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COMPARATIVE ANALYSIS OF THE EFFECTIVENESS OF THE INCISION DESIGNS BY BAYNE AND EVANS IN THE CORRECTION OF CONGENITAL RADIAL CLUBHAND IN CHILDREN

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Introduction. In 1733, Petit first described the deformation of the forearm, congenital radial clubhand. A large number of modifications in the surgical treatment of this deformation have been developed. In the available literature, there is no comparative analysis of the applied designs of the sections.

Aim. The goal is a comparative analysis of the effectiveness of the use of dorsal rotation flap by Evans, and incision designs by Bayne, in the correction of congenital radial clubhand in children.

Material and methods. Between 2013 and 2016, block randomization of 40 children with congenital radial clubhand was used and grouped by procedures. Surgical correction was performed using two different incision designs (the first group by Bayne and the second by Evans). The analysis of the early postoperative complications was performed. The evaluation in the late postoperative period of soft tissue condition of the forearm using a pinch test, Vancouver scale, and a visual analog scale was carried out.

Results. Based upon gender, patients were divided with male predominance in both groups with 7 girls and 13 boys in the first group, and 8 girls and 12 boys in the second group. In the immediate postoperative period, marginal necrosis was observed in the first group (35%). In the late postoperative period, the study showed an advantage of using dorsal rotation flap by Evans versus the incision designs by Bayne.

Conclusion. Using incision designs by Evans with the formation of a dorsal rotation flap provided a more aesthetic and functional result.

Keywords: congenital radial clubhand, dorsal rotation flap by Evans, incision designs, surgical treatment.

СРАВНИТЕЛЬНЫЙ АНАЛИЗ ЭФФЕКТИВНОСТИ ДИЗАЙНОВ РАЗРЕЗОВ ПО BAYNE И EVANS ПРИ КОРРЕКЦИИ ВРОЖДЕННОЙ ЛУЧЕВОЙ КОСОРУКОСТИ У ДЕТЕЙ

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Введение. В 1733 г. Petit впервые описывает деформацию предплечья — врожденную лучевую косорукость. Разработано большое количество модификаций оперативного лечения данной деформации с применением разнообразных дизайнов разрезов. В доступной литературе отсутствует сравнительный анализ применяемых дизайнов разрезов.

Цель исследования — сравнительный анализ эффективности использования тыльного двухлепесткового лоскута по Evans и дизайна разрезов по Bayne при коррекции врожденной лучевой косорукости у детей.

Материалы и методы. С 2013 по 2016 г. выполнена блоковая рандомизация 40 детей с врожденной лучевой косорукостью на две группы. Хирургическая коррекция проводилась с использованием двух различных дизайнов разрезов (первая группа — по Bayne и вторая — по Evans). Проведен анализ ближайших послеоперационных осложнений. Выполнена оценка в отдаленном послеоперационном периоде состояния мягких тканей предплечья с использованием щипковой пробы, шкалы Ванкувера и визуальной аналоговой шкалы.

Результаты исследования. По полу пациенты были распределены с преобладанием мужского пола в обеих группах: в первой 7 девочек и 13 мальчиков, а во второй — 8 и 12 соответственно. В ближайшем послеоперационном периоде отмечались краевые некрозы преимущественно в первой группе (35 %). В отдаленном

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послеоперационном периоде исследование показало преимущество тыльного двухлепесткового лоскута по Evans перед дизайном разрезов по Bayne.

Выводы. Использование дизайна разрезов по Evans с формированием двухлепесткового лоскута по сравнению с дизайном разрезов по Bayne позволяет получить более эстетический и функциональный результат.

Ключевые слова: врожденная лучевая косорукость, двухлепестковый лоскут по Evans, дизайн разрезов, хирургическое лечение.

Introduction

The first mention of congenital radial clubhand was noted in 1733 when Petit described the bilateral deformity of the forearm and the hand in a stillborn male fetus. Many authors have pointed out the characteristic clinical signs of congenital radial clubhand: saber-like deformity of the forearm, palmar-radial deviation of the hand, hypoplasia of the first finger, abnormality of development of the three-phalangeal fingers [1]. However, the state of soft tissues, namely, the skin, was not taken into consideration.

For more than a century after its first mention, no publications emerged on the methods of the surgical treatment of congenital radial clubhand. In 1894, Sayre published a detailed article describing the causes of radial clubhand. He proposed a basic technique of surgery consisting of fixing of a hand on an ulnar bone. This was achieved by forming a depression in the bones of the proximal row of the wrist bones, excision of the soft tissue interpanat, partial resection of the distal segment of the ulnar bone, and fixing them with each other. Subsequent methods proposed for surgery were in most cases different modifications of the one described by Sayre [2-4].

With the development of hand surgery, new methods have been described in the treatment of congenital radial clubhand. Blauth (1969) demonstrated his experience in the treatment of 89 patients by analyzing the anatomical features and demonstrating the results of surgical treatment [4]. However, the incision made in this case did not differ significantly; linear access was also employed, but with a different length. The continuation of the incision to the dorsal surface of the hand as described by Sayre was not performed. In the author's opinion, such access is optimal for the visualization of anatomical structures. Correction of the excess of soft tissues along the ulnar margin of the forearm was not performed [4].

According to Lamb (1979), the making of a linear incision restricts the view of the surgical field. The proposed arc-shaped incision allowed a more convenient access [5]. Buck-Gramcko concurs by performing an S-shaped access on the rear surface of the forearm [2].

At the same time, the design of the incisions was developed, which enabled the displacement or correction of excess skin on the ulnar margin of the forearm. According to Watson, Z-grafting on the radial and ulnar margins leads to a decrease in tension and tissue redistribution [6]. However, Bayne and Klug disagree and implement the Z-grafting on the radial surface of the forearm in combination with the excision of excess skin along the ulnar margin [7].

A completely new technique of skin redistribution was suggested by Evans (1995). He used the method of dorsal rotation flap developed by Esser [8]. In this technique, the first rotation flap was formed along the ulnar margin in the projection of skin excess, and the second was formed on the dorsal surface of the hand, with the continuation of the incision in the transverse direction to the radial surface, to the area of the skin deficiency [9].VanHeest and Grierson (2007) described a modification of the rotation flap of the dorsal surface of the forearm. The rotation flap was formed mainly on the dorsal surface with transition to the ulnar surface. The remaining excess skin was excised [3, 10]. This did not enable the adequate use of existing tissues to supplement the skin deficit along the radial margin of the forearm. Vuillermin et al. (2015) modified the Evans flap by forming it on the inner surface of the forearm and unfolding it by 180°. The difference was in the position of the second rotation flap located on the forearm, but not on the hand [11].

The analysis of the accesses used by different authors to perform the centering or radialization of the hand enabled to categorize incision designs into 2 groups having fundamental differences. Group 1 consisted of incisions that provided access to only anatomical structures. Group 2 was formed by incisions ensuring the redistribution of excess

soft tissue located along the ulnar margin of the forearm. However, available literature does not provide a comparative analysis of various methods that aid in assessing the efficacy of the proposed designs described above.

In the present study, our aim was the comparative analysis of efficacy of the dorsal rotation flap by Evans and the incision design by Bayne for the correction of congenital radial clubhand in children.

Materials and methods

This study was conducted in the department of hand reconstructive microsurgery and surgery of the Turner Scientific and Research Institute for Children's Orthopedics between 2013 and 2016. Block randomization of 40 children with congenital radial clubhand of IV degree into 2 groups (classification by Bayne and Klug) was performed. All patients (or their representatives) voluntarily signed and provided an informed consent for participating in this study and for undergoing surgical intervention. For patients in group 1, the incision design proposed by Bayne was used (Fig. 1). For patients in group 2, the incision design described by Evans was used to form the dorsal rotation flap (Fig. 2).

In both groups, the age of patients at the time of surgical treatment ranged from 11 months to 2 years (the mean value was 1.2 ± 0.5 years).

There was a preponderance of male patients, with 13 boys and 7 girls in group 1. There were 12 boys and 8 girls in group 2. The follow-up period was from 6 months to 5 years (mean value was 2.4 ± 0.7 years).

The condition of the soft tissue of the forearm and hand was evaluated in the immediate postoperative period and at least 6 months after the surgical intervention. In the immediate postoperative period, all patients were assessed for evidence of marginal necrosis of the displaced flaps; the area of necrosis was also measured.

On long-term follow-up, the state of soft tissues was assessed by controlling the skin mobility on the radial margin of the forearm by performing a pinch test. The researcher pinched a fold of the patient's skin using the tips of the first and second fingers in a transverse direction to the axis of the forearm of the patient. The test was evaluated as positive in cases where it was possible to make a skin fold, and in other cases it was evaluated as negative.

To assess the condition of postoperative scars, the Vancouver scale was used. Four criteria were studied: pigmentation (0–3 points), elasticity (0–5 points), height (0–3 points), and vascularization (0–3 points).

The assessment of satisfaction with the cosmetic result after the deformity correction was performed using a visual analog scale (Fig. 3). This was carried out with the help of parents, who were asked to assess the cosmetic state of postoperative scars, but not the extent of deformity correction itself. This was because parents may be satisfied with the correction of radial deviation of the hand, but not with the cosmetic state of postoperative scars. The minimum score indicated satisfaction with the result.

Results of the study

The main purpose of the incisions performed is to ensure optimal access to the underlying structures. In both groups, the incision designs provided sufficient visualization necessary to perform the correction of congenital radial clubhand.

The assessment of the condition of the displaced flaps in the immediate postoperative period revealed

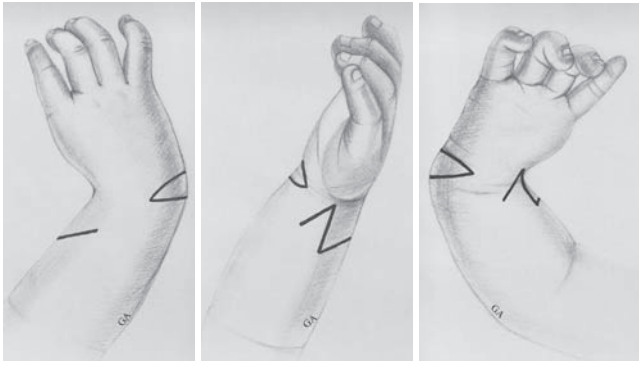

Fig. 1. Incision Designs as proposed by Bayne

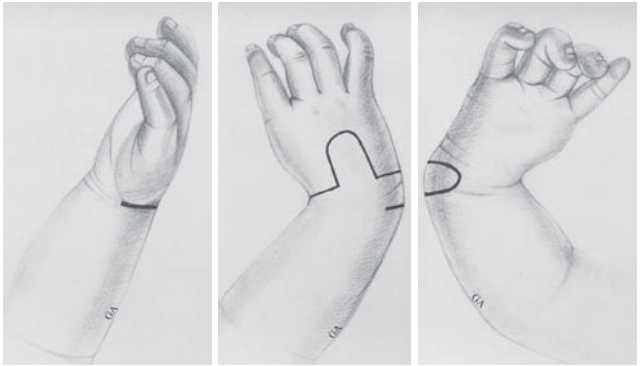

Fig. 2. Incision Designs as proposed by Evans for the formation of a dorsal rotation flap

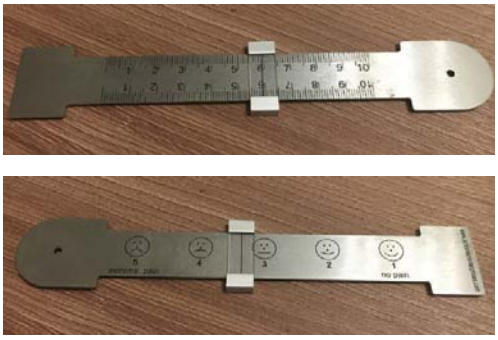

Fig. 3. Visual analog scale

Fig. 4. Appearance of the hand and forearm with the incision design by Bayne before surgical treatment

Fig. 5. Appearance of the scar 1 year after the surgery

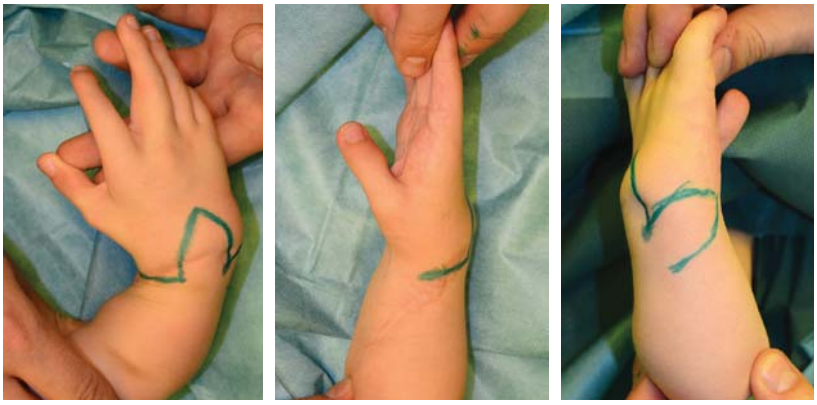

Fig. 6. Appearance of the hand and forearm with marking of the dorsal rotation flap by Evans before the surgical treatment

Fig. 7. Result 6 months after the application of the dorsal rotation flap by Evans in a patient with TAR syndrome

marginal necrosis in 7 patients (35%) of group 1, whereas in group 2 it was noted only in 2 patients (10%). The area of necrosis varied from 2 to 8 cm^2 (mean 4 ± 0.9 cm^2). There were no significant differences noted in the areas of necroses in both groups; however, this was more frequent in group 1 ($p < 0.05$).

On long-term postoperative follow-up period, a control examination was performed for evaluation of the skin and postoperative scars, followed by photographic documentation.

Assessment of skin mobility on the radial margin of the forearm showed a positive pinch test in 3 patients and negative in 17 patients in group 1.

In group 2, this test was positive in 16 cases and negative in 4 patients.

The total number of points on the Vancouver scale in assessing the condition of the scars varied in group 1 from 3 to 8 points (mean value 5 ± 2.4), and in group 2 it was from 0 to 7 points (mean value 3 ± 1.7), $p < 0.05$. A detailed analysis of the assessment of the condition of postoperative scars by the Vancouver scale in group 1 showed that the mean score values amounted to the following: pigmentation of the scar, 0.8; elasticity, 2.7; height of the scar, 1.1; and vascularization, 0.2. In group 2, these indicators differed toward decrease as follows: pigmentation of the scar, 0.75; elasticity, 0.9; height of the scar, 0.3; and vascularization, 0.2.

Satisfaction with the cosmetic appearance of postoperative scars was assessed using a visual analog scale, with the help of parents. In group 1, the score varied from 5.2 to 8.4 (mean value 7.4 ± 1.5), while in group 2 it varied from 2.1 to 4.7 (mean value 2.5 ± 0.7), $p < 0.05$.

The clinical example of the use of the incision design by Bayne is provided below.

The marking was made on the radial surface, in the projection of maximum tension. Fig. 4 demonstrates congenital radial clubhand in a patient aged 1 year. The hand is located in the palmar-radial deviation, and along the ulnar margin there is marked skin excess. The first stage eliminates the tension along the radial margin of the hand with the help of Z-grafting. After moving the hand to the central position, the amount of skin to be excised along the ulnar margin is accurately determined. In the immediate postoperative period, no marginal necrosis of the displaced flaps was detected. One year after the surgical correction of the deformity, a deficiency of soft tissues was noted: the pinch test showed negative results. When assessing the condition of the scar on the Vancouver scale, scar pigmentation was not detected; elasticity was 2 points, the scar height in some places exceeded 2 mm, and vascularization was 0 points (Fig. 5). Satisfaction with the esthetic state of the postoperative scars was 4.7 points, which was caused by the condition of the postoperative scar palpable in some areas in the form of a dense band.

A clinical example of the application of a rotation flap by Evans in a 3-year-old with thrombocytopenia with absent radius (TAR) syndrome is presented below. This syndrome is characterized with a marked deficiency of skin along the ulnar margin of the forearm, palmar-radial deviation of the hand, and preserved first ray of the hand (Fig. 6). In the immediate postoperative period, no marginal necrosis was noted. Evaluation of the state of soft tissue was performed 6 months after the surgery. The pinch test showed positive results. When assessing the condition of the scar on the Vancouver scale, scar pigmentation was not observed, the elasticity was 1 point, the height of the scar was at the same level with the skin, and vascularization was 1 point (Fig. 7). Satisfaction with the esthetic state of the postoperative scars was 3.2 points, which was caused by persistent vascularization due to incomplete formation.

Discussion

Radial clubhand is a congenital malformation of the upper limb, characterized by longitudinal hypoplasia of the forearm and hand on the radial surface [1]. Characteristic signs, as described previously [2, 5, 7], include saber-like deformity of the forearm and palmar-radial deviation of the hand. This, in our opinion, is also an indirect sign of skin deficit along the radial margin of the forearm.

Group 1 showed a high incidence of marginal necrosis in the immediate postoperative period. This is caused by the existing skin deficiency and tension on skin flaps, despite Z-grafting. The author of this technique does not describe this type of complication [9].

In group 1, all patients had a decrease in soft tissue tension along the radial margin of the forearm, but the skin deficit persisted, whereas in patients of group 2, there was no soft tissue deficiency. Evans indicates a uniform distribution of skin with the use of a dorsal rotation flap [9], which was also noted in patients of group 2 and was confirmed by the pinch test.

Analysis of postoperative scars using the Vancouver scale indicated the changes in elasticity and height of postoperative scars in group 1. The formation of scars in group 1 was of the hypertrophic type. The reason for this is the frequency of marginal necrosis in the immediate postoperative period, caused by impaired blood flow in the displaced flaps due to tension.

Most parents were satisfied with the overall results of surgical correction of existing deformities. However, when assessing the cosmetic state of postoperative scars,

satisfaction was significantly higher in the group using the Evans incision, which corresponds to the results reported in the studies by Evans, but does not concur with the data reported by Bayne and Klug [7, 9].

Conclusions

1. The state of the skin in children with congenital radial clubhand is characterized by a deficiency along the radial margin of the forearm and skin excess along the ulnar margin.

2. Local Z-grafting in the projection of soft tissue tension does not allow full correction of the skin deficiency. Simple excision of excess skin along the ulnar margin aligns only the outline of the forearm.

3. A number of postoperative complications, accompanied by edge necrosis of the displaced flaps, prevailed in the patients of group 1 and resulted in unsatisfactory cosmetic results.

4. Application of the incision design proposed by Evans allowed the effective use of excess skin on the ulnar margin and its uniform redistribution to the forearm.

Thus, the present study demonstrated high efficiency in the application of the dorsal rotation flap by Evans in comparison with the incision design by Bayne.

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