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Management of cubitus varus deformity with Supracondylar dome osteotomy in children :

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Abstract:
Introduction:
Cubitus varus deformity is among the late complications following supracondylar fractures of the distal humerus in the children, with significant aesthetic concerns for patients and their families. Traditional corrective procedures like lateral closing wedge osteotomy have shown unsatisfactory outcomes due to complications such as neuropraxia and unsightly scarring. Dome osteotomy has emerged as a promising alternative, offering advantages in addressing deformities while minimizing complications.

Materials and methods:
A prospective study has been performed from March 2021 to April 2023 at Saveetha Medical College and Hospital, Chennai, involving 10 pediatric patients with cubitus varus deformity who underwent dome osteotomy. Preoperative assessment included radiographic evaluation and identification of osteotomy sites. The surgical technique involved meticulous osteotomy, correction of deformity, and fixation using K-wires and mini external fixators. Postoperative care included early mobilization and regular follow-up.

Results *:*
Results showed favorable outcomes in terms of cosmetic appearance and functional improvement. Six patients achieved excellent outcomes, 3 had better outcomes, and 1 patient experienced a fair outcome. Flexion improved postoperatively, with no significant complications observed except for transient ulnar neuropraxia in one patient.
The discussion highlights the effectiveness of dome osteotomy in correcting cubitus varus deformity while minimizing complications associated with traditional methods. The procedure offers superior cosmetic outcomes and functional restoration, making it a valuable option for pediatric patients with this condition.

Conclusion:

Dome osteotomy is a straightforward, safe, and effective process which ensures a near-normal cosmetic outcome while preventing lateral condyle prominence.

Keywords : *Supracondylar fracture , dome osteotomy*

INTRODUCTION :

The most common late outcome of a distal humerus supracondylar fracture in the children is cubitus varus deformity, which can occur in 4–58% of cases [1]. Elbow injuries are frequently found in skeletally immature children, typically occurring among the ages of 5-10yrs [2,3]. The distal humerus metaphyseal area is particularly susceptible to injury, making supracondylar fractures the most common type of elbow injury in this group of age. Factors contributing to the increased incidence include frequent falls during play, cycling accidents, and accidents such as falling from beds or sofas indoors. These injuries tend to occur more often on the non-dominant side and are more common in boys than girls. Additionally, associated vascular injuries are present in approximately 1percent of cases, while nerve injuries involving the median as well as radial nerves are found in at least 7percent of cases, further complicating management and adding to the overall concern. [4,5]. For improved functional results, aggressive treatment and an appropriate rehabilitation plan are required for fractures in this area [1].

Cubitus varus deformity affects the humerus distal bone fragment in the children who have suffered from a supracondylar fracture. It is characterized by hyperextension, varus, and internal rotation. Usually, the appearance of the abnormality is more concerning than the functional handicap. Parents of affected children often seek surgical intervention to improve the elbow's appearance, despite minimal impairment of function. Since cubitus varus deformity does not spontaneously resolve and tends to persist, surgery is the only effective approach for the correction of the deformity. Several corrective osteotomy processes were suggested for treating cubitus varus deformity, each aiming to address coronal, sagittal, and rotational deformities while preventing elbow stiffness. The most commonly utilized method, lateral closing wedge osteotomy, has yielded disappointing clinical results due to its significant complication rate. Studies have shown complications like sepsis, neuropraxia, and cosmetically unacceptable scarring. The dome osteotomy, initially mentioned by Tachdjian in 1972 and later reported by Higaki and Ikuta in 1982, emerged as an alternative to address complications associated with lateral closing wedge osteotomy. Many authors have since highlighted the efficacy of dome osteotomy for correcting cubitus varus deformity, emphasizing its advantages over traditional methods. While many surgeons traditionally favored lateral closing wedge osteotomy, recent studies in the Western world have increasingly recognized the benefits of dome osteotomy for this condition.

Our study aims to evlauate the functional outcome of dome osteotomy in malunited supracondylar fracture with cubitus varus deformity in children .

MATERIALS AND METHODS

The research has been performed prospectively from March 2021 to April 2023 in the Orthopedics Department of Saveetha Medical College and Hospital in Chennai. Ten individuals who met the study's requirements were chosen. All of the patients gave their written consent.

Study Place: Department of Orthopaedics, Saveetha Medical College, Thandalam.
Study period: March 2021 – April 2023
10 individuals with cubitus varus deformity were chosen to undergo dome osteotomy. Certain criteria were used for inclusion and exclusion.

Inclusion criteria:
1. Patient's age: 5 to 15 years old.
2. Deformity's appearance for longer than a year.

Exclusion criteria:
1. Patient age range: under five years old to over fifteen.
2. Deformity occurrence lasting shorter than a year.
3. Patient not fit for anesthesia. 4. Connected to more severe wounds or coexisting diseases.

PREOPERATIVE ASSESSMENT

Anteroposterior as well as lateral radiographs of both the elbows have been attained, showing the elbow in full extension and the forearm in full supination. Using the Oppenhiem method, the humerus-elbow-wrist angle has been calculated on both the sides for each patient, and the correction angle has been computed. On the afflicted side, the LCPI (Lateral Condylar Prominence Index) was determined by utilizing the methodology outlined by H.K. Wong. The affected elbow's range of motion was observed, along with pain complaints, motor function loss, and cosmesis.

PREOPERATIVE PLAN FOR OSTEOTOMY

1st, the angles of the humerus, elbow, and wrist on each side were measured. The change in angle was then computed. Next, the damaged side's anterior-posterior radiograph was overlayed with the mid-humeral axis. Two points were marked: one at the intersection of the lateral condylar epiphysis and the distal humerus (point A) and another at the location where this axis intersected the olecranon fossa (point O). Points O & A were then associated. Next, a correction angle has been drawn, using OA as the base. A 2nd location (point B) has been indicated where the distal humerus was severed by this angle. O now served as the dome's center, and OB as its radius. Point O has been used as the dome center that was drawn using this radius (Fig 3). The suggested osteotomy site was the dome's arc.

INDICATIONS OF SURGERY

All of these instances had elbow disfigurement, which was a sign that surgery was necessary.

Methods of Surgery For the procedure, all required aseptic measures and preparations were completed. A Moore's pin was inserted perpendicular to the humerus' coronal plane and from posterior to the anterior, immediately proximal to the olecranon fossa. A raised periosteum and humerus border were incised with a knife. Utilizing an SDCP (Small Dynamic Compression Plate) mounted on a moore's pin as a jig, several holes in the form of a dome were drilled. Parallel to the articular surface and distal to the

osteotomy site, a K-wire has been inserted. Parallel to this wire was another K-wire that was passed. Also, 2 K-wires had been inserted from the medial to the lateral side, proximal to the osteotomy site. To finish the bone break, a 10 mm osteotome was used to connect the osteotomy holes. Under fluoroscopy, the deformity was rectified by translating the distal piece & derotating if necessary. The tiny external fixator, which served as a lateral tension band, was utilized to attach the K-wires. If stability was uncertain, a second K-wire was employed. Furthermore, in situations where an anterior ledge was present and limited elbow flexion, a ledge excision was performed before dome osteotomy. Following Surgery, an arm sling was used to rest the injured limb. After the patient no longer experienced pain, exercise began. An X-ray was taken after the procedure, and the LCPI and carrying angle were computed. Four weeks later, another X-ray was taken. The fixator and K-wires were removed after there was adequate union. X-rays were taken as a follow-up every four weeks until all expected outcomes were obtained and the radiological union was completed. Motion range at the elbow, LCPI, and final follow-up carrying angle were assessed [Table/Fig-7]. Regarding cosmetic satisfaction with the outcomes, parents, and patients were questioned. The following grade was assigned based on the Mitchell and Adams Criteria [18]: 1. Great: Less than 50 change in carrying angle and less than 100 restrictions on mobility in any plane. 2. Positive: Limitation of flexion, extension, or rotation by 100 to 200; change in carrying angle from 50 to 150 (i.e., not beyond cubitus rectus). 3. Unsatisfactory: When the modifications go beyond the boundaries specified above.

Surgical Procedure:

- All operations were conducted under the general anesthesia. Patients have been positioned laterally, with a tourniquet applied. The affected arm was supported with at least 90° of elbow flexion.
- An incision was made in the midline posteriorly, reaching about 3 cm distal to the olecranon, and curved laterally around it. Two fasciocutaneous flaps were made by identifying, splitting in the midline, and elevating the fascia covering the triceps brachii together with the dermis and subcutaneous tissue. The triceps muscle and the intermuscular septae posterior surface were separated by the dissection, which revealed the lateral and medial triceps boundaries. To reach the posterolateral humeral shaft, the triceps muscle has been raised and drawn back. To prevent damage, the ulnar nerve was located and given protection via a penrose drain. Following medial paratricipital dissection, the distal humerus posteromedial region was revealed. Visualization of the entire posterior distal humerus was made possible by the triceps muscle being mobilized and elevated. The periosteum as well as pericondrium junction of the distal humerus were identified.
- The osteotomy locations were marked by placing the preoperatively created template over the posterior part of the humerus. An osteotome was used to finish the osteotomy after interrupted holes had been created along the expected osteotomy arc. To enable full division of the anterior periosteum as well as smooth the spikes over the cortex's edge, the proximal piece was dragged outward. Until the intended realignment of the elbow was accomplished, the distal fragment has been then rotated along the arc. For the percutaneous, osteotomy cross-k-wire fixation was used. The wires were bent and left proud for simple removal. In ordinary instances, there was no need for a drain; the incision was closed in layers.

Postoperative Care:

- Patients were told to start vigorous finger and wrist exercises as well as shoulder pendulum movements right away. After four weeks, the back slab was removed, and the stitches were taken out after 14 days. Following the fifth week, the K wires were removed. Post operative follow up was done at 1month , 3months , 6 months and 1 year .

Elbow movements that were mildly vigorous were recommended. Until the last follow-up, radiographs were taken every three months after initially being taken monthly.
The acquired data are utilized with IBM SPSS version 22.0. Continuous variables are defined as mean +/- standard deviation, while categorical variables have been observed as percentages & numbers. A P value < 0.05 has been taken as statistically significant.

Results :

All ten patients underwent clinical and radiographic review, with follow-up durations ranging from 6 months to 1 year. Among them six patients achieved an excellent outcome, 3 had better results, and 1 patient experienced a fair outcome.
Flexion
During the Pre-operative period, six patients exhibited a normal range of motion, while four patients had hyperextension, with two showing 10 degrees and two showing 5 degrees of hyperextension. On average, the range of motion before surgery was 127.5 degrees, which decreased to 130 degrees after surgery. (Table 1)
Cosmetic Outcome
There were no complaints of medial fullness of the elbow or a pronounced lateral condyle in any of the patients' elbow appearances. The carrying angle has been within five degrees of the unaffected contralateral side in six individuals. (Table 2)
Complication
This includes one patient for each ulnar neuropraxia. Without any associated motor impairment, ulnar nerve neuropraxia appeared as tingling and numbness in the ulnar distribution and went away on its own. No patient had atrophy of the arm musculature, discomfort, or motor weakness. Revision surgery was not required, and there has been no fixation failure & correction loss throughout the stage of healing.

Discussion :

Cubitus varus, a supracondylar fracture common complication of humerus in the children treated nonoperatively, is characterized by a varying incidence of 4percent to 58percent. Insufficient reduction, reduction loss resulting in malunion, or disruption of growth at the humerus lower end can all cause this deformity. A varus deformity can eventually result from residual rotational misalignment, which many experts believe is the cause of the deformity. This misalignment can also cause medial tilt. In our study, all 10 patients had a prior history of supracondylar humerus fractures, all of which were managed conservatively without reduction or fixation. There were no associated injuries reported.

Cubitus varus has been linked to a variety of conditions, including tardy postero-lateral rotatory instability of the elbow, ulnar neuropathy, snapping of the medial triceps, distal humeral epiphysis avascular necrosis, and secondary distal humeral & lateral condylar fractures, the majority of patients present with aesthetic concerns rather than functional impairment. In our study, all 10 patients underwent surgery due to the unsightly deformity, despite maintaining normal elbow function.

There are a few different ways to correct cubitus varus: lateral closing wedge osteotomy, medial opening wedge osteotomy, lateral closing wedge osteotomy as well as simultaneous derotation arc osteotomy, dome osteotomy, and posterolaterla osteotomy. The most popular way to correct the deformity is lateral closing wedge osteotomy. Even though the distressed elbow carrying angle is adjusted to match the unaffected side, osteotomies that prevent distal humerus translation may nevertheless result in a varus deformity in the joint's postoperative appearance. The lateral humeral condyle's protrusion can be ascribed to a radial shift in the distal humerus fragment with respect to the proximal humeral shaft, which caused the cosmetic discrepancy.

In a group of 22 patients, Wong et al. [6] found that the incidence of this consequence was 64%. The lateral condyle's prominence is innate to the lateral closure wedge osteotomy's design since cutting the wedge leaves two unevenly sized pieces that hinge on the medial cortex. By efficiently shifting the distal fragment laterally, closing the osteotomy highlights the prominence of the lateral condyle and compromises the cosmetic result.

Tachdjian [7] initially explained the dome osteotomy for correcting cubitus varus, although no specific outcomes have been observed. Kanaujia et al [8] and Tien et al [9] subsequently reported favorable outcomes without complications using this technique. Dome osteotomy utilizes the humerus midline as the rotation center, preventing the lateral condyle from becoming prominent.

There is an additional disadvantage to lateral closure wedge osteotomy, aside from the possibility of lateral condylar prominence. Since the medial cortex is the distal humeral fragment's center of rotation, mobilization during correction requires a wide rotation arc. This can worsen already-tightened medial structures and produce a larger varus moment at the osteotomy site, which could result in loss of correction and mechanical instability. Conversely, in a dome osteotomy, the distal fragment's center of rotation is near the humeral midline, which results in a significantly smaller varus moment and therefore more mechanical stability.

Ippolito et al [10] reported that approximately 60percent of patients had unattractive postoperative scars, often due to the standard lateral longitudinal incision crossing Langer's lines, leading to a tendency for hypertrophic scarring. Only one patient in our study experienced ulnar neuropraxia, which appeared as tingling as well as numbness in the ulnar distribution without any corresponding motor deficit and went away on its own. Elbow stiffness, pin loosening, or pin tract infections did not occur in any of our patients. The posterior longitudinal incision used for dome osteotomy results in a cosmetically more acceptable scar, as its location is less conspicuous during normal arm positions. In terms of carrying angle correction, total outcomes, and the frequency of complications like neurapraxia, infection, and correction loss, the dome osteotomy results I had for cubitus varus deformity were similar to those of other writers.

Conclusion :

Dome osteotomy, utilized for correcting cubitus varus deformity, demonstrates excellent cosmetic results and minimal complications. It offers many advantages over lateral closing wedge osteotomy, including greater stability at the osteotomy site for maintaining correction, prevention of lateral condyle prominence, and a more cosmetically acceptable posterior scar compared to the lateral scar in the lateral closing wedge osteotomy. Overall, dome osteotomy is a straightforward, safe, and effective process that ensures a near-normal cosmetic outcome while preventing lateral condyle prominence.

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Information of 10 patients pre-operative and post-operative Period :

Table 1 :Pre-operative

S.NO	Age in years	Sex	Affected side	Previous diagnosis	INTERVAL BETWEEN INJURY AND SURGERY	Pre-op carrying angle	Pre-op flexion	Pre-op extension
1	8	M	Left	SC #	10 MONTHS	-14 *	100 *	0
2	10	F	Right	SC #	11 MONTHS	-19 *	125 *	-5
3	12	M	Right	SC #	12 MONTHS	-6 *	135 *	-10
4	8	F	Left	SC #	16 MONTHS	-15 *	130	0
5	6	M	Right	SC #	18 MONTHS	-8 *	120 *	-5
6	14	F	Left	SC #	14 MONTHS	-12 *	125 *	0
7	6	M	Right	SC #	72 MONTHS	-4 *	130 *	0
8	9	M	Right	SC #	8 MONTHS	-9 *	135 *	-10
9	5	M	Left	SC #	24 MONTHS	-13 *	100 *	-5
10	12	M	Left	SC #	6 MONTHS	-19 *	130 *	0

Table 2 :Post operative :

S.no	Follow up months	Flexion Post op	Extension Post op	Post op Carrying angle	Complication	Result
1		120 *	0 *	10 *	Normal	Excellent
2		130 *	0 *	15 *	Normal	Excellent
3		130 *	0 *	12 *	Normal	Excellent
4		130 *	0 *	13 *	Normal	Excellent
5		130 *	0 *	8 *	Normal	Good
6		130 *	0 *	9 *	Normal	Good
7		135 *	0 *	8 *	Normal	Excellent
8		110 *	0 *	12 *	Ulnar N neurpraxia	Fair
9		125 *	0 *	4 *	Normal	Good
10		130 *	0 *	18 *	Normal	Excellent