehension, progressive cubitus valgus deformity, restriction of elbow motion, and ulnar nerve dysfunction [5, 22]). Restriction of elbow movements is one of the main functional limitation in children with LCH nonunion but restriction of extension does makes accurate measurement of carrying angle difficult [2, 18]. Improvement as well as loss in elbow movements following LCH nonuion surgery is reported The onset of pain after sports and work occurs after an average of 9.7 years after injury, and the onset of ulnar nerve dysfunction began at an average of 12.7 years but as early as 1.5 years [18]. Gay and Love (1947) found the average age of onset of ulnar neuropathy after an elbow injury is 38 years, and the average interval between injury and onset of symptoms is 22 years. Flynn reported that Ulnar neuritis usually occurs 15-55 years after the injury [15]. Contarary to that many authors have reported ulnar neuritis as early as three years postinjury. Satoshi noted that average carrying angle in children with ulnar nerve symptoms was 26.7 degrees (Satoshi Toh) [2, 22]. They noted good resolution of pain and apprehension following successful union and reported better results in patients with Milch Type 2 injury than patients with type 1 injury with higher complication rate in type 1 patients (Satoshi Toh). In another study, patients with nonunion following Milch type 2 injury rarely developed disabling symptoms except the ulnar nerve dysfunction; contrarily, pain, instability, and loss of elbow motion, and ulnar nerve involvement were common in nonunion following Milch type 1 injury. The authors recommended early treatment of nonunion of a Milch Type-I fracture [18].

Management

A) Conservative management

Traditionally, surgery, or more precisely extensive surgery for neglected lateral condyle fractures is avoided, due to the propensity to cause damage to the vasculature and subsequent stiffness [3, 15]. The reason for this may be the fact that these non-unions may be almost completely asymptomatic especially for all routine activities and most do have almost full range of motion. Jakob and colleagues were one of the first to put forth this theory of non-operative management of neglected LCH fractures [10]. Flynn et al emphasized that major dissection and surgery should be avoided especially in rotated fragments and when the metaphyseal fragment is in a poor position [15]. The principle which was followed was to allow the fracture to mal/non-unite and treat it surgically only if and when it leads to a deformity. The deformity can be treated at that time, without actually treating or dissecting the non-union.

Authors find no role of conservative management in children with LCH nonunion.

B) In-situ fixation

Percutaneous In-situ fixation-

Knight et al reported good results with of minimal invasive percutaneous screw fixation without formal open reduction in children with LCH nonunion presented within 16 weeks of injury [24] It was claimed to be the first report but earlier Morris had reported use of percutaneous screw for one year old LCH nonunion in 4 year old child, who had previous ORIF [25].

This technique has the advantage of not opening the elbow joint, thereby avoiding soft

tissue stripping and preserving preexisting callus and thus, reducing the risk of AVN and infection (Figure 1 a, b, c). Screw compression was found to reduce the amount of joint fluid passing across the intra-articular nonunion and promoting union. They found metaphyseal fragment larger than at the

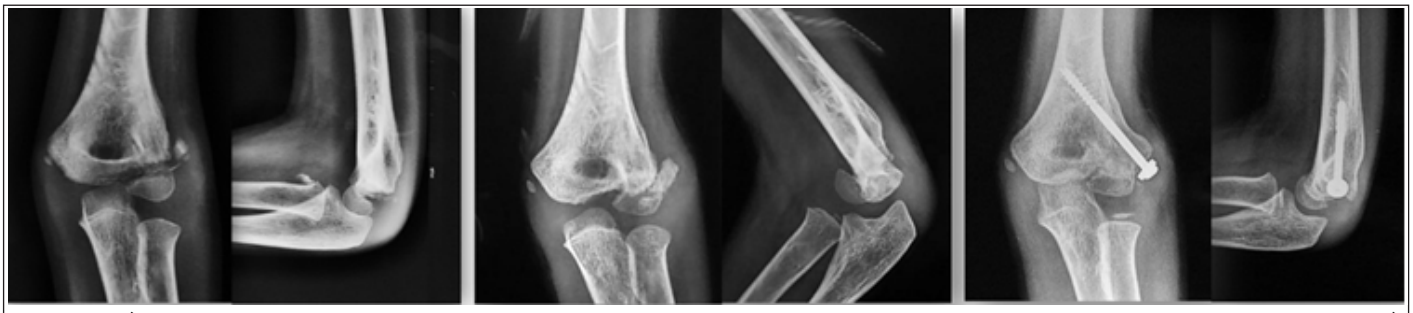

Figure 1: a) Injury film of the elbow of a 6 year old child with lateral condyle humerus fracture which was conserved elsewhere. b) Xray of the same child 3 months after injury showing non-union of the fragment. c) X-ray of the child 6 months after percutaneous screw fixation with CC screw showing excellent healing.

Figure 2: a) Injury film of the elbow of a 6 year old boy with "minimally displaced" fracture lateral condyle humerus, which was conserved elsewhere. b) X-ray of the elbow of the same child after 8 weeks showing gross displacement and non-union. c) X-ray of the child 6 months after mini-open reduction and internal fixation with cc screw and k wire fixation.

time of initial injury, allowing use of larger screws.

The authors have found this technique very effective in early stages of nonunion with minimal displacement.

Open In-situ fixation

Park et al in their study reported a series of 16 patients with mini open in-situ fixation for LCH nonunion with good results in terms of union and functional results [26]. They exposed the interval between the metaphyseal fragment of the LCH and the distal humeral metaphysis after making a small anterior skin incision under fluoroscopic guidance. The metaphyseal surface of fracture site was freshened with small curate preserving the physis; no attempt to realign the articular surface or distal mobilization of the metaphyseal fragment was done. Compression of metaphyseal side was achieved by 3.5 or 4.5 mm cannulated screw without bone graft (Figure 2 a, b, c).

They could achieve union in all patients without premature growth arrest, avascular necrosis, and fish-tail deformity. All their patients had Milch type 2 injuries with interval between injury and operation 4.8 months (range, 3 to 12months). They recommended their technique for relatively minimal displaced and fresh nonunion of LCH.

Prakash and Mehtani in 2017 compared in situ fixation (similar to the method described by Park) with ORIF for LCH nonunion in terms of elbow score; they used bone graft in all cases [6]. Both methods showed comparative results in terms of elbow scores but the rates of radiological union was slightly lesser with in-situ fixation than ORIF. They found better functional outcomes, lesser post-operative complications and decreased surgical times with in-situ fixation.

We do not see advantage of mini-open screw fixation over percutaneous screw fixation for late presenting LCH. We recommend In-situ fixation of minimally displaced nonunion of LCH presenting within 4-5 months of injury. For children presenting between 4-12 months mini open technique described by Park without bone grafting should be used. Using bone grafting for LCH nonunion presenting within one year

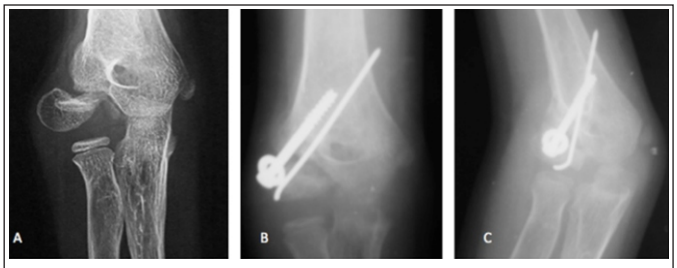

Figure 3: a) Pre-operative xray of the elbow of a 8 year old child with grossly displaced and rotated (Song type 5) fracture lateral condyle humerus which was 3 months post-trauma. b and c) AP and oblique xray of the child after open reduction and internal fixation with CC screw and k wire fixation.

may not be necessary.

C) Open reduction and anatomical fixation:

Over the years, with more and more research being done on the blood supply of the lateral condyle and the ways and means to prevent damage to it, there have been some articles describing open anatomical reduction and internal fixation for these fractures. Agarwal et al in 2012 showed good to excellent results in most of the cases treated with open reduction and internal fixation with bone grafting and put forth a few guidelines regarding the management of neglected LCH fractures [12].

Surgical steps

Lateral Kocher's approach and posterolateral approach [27] , both have been used for established nonunion of LCH; Kochers approach is more common. Kocher's approach uses interval between the Brachialis and Triceps proximally and the ECU and the Anconeus distally; care should be taken to be always anterior to the common extensor origin and not to go too distally. To avoid postoperative joint adhesions and AVN of the LCH, no attempt is made to mobilize the lateral condyle by means of extensive soft tissue dissection for the purpose of reducing the fracture to its original

anatomic position (Figure 3 a, b, c). The nonunion site is exposed gently and the fibrous tissue in the gap between the fracture fragments is removed. The fracture surfaces over the metaphysis is then freshened but the surfaces of the physis and epiphysis should not be touched [11] Agarwal noted that sometimes, the overgrowth of condylar fragment makes it difficult to identify the articular surface from the metaphyseal region of the fragment, in such cases search for overhang cartilage is made, and excess overhanging cartilage is trimmed to get bleeding metaphyseal bone. They recommended nibbling of metaphyseal area to create space for easy realignment or rotation of fragment rather than stripping posterior soft tissue carrying blood supply to the fragment [12, 13] Shabir et al suggested that in order to achieve good

apposition of the fracture fragments, it is sometimes prudent to cut the anterior parts of the capsule and synovial adhesions taking care to limit the dissection anteriorly [20]. The criteria for articular step is 2 mm for acute fractures. However, the exact criteria for neglected late-presenting fractures is not well defined.

In very late presenting cases, Roye recommended functional reduction in which LCH fragment is carefully mobilised with intact soft tissue pedicle preserving vascular supply and fixed in the position that allows the greatest range of motion. Optimum position of the fragment can be decided by temporarily fixing the fragment and dynamically assessing range of movements; the bone graft is then placed between the freshened apposing surfaces and should be stabilised with screw Parajit also recommended that If an anatomic reduction is not possible, the fragment is fixed in the position that allowed the best motion and near normal carrying angle. The LCH fragment is temporarily fixed with k wire; If elbow range at this position is more than 120 degrees, final fixation in this position is done but if flexion is at less than 120 degrees, the fragment is moved in more flexed position [11].

Masada noted that when the olecranon fossa is not deep enough to allow full extension of the elbow, resection of the proximal part of the olecranon improves extension) [5]. Gaur et al have suggested making multiple "pie-crusting" incisions on the common extensor origin in order to achieve some mobility of the fragment especially in displaced and rotated fragments [6].

Some authors have used more extensile approaches for more displaced or older fractures. Agarwal et al have used the Bryan and Morrey's extensile approach in fractures where the condylar fragment is high riding [12]. Bohler et al have described using the trans-olecrenon approach for avoiding extensive soft tissue dissection [28].

Fixation Methods

There is also a wide variation about the choice of fixation- with k-wires and screw-wire combination being the common two methods used. Ranjan et al in 2018 were the first to compare these two methods of fixation for neglected fractures [29]. Though they found that the functional scores to be statistically similar in both the methods, the period of immobilization was significantly higher in k-wires as compared to CC screws. They found that the patient could initiate physiotherapy much earlier with the more secure fixation of CCS as against k wires. Also, they found that they could safely pass the CCS through the capitellar physis and the ossific nucleus without causing any major damage. They also found CS to be better in terms of final carrying angle and time to gain final range of motion. Use of tension band wiring alone or along with screw fixation is also described [18, 23].

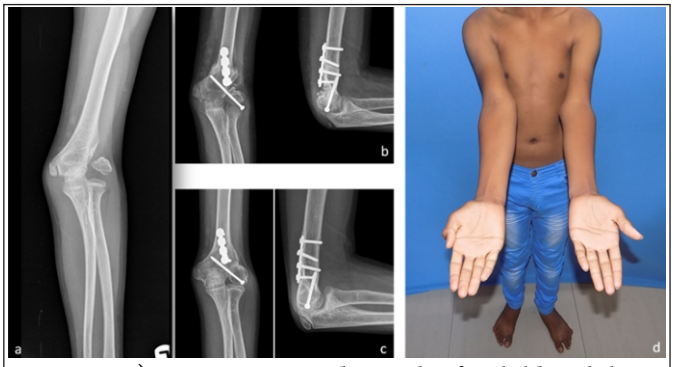

Figure 4: a) Pre-operative radiograph of a child with long-standing non-union of the lateral humeral condyle with cubitus valgus with ulnar nerve palsy. b) Immediate post-operative xray after corrective (lateral closed wedge) osteotomy along with screw fixation of the lateral condyle non-union and anterior transposition of the nerve. c) 6 months post-operative showing excellent healing and alignment d) clinical photograph of the child showing normal alignment of the elbow.

Bone grafting

Some authors have described adding bone grafting as a routine for the fixation of all LCH non-unions. Use of Iliac bone graft is by far the commonest [2, 29] Agarwal et al have described taking the graft from the lower humerus or the proximal ulna in order to decrease the donor site morbidity and allowing grafting through the same incision. They found good results with this method of peg- grafting, peg grafting is a well-established technique and was described by Jeffery in 1958 [21]. Ibrahim described use of bone removed from closing wedge osteotomy as a graft) [28].

Cubitus valgus correction

Simultaneous correction of cubitus valgus with carrying angle > 20-40 degrees have been described by many authors [11] (Figure 4 a, b, c, d). The osteotomy was done simultaneously as well as at later date). Tien used triceps split approach [30] while Abed used paratricipital approach to correct cubitus valgus with dome osteotomy [31]. Some have used lateral approach with lateral closed wedge [28] or dome osteotomy [11] for correction of cubitus valgus.

Anterior transposition of Ulnar nerve (UNT)

Many authors have transposed Ulnar nerve anteriorly in patients with Ulnar nerve dysfunction [11, 18] or routinely with LCH nonunion surgery [30, 31]. Some surgeons have refrained from doing UNT even in patients with ulnar nerve dysfunction [28,32]. Masada treated patients of LCH nonunion with only UNT, UNT with supracondylar osteotomy with or without osteosynthesis LCH nonuinion.

Bone graft can be harvested from distal humerus or proximal ulnar metaphysis or from wedge removed for supracondylar

osteotomy. Stable fixation with screw is preferred except in very young children.

Conclusion

Neglected lateral condyle humerus fractures present many difficulties both with or without treatment. The earlier protocol of supervised neglect is slowly changing to one of prudent fixation with minimal dissection of the fragment, optimal reduction and stable fixation. Even when accurate open reduction is performed, soft tissue stripping should not be performed due to the risk of avascular necrosis and stiffness. K-wires and cannulated screws are equally used, though screw fixation provides better stability and allows early mobilization. Deformity correction and/or ulnar nerve transposition can be performed if and when deformity occurs.

Figure 5: Flowchart for the management of neglected lateral condyle humerus fractures

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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