

Loss of correction in cubitus varus deformity after osteotomy

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Research article

Keywords: cubitus varus, osteotomy, Loss of correction

Posted Date: May 5th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-26279/v1>

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Version of Record: A version of this preprint was published at Medicine on December 10th, 2021. See the published version at <https://doi.org/10.1097/MD.0000000000027848>.

Abstract

Purpose Cubitus varus deformity in the pediatric population is an infrequent but clinically important disease to orthopedic surgeons. Since these patient populations are different in many respects, we sought out to investigate the rates of loss of correction over time as well as the factors associated with loss of correction in pediatric patients undergoing osteotomy for treatment of cubitus varus deformity.

Methods Between 2008-7 and 2017-7, we treated 30 cases of cubital varus had underwent the the osteotomy. We compared preoperative and postoperative clinical and imaging parameters (H-cobb angle, Baumann angle) for all patients. Postoperative evaluation was performed by telephone interview.

Results In our study, there were 30 patients, included 17 males and 13 females. the mean age was 75 months old. In the first follow-up, approximately 80 % of patients had a loss of correction of H-cobb angle and 83% of patients at the second follow-up. The Baumann angle also had a loss of correction, about 57% was lost at the first follow-up, and 43% was lost at the second follow-up. The average interval between the first follow-up and the second follow-up was 24 days. The H-cobb angle mean loss was 2.4°. There was a statistically significant difference between the H-cobb angle measured before surgery and the angle measured after surgery ($p < 0.05$). There were significant differences between the two angles. There was no statistically significant difference between the H-cobb angle measured at the third postoperative period and the contralateral healthy elbow H-cobb angle. There was a statistically significant difference between the Baumann angle measured before surgery and the angle measured after surgery ($p < 0.05$). The Baumann angle measured in the second and third postoperative periods was significantly different from that of the contralateral healthy elbow joint. According to the survival curve analysis, we can see that the median survival time of the H-cobb angle and the Baumann angle is 27 and 34 months.

Conclusions The postoperative angle loss will last for a period of time, which mainly occurs during the first and second follow-up period. Therefore, it is important to pay attention to the follow-up of the patient for a period of time after the operation, and take measures to avoid rapid angle loss. Angle loss was significantly reduced after the third follow-up. Further study is needed on this subgroup of patients with cubitus varus given the differences in strategies needed to correct and maintain their deformity correction.

Background

Cubitus varus is a well-recognized complication of pediatric supracondylar fracture that is observed during the initial injury, after conservative treatment, or even after operative treatment, and as a late development pattern.[3,8,13,19] Traditionally, "cubitus varus" consists of varus, extension, and internal rotation. However, several recent studies have revealed through 2- or 3-dimensional (3D) analysis that the morphologic and alignment changes of the elbow joint developed over time during the progress of varus deformities. Trochlear deformity and partial hypoplasia due to compromised growth potential after injury have been regarded as keystones for further progression to varus and misalignment and even to late

manifestations such as posterolateral rotatory instability.[5,7,14,16,18]Surgical corrections for moderate-to-severe deformities have been introduced to improve cosmetic conditions or prevent functional impairment such as restricted range of motion, instability, and ulnar nerve neuropathy.[1,2,4,6,9-12,14-18] Various correction methods have been introduced, but some investigators have suggested that an osteotomy, which leaves a loss of correction, does not completely improve the appearance of the elbow and forearm. And then we don't know when the angle will be lost,also we don't have a idea that what caused it.So we are dsired to get the key point of the loss correction after osteotomy ,then we can have more effective method that can avoid angle lost.

we established the hypothesis that the loss of correction will last a period after osteotomy.But we don't know the time when the loss will be ceased.We need more evidence to find out the rule for loss of correction after osteotomy. Therefore, we collected all cases of cubit varus in our hospital, conducted a retrospective analysis, recorded the relevant data of each postoperative follow-up and conducted statistical analysis, trying to obtain the rule of Angle loss after cubit varus and hope to analyze the causes of Angle loss, improve our surgical treatment methods, so as to reduce or even avoid Angle loss.

Methods

Medical records and radiographs were retrospectively reviewed from a single institution, Shenzhen children's hospital, from July 2008 to July 2017.

Clinical and radiographic measurements were recorded. The first follow-up was at the third day after surgery.Data fields collected included age, gender, functional parameters, Interval between follow-up, and radiographic parameters. H-cobb angle measurement method: in the elbow orthophoto, connect the most convex part of the inner and outer sides of the distal humerus, and make another line segment perpendicular to the humeral trunk line, the angle between this line segment and the inner and outer protrusion The humerus-cobb angle (H-cobb angle).Baumann angle☒The angle between the long axis of the humerus shaft and the epiphyseal line of the outer edge of the small head of the humerus.(Figure 1)

Statistical analysis was performed using SPSS 21 software using Student's t tests, Chi square tests, and Fisher's exact tests when appropriate. The survival curve analysis was calculated by graphpad prisim 7 and the correlation curves were fitted. All results were reported as means and standard deviation. A p value of 0.05 was considered statistically significant.

Results

In our study,there were 30 patients,included 17 males and 13 females.the mean age was 75 months old(Table 1).In the first follow-up,Approximately 80 % of patients had a loss of correction of H-cobb. And 83% of patients at the second follow-up. The Baumann angle also had a loss of correction,about 57% was lost at the first follow-up,and 43% was lost at the second follow-up. The average interval between the first follow-up and the second follow-up was 24 days, The H-cobb angle mean loss was 2.4°.There was a

statistically significant difference between the H-cobb angle measured before surgery and the angle measured after surgery ($p < 0.05$). There was no statistically significant difference between the H-cobb angle measured at the third postoperative period and the contralateral healthy elbow H-cobb angle. There was a statistically significant difference between the Baumann angle measured before surgery and the angle measured after surgery ($p < 0.05$), and no significant difference was found between the angles measured after surgery. The Baumann angle measured in the second and third postoperative periods was significantly different from that of the contralateral healthy elbow joint. (Table 2/3)

According to the survival curve analysis, we can see that the median survival time of the H-cobb angle and the Baumann angle is 27 and 34 months. As Figure 2 to 5, we can see that the children's angle loss during the second postoperative follow-up is in a state of continuous loss. At the third postoperative follow-up, the angle loss of the children was stable, so we have reason to believe that the angle loss of most children had stopped before the third follow-up.

Discussion

Some good idea comes to our study and have a good assistant to our research, although we can't find more studies related with cubitus varus. Since the advent of thoracic pedicle screws in scoliosis, it has been increasingly popularized for deformity correction [25]. A systematic literature review [23] has reported that these constructs have a larger percentage of Cobb angle correction compared with hooks and hybrid constructs in AIS as well as in the adult literature [24]. We can't find more information about the angle loss of correction after cubitus varus osteotomy, but we found some literatures had reported that pedicle screw-only fixation in AIS is associated with significantly fewer spinal segments instrumented, shorter operating time, less need for anterior releases, as well as fewer thoracoplasties [21]. However, loss of correction over time in AIS patients can still be a problem [20, 22, 26–28]. Overall, pedicle screw constructs in AIS appear to have loss of correction approximately half as frequently as hybrid constructs, but still occurs in approximately 10 % of cases [29]. Although the loss of correction in AIS patients was not a bony structure loss purely, but we have more chance get idea about the angle loss of correction in cubitus varus patients.

In this study, we did not use the internationally recognized carrying angle as the research object, mainly for the following reasons: First, because all of our patients were fixed with plaster after surgery, the X-rays of the children at the time of review were when wearing plaster. The shooting angle cannot be accurately measured. Second, the measurement method of the carrying angle is controversial. At present, it can be found from the literature that the more common definition of the carrying angle is to measure the carrying angle from the appearance of the patient. The angle between the bony structures in the film can better represent the clinical significance of the carrying angle. Therefore, in this study, we proposed the concept of the H-cobb angle. The H-cobb angle can accurately measure the true situation of postoperative correction angle loss when the humerus is used as the standard orthotopic radiograph.

According to our study, the average time of Angle loss after cubital varus osteotomy is about 24 days after surgery, and 80% of children will lose Angle during this period. Therefore, we have reason to believe that 24 days after surgery is a critical period for Angle loss after osteotomy, and it is very necessary to take a series of preventive measures during this period. From Figure 2 to 5, we can see that the children's angle loss during the second postoperative follow-up is in a state of continuous loss. At the third postoperative follow-up, the angle loss of the children was stable, so we have reason to believe that the angle loss of most children had stopped before the third follow-up. But as a result of our sample size is less, can't risk factors research, a moment can't effectively identify what factors during this important role, so it can't provide specific prevention measures, the current according to the case found mansard bone cutting can reduce the occurrence of postoperative Angle cutting bone loss, but no effective statistical data to support.

We found that some of the children did not have Angle loss after surgery. As mentioned in the previous AIS related cases, our children had different fixation modes. Then, could we also reduce the Angle loss after osteotomy due to the change of fixation mode? At present, we do not have a large number of cases to confirm our hypothesis, so we will take the fixed mode as an important object in the later study to explore the possibility of less postoperative Angle loss.

In addition, we found that the loss of h-cobb Angle would not always be accompanied by the increase of Baumann Angle after surgery, and we got a valid answer for this reason. Due to the growth uncertainty of Baumann Angle, we speculated that the development of Baumann Angle after surgery might affect our relevant research results, so we do not recommend using Baumann in elbow varus related research Angle as the main reference for data collection.

Conclusion

The postoperative angle loss will last for a period of time, which mainly occurs during the first follow-up period. Therefore, it is important to pay attention to the follow-up of the patient for a period of time after the operation, and take measures to avoid rapid angle loss. Angle loss was significantly reduced after the average third follow-up. Further study is needed on this subgroup of patients with cubitus varus given the differences in strategies needed to correct and maintain their deformity correction.

Declarations

- Ethics approval and consent to participate

Not applicable.

- Consent to publish

Not applicable.

- Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

- Competing interests

The authors declare that they have no competing interests.

- Funding

No funding

- Authors' Contributions

YC and ZYB performed the acquisition of data, analytical studies and wrote the manuscript; HJM planned the study, checked the final form of the manuscript and approved the final manuscript. All authors read and approved the final manuscript.

- Acknowledgements

None.

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Tables

Table 1

No. of patients	30
Age* (Months)	75
Sex	
Male	17
Female	13
Refracture	0
Angle loss of the second follow-up(days)	24

Table 2 H-cobb paired t test

	mean	SD	S.E. Mean	95% CI lower limit	upper	t	df	Sig. (two-tailed)
Pair 1 Third - Normal	.62500	2.09604	.38268	-.15767	1.40767	1.633	29	.113
Pair 2 Preop - First	17.84333	9.66684	1.76492	14.23367	21.45299	10.110	29	.000
Pair 3 Preop - Second	-7.76567	8.74659	1.59690	-11.03170	-4.49963	-4.863	29	.000
Pair 4 Preop - Third	-5.37933	8.45748	1.54412	-8.53741	-2.22126	-3.484	29	.002
Pair 5 First - Second	-25.60900	8.41630	1.53660	-28.75170	-22.46630	-16.666	29	.000
Pair 6 First - Third	-23.22267	9.20141	1.67994	-26.65853	-19.78681	-13.824	29	.000
Pair 7 First - Normal	-22.59767	8.58228	1.56690	-25.80234	-19.39299	-14.422	29	.000
Pair 8 Second - Third	2.38633	3.26687	.59645	1.16647	3.60620	4.001	29	.000
Pair 9 Second - Normal	3.01133	3.59397	.65617	1.66932	4.35334	4.589	29	.000

Table 3 Baumann angle paired t test

	Mean	SD	S.E. Mean	95%CI lower limit	upper limit	t	df	Sig.(Two)
Pair 1 Preop - First	24.23300	10.22271	1.86640	20.41578	28.05022	12.984	29	.000
Pair 2 Preop - Second	24.44433	11.49915	2.09945	20.15048	28.73819	11.643	29	.000
Pair 3 Preop - Third	24.05931	9.52319	1.76841	20.43688	27.68174	13.605	28	.000
Pair 4 Preop - Normal	20.02233	14.63572	2.67210	14.55727	25.48740	7.493	29	.000
Pair 5 First - Second	.21133	6.28597	1.14766	-2.13589	2.55855	.184	29	.855
Pair 6 First - Third	-.51621	7.70352	1.43051	-3.44647	2.41405	-.361	28	.721
Pair 7 First - Normal	-4.21067	11.87207	2.16753	-8.64377	.22244	-1.943	29	.062
Pair 8 Second - Third	-.98862	5.72523	1.06315	-3.16638	1.18914	-.930	28	.360
Pair 9 Second - Normal	-4.42200	10.50540	1.91801	-8.34478	-.49922	-2.306	29	.028
Pair 10 Third - Normal	-3.64379	10.42926	1.93666	-7.61087	.32328	-1.881	28	.070

Figures

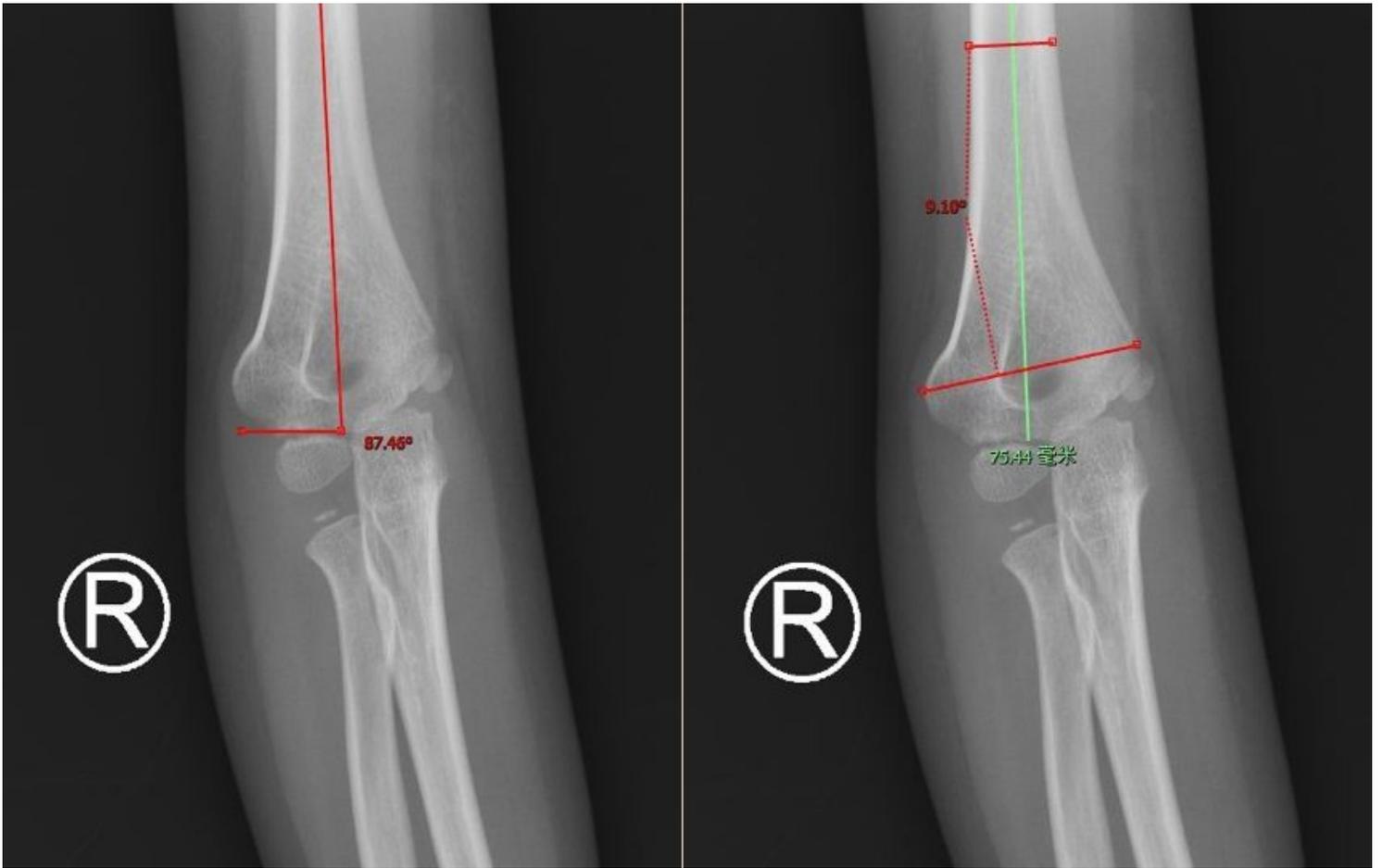


Figure 1

Baumann angle and H-cobb angle measurement method

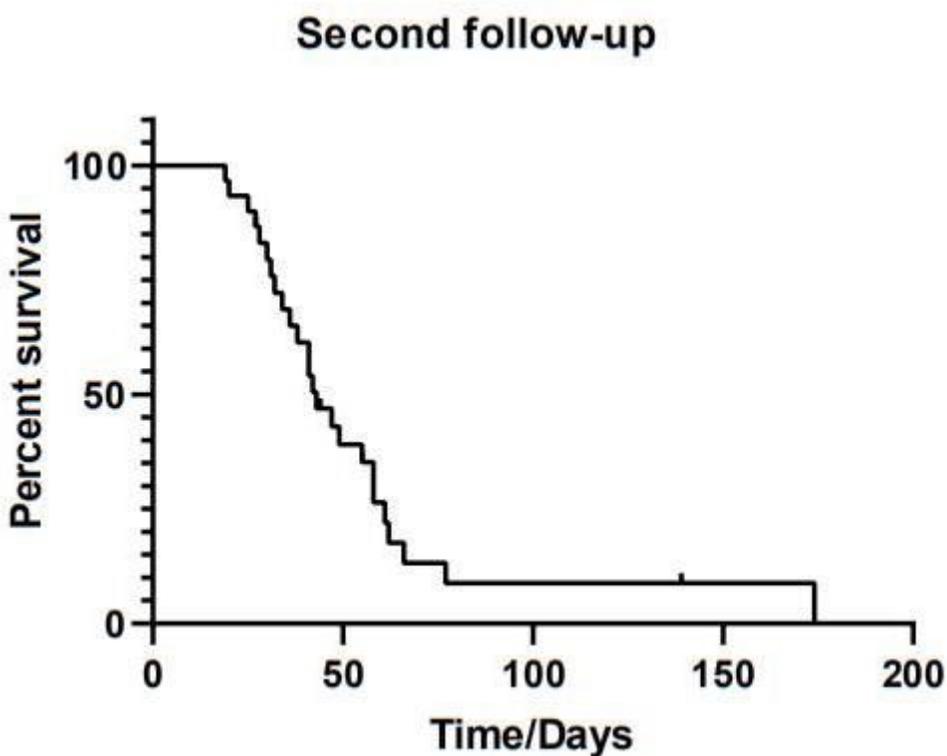
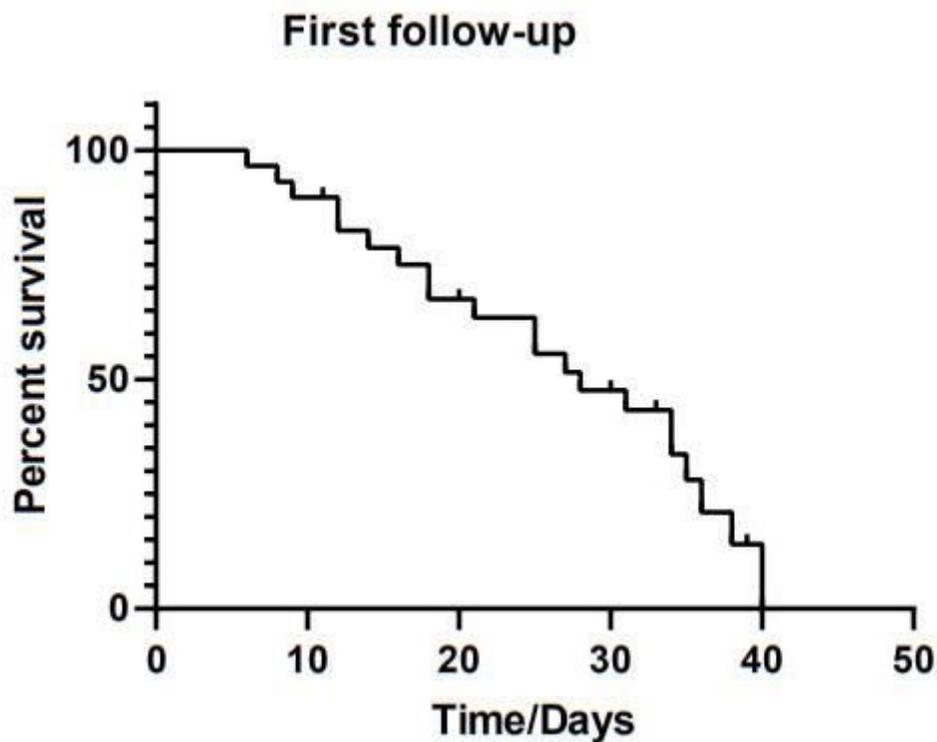
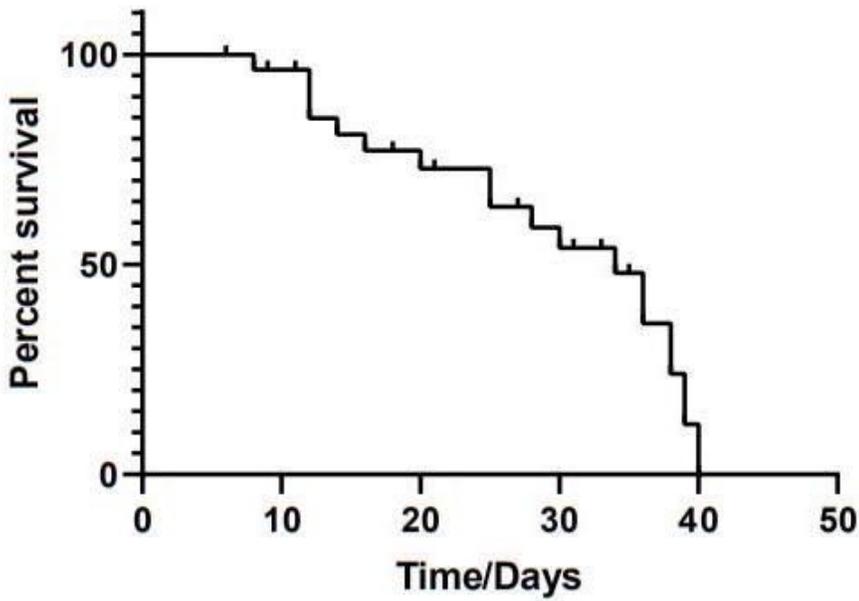


Figure 2

According to the survival curve analysis, we can see that the median survival time of the H-cobb angle and the Baumann angle is. From Figures 2 and 3, we can see that the children's angle loss during the second postoperative follow-up is in a state of continuous loss. At the third postoperative follow-up, the angle loss of the children was stable, so we have reason to believe that the angle loss of most children had stopped before the third follow-up.

Baumann angle

First Follow-up



Second Follow-up

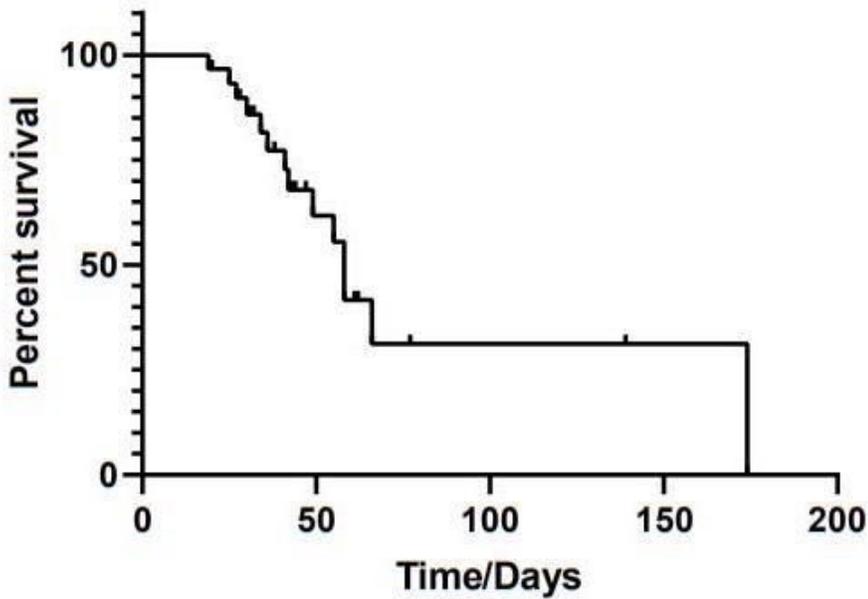


Figure 3

According to the survival curve analysis, we can see that the median survival time of the H-cobb angle and the Baumann angle is. From Figures 2 and 3, we can see that the children's angle loss during the second postoperative follow-up is in a state of continuous loss. At the third postoperative follow-up, the angle loss of the children was stable, so we have reason to believe that the angle loss of most children had stopped before the third follow-up.

Data 3

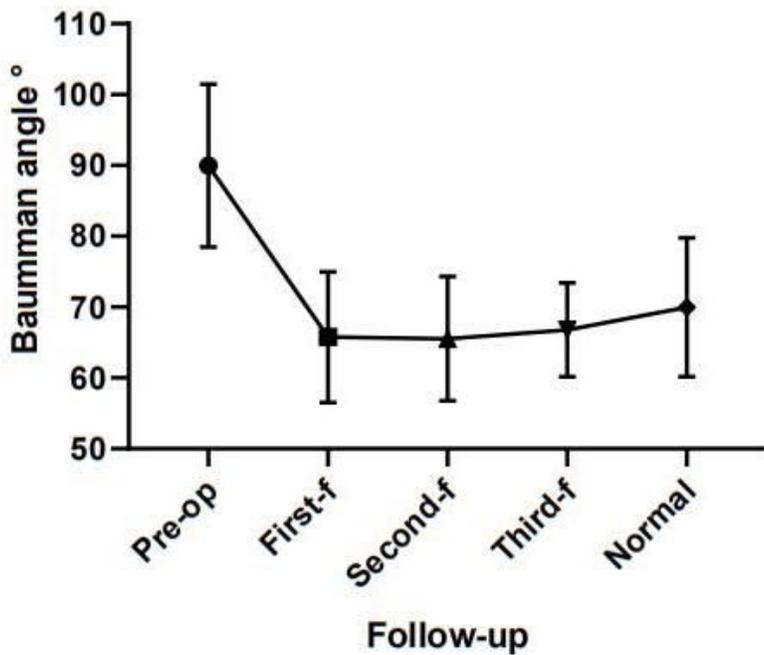
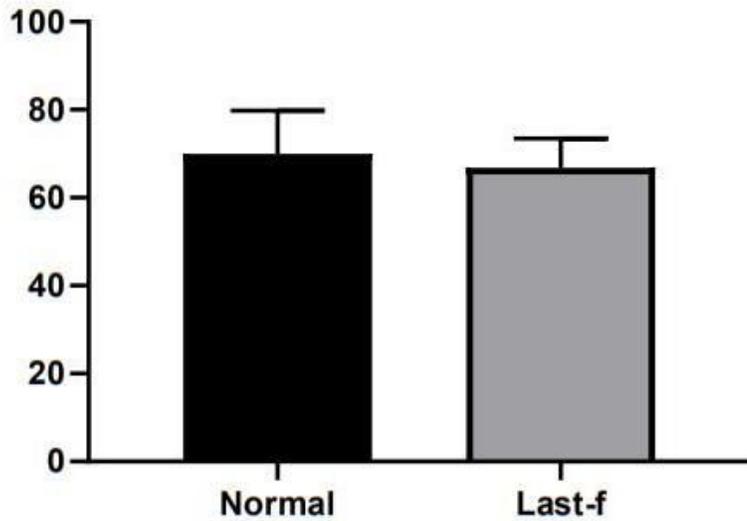
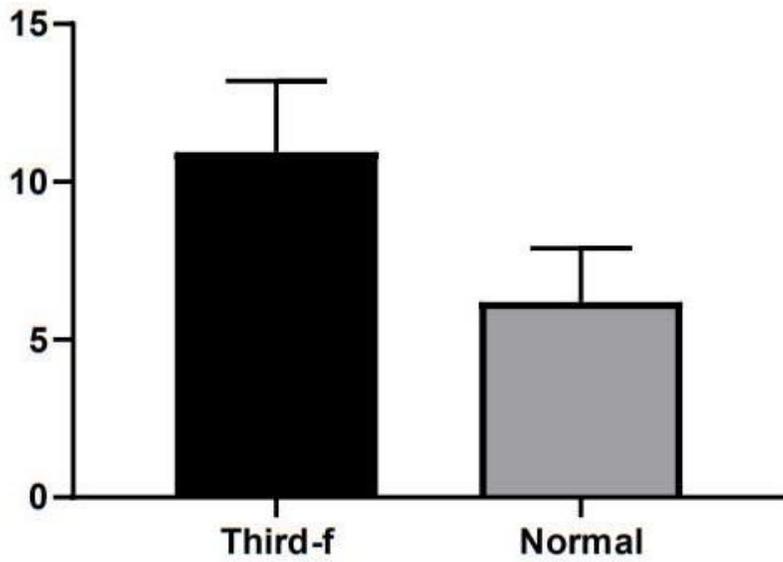


Figure 4

the H-cobb angle and Baumann angle were significantly improved after surgery. The value of the Baumann angle of the affected limb at the last follow-up was not significantly different from that of the healthy side. However, there was a statistical difference in the H-cobb angle value between the last follow-up and the healthy side.

Data 5



Data 4

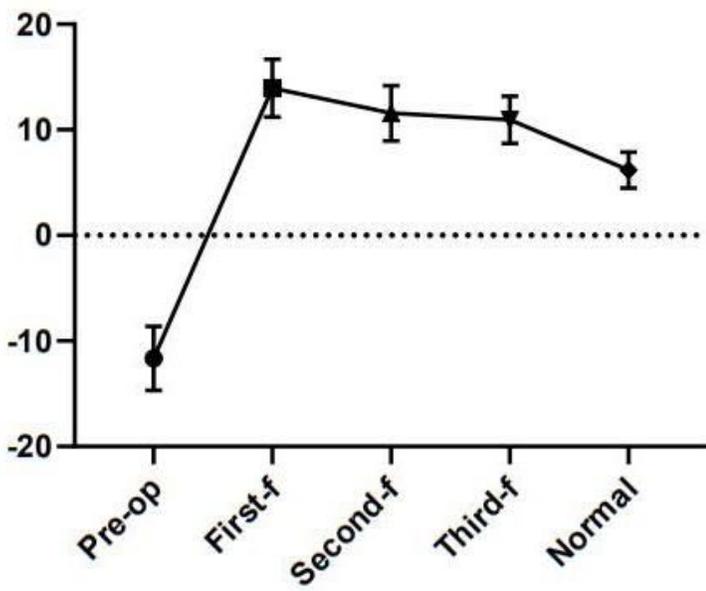


Figure 5

the H-cobb angle and Baumann angle were significantly improved after surgery. The value of the Baumann angle of the affected limb at the last follow-up was not significantly different from that of the healthy side. However, there was a statistical difference in the H-cobb angle value between the last follow-up and the healthy side.