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Neglected Monteggia Lesion in Children (Meta-Analysis of Published Series)

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Original Research Article

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Abstract: Neglected Monteggia lesion is defined as a combination of ulnar fracture and dislocation of the radial head seen at least 4 weeks after the trauma causing it. The treatment of these lesions represents a challenge and a subject of debate in pediatric traumatology. This is a meta-analysis based on case series published online during the previous 40 years whose objective is: To establish an epidemiological, clinical and radiological profile of patients suffering from this lesion. To specify the techniques used in the management, and to compare their results and their complications. 45 case series were included in our study. The total number of patients in these series was 606. 54.11% of patients were male and 45.89% female. The average age at the time of the trauma was 6.7 years. The lesion concerned the right side in 56.63% and the left side in 43.37%. Radiologically, Bado's classification was the most widely used; 81.65% of the lesions were type I, 11.85% were type III, 4.92% type II, and 1.65% type IV. The average duration between injury and therapeutic care was 13.3 months, 99.3% of patients were treated surgically. The Boyd's procedure was the most used (54%). Bouyala's operation was performed in more than three quarters of the cases included (76.5%). The average follow-up period in all series was 49.95 months. One in three patients had a postoperative complication (34%), The subluxation of the radial head was the most frequent (24.7% of complications). The comparison of the techniques used in the management of the neglected Monteggia lesion showed that the Bouyala's procedure without ligamentoplasty provides the best functional result and the lowest complication rate postoperatively.
Keywords: Monteggia - neglected - child - fracture dislocation - Bouyala.

INTRODUCTION

The Monteggia lesion is defined by the association of a fracture of the ulnar axis of type and variable seat, and dislocation of the radial head [1]; it owes its name to the Italian surgeon Giovanni Baptista Monteggia who made his first description in 1814.

It is a relatively rare lesion, accounting for 1.7% of forearm fractures in a Bado cohort with 3200 cases [1]. This lesion results most often from an indirect mechanism by hyper-pronation of the forearm during a fall on the palm of the hand or by hyper-extension [2].

The positive diagnosis of this lesion is based on a good quality radiograph taking the elbow and forearm of the affected limb in front and in profile which allows to detect the two components of the lesion: the ulnar fracture which is often obvious, and dislocation of the radial head using the construction of the Stören line [2- 4].

Several radiological classifications of the lesion have been proposed, the most used is that of Bado which classifies the lesion into 4 types with a group of "equivalents of the lesion" [1]. This Fracture-dislocation represents a classic diagnostic trap in pediatric traumatology [3].

About 25 to 50% of these lesions are initially unknown by health professionals [5]. The lesion considers itself "chronic" or "neglected" if it is managed 4 weeks after the trauma [6].

The high rate of negligence is explained by:

- The rarity of the lesion.
- The clinical and radiological predominance of the ulnar fracture on dislocation of the radial head, leading to misdiagnosis and therefore inadequate treatment [7].
- The peculiarities of fractures in children which are often not very displaced: plastic fractures, fractures in green wood, fractures in butter ball [7].
- Progressive bone maturation in the pediatric population, which complicates radiological interpretation [3].
- the use of traditional fracture treatment methods such as "jbira", especially in developing countries.

The result of this negligence is the constitution of fibrosis around the radial head, which is clinically

translated by the limitation of the elbow movements and the prominence of the radial head in the short term; in the long term there is a progressive deterioration of the function of the elbow with the appearance of pain with the effort, and the discontinuity of the external column of the forearm decreases the strength of the elbow and creates a cubitus little by little valgus with asymmetric growth of both forearm bones that can lead to neurologic complications by stretching the ulnar or posterior interosseous nerves [4].

Unlike the recent Monteggia lesion where treatment is simple and usually orthopedic, the management of chronic Monteggia lesions is complex and represents a therapeutic challenge in pediatric traumatology, it is primarily surgical because fibrosis prevents any orthopedic reduction. [9], several surgical techniques have been proposed:

- Blood reduction of the radial head after resection of fibrous tissue interposed with or without trans-capillary-radial racking, with or without reconstruction of the ring ligament.
- Osteotomies of the ulna and / or radius.
- Resection of the radial head at the end of growth.
- Associations of several techniques such as:

The intervention of Bouyala: it is a combination between an open reduction of the radial head and a high osteotomy of the ulna with or without reconstruction of the ring ligament [8]. The ilizarove procedure: consists of an ulnar osteotomy with progressive lengthening using an external fixator [9].

So far there is no consensus on the ideal technique for treating the neglected Monteggia lesion, the publications on the subject are very heterogeneous and sometimes controversial and the therapeutic indications are poorly specified.

In this work we conducted a retrospective study (meta-analysis) based on the series of cases of "neglected Monteggia lesion in children" published online during the previous 40 years (1977-2017) whose purpose is:

- To establish an epidemiological, clinical, and radiological profile of patients with this lesion.
- To specify the therapeutic techniques used in the treatment.
- To evaluate the results of the therapeutic techniques used and to specify their complications.
- Compare the results and complications obtained after each technique.

MATERIALS & METHODS

A search in the literature was conducted using online databases and targeting the keywords of this pathology. The summary of each result was examined, interesting articles were recorded for a second, more detailed analysis.

The full texts of the articles have been researched and analyzed. We included in our studies, case series that were published between 1977 and 2017 that reported more than 2 cases of patients under the age of 18 treated for post-traumatic "Monteggia injury" supported at more than 4 weeks of initial (chronic) trauma.

Epidemiological, radiological, and therapeutic data were extracted on Microsoft Excel sheets from the full texts. The comparison of the therapeutic results between all the included series was not possible because of the heterogeneity of the evaluation systems used, so the comparison was limited to the series that used the most common means of evaluation: performance of Kim's elbow).

Statistical exploitation of the data was done by non-parametric tests; Anova significance test at a factor of 5%, and Spearman's correlation test.

RESULTS

The total number of abstracts initially recorded was 680. After a more detailed review and application of the inclusion criteria, 45 case series were included in our systematic review. The total number of cases in these series was 606 patients.

The largest series was Garg *et al*. [10] with 63 cases, the number of patients was less than or equal to 10 in 46% of the included series, less than 20 in 77%, less than 30 in 95% , with only 2 series that reported more than 30 cases Garg *et al*. [10] and Lu *et al*. [11].

- The age of the patients at the time of the trauma was between 10 months and 15 years with an average of 6.7 years.
- The sex of the patients was mentioned for 486 out of 606 cases. 54.11% were male and 45.89% female.
- The laterality of the lesion was specified in 25 out of 45 series. The right side was reached in 56.63%, the left in 43.37%.
- Only 6 series that specified the cause of the trauma [12-17]. The most common causes were: Simple falls during walking, during domestic games, falls during sports activities (football, cycling ...), AVP and assault.

The reason for consultation was specified in 22 series. The most common symptoms found in patients were in order of decreasing frequency:

- Limitations of elbow and forearm mobility: flexion/ extension deficit was more common than pronation / supination deficit.
- Deformities of the elbow and forearm: the deformity in ulna valgus was the most frequent followed by the prominence of the radial head.
- Elbow pain.
- Paralysis of the radial nerve.

- Slamming the mobilization of the elbow.

34 series mentioned the radiological type of the lesion. According to the Bado classification [1]: 81.65% of the lesions were type I, 4.92% were type II, 11.85% type III and 1.65% type IV.

Therapeutic abstention was decided in 2 patients (0.33% of patients). Orthopedic treatment in 2 patients (0.33% of patients). 99.3% of the patients were treated surgically.

- The age of patients at the time of surgery ranged from 11 months to 18 years with an average of 7.8 years. According to the Spearman test, there was no statistically significant correlation between age at the time of surgery and postoperative functional outcome (Kim elbow performance score). [R = 0.42204, bilateral value P = 0.34559].
- The delay between injury and trauma ranged from 4 weeks to 10 years, the mean was 13.3 months. Spearman's nonparametric test did not show a statistically significant correlation between duration of neglect of the lesion and postoperative functional outcome (Kim's elbow performance score). [R = -0.08369, the bilateral value of P = 0.51783]
- The approach was specified for 494 cases. Boyd's route was the most used (54%), followed by Kocher (32.8%), Henry (11.33%), and Kalpan (1.2%).

Surgical procedures performed being

- A surgical reduction of the radial head in 43 series (90% of patients).
- Trans-capitulo-radial stall was performed to maintain the reduction of the radial head in 25 series (selective cases in 12 series) and in 37.5% of patients.
- Reconstruction of the ring ligament in 50% of patients (The graft used was the fascia of triceps in 62% of cases, the fascia of the forearm in 15.4%, the fragments of the ring ligament and the long palmar muscle in 8.4% each, and the fascia lata in 5.4%).
- Ulnar osteotomy: 523 of the 606 patients underwent the procedure, ie 86%.
- The over-corrective transverse osteotomy with angulation-distraction-elongation described by Hirayama *et al*. [18] and Bouyala et al [8] was the most widely practiced.
- The most common site of the osteotomy was proximal metaphyseal, followed by osteotomy of the fracture site in 8 series and diaphyseal osteotomy in 4 series.
- The most commonly used osteotomy fixation device was the screwed plates followed by the screws alone, then the medomedullary racking and the external fixator.
- Radial osteotomy in 14 patients (2.3% of cases).
- Rectal head resection in 10 patients (1.65% of cases).
- Plasty of the radial head in 2 patients (0.33%).

The intervention of Bouyala (combination of open reduction and proximal ulnar osteotomy) with reconstruction of the ring ligament was the most used (41.7%), followed by the intervention of Bouyala without reconstruction of the ring ligament (34), 8%). The mean follow-up in all series was 49.95 months, ranging from 10 months to 26 years.

The authors used heterogeneous means of evaluation, the most common were

- Kim's elbow performance score: in 16 out of 45 series, 35.5% (223 cases).
- The Mayo Elbow Performance Index (MEPI): in 9 out of 45 series or 20% (197 cases).
- Bruce *et al*. and modified Bruce score by Letts *et al.* in the Hirayama *et al*. series [18] and the Inoue and Shionoya series [19] (21 cases).
- Score of the oxford elbow: in the series of Rahbek *et al*. [20] (16 cases).

In the other series no score was used, the evaluation of clinical results was by comparing the range of motion of the elbow and forearm before and after treatment.

- The radiological evaluation was by intraoperative radioscopy and then by standard radiography of the elbow and forearm immediately postoperatively and during follow-up in search of complications.
- 20 different complications were found, with a total of 206 complications in all included series. 34% of cases had a postoperative complication.

The subluxation of the radial head was the most common, it represented 24.7% of complications followed by the reluxation of the radial head, infection of the operative site, the hypertrophy of the radial head, delayed consolidation, osteoarthritis of the elbow, ulna valgus, pain and blockage of the elbow, secondary displacement, radio-ulnar synostosis, pseudarthrosis, paralysis of the ulnar nerve, posterior interosseous nerve, radial nerve, heterotopic ossification, compartment syndrome, elbow instability.

The comparison was between the 4 most used surgical procedures, it concerned the clinical result and the rate of postoperative complications.

Due to the heterogeneity of the clinical outcome measures used in the included series, we limited the comparison to the studies that used the Kim score. Finally, 13 series were included in the comparison with a total of 134 cases treated with 4 surgical procedures.

- 55 were treated by the Bouyala technique (open radial head reduction associated with a high ulnar osteotomy) with reconstruction of the ring ligament: 78.2% of patients had an "excellent" Kim score postoperatively, 18, 2% had a "good" score, and 3.6% had a "fair" score, 23.6% of patients had a postoperative complication.

- 36 cases were treated by the Bouyala technique without reconstruction of the ring ligament, of which 83.3% had an "excellent" Kim score postoperatively and 16.7% had a "good" score, the complication rate was 13.8%.

- 15 patients underwent open reduction of the radial head with reconstruction of the ring ligament, the postoperative Kim score was "excellent" in 80% of cases and "good" in 20%, the complication rate was 26.6 %.

- 28 patients were treated with ulnar osteotomy alone, the postoperative Kim score was "excellent" in 89.3% of cases, "good" in 3.6%, and "fair" in 7.1%. Complication rate was 46.4%.

DISCUSSION

The treatment of the Monteggia lesion represents a challenge in traumatology since the first description of the lesion until today, several surgical gestures have been proposed to treat this fracture-dislocation. While some authors prefer to use isolation, others find that their association with surgical procedures is more beneficial.

In the series included, the elbow was approached by several ways including

- The Postero-Lateral Boyd [21]: was the most used, 54% of operated elbows were approached by this route. This is Ollier's way, modified by Cadenat then taken over by Speed and Boyd in 1940 [9]. Some authors have observed posterolateral instability and radioulnar synostosis after the Boyd approach [22]. Gordon proposed a modification of the Boyd approach that preserves the vascularity of the proximal ulnar fragment and reduces the risk of radioulnar synostosis [22,23]. Currently the authors recommend the Boyd pathway with modifications made by Gordon to approach the elbow in case of Monteggia lesion because of the potential danger of the classical pathway [22,23].
- The external Kocher route [23,24]: was used in 32,8% of the cases included in our study.
- Henry's anteroposterior [22-24]: 11.33% of cases were treated by this route.
- The Kalpan pathway: has been used in the Degreef and De Smet series [25] in only 6 patients (1.2% of cases). It is a classical, first lateral approach of the elbow that passes between the short and long extensor muscles of the carpus.

The bloody reduction of the radial head is an essential step in the treatment of the neglected lesion of Monteggia, it was performed in 90% of the cases included in our study. The radial head can then be held in place by trans-capituloradial racking or by repairing the ring ligament either by simple sutures or by reconstruction from a muscular fascia.

There are 2 techniques for laying the trans-capitulo-radial spindle

- Put the pin at the beginning of the procedure to practice ulnar synthesis under better conditions, the pin is removed at the end of the procedure.
- Typical placement at the end of the procedure of a Kirschner wire transfixing the capitulum and the radial epiphysis by fixing the radial neck in a good position. In our study, conventional plugging was used in 37.5% of patients.

The ring ligament is replaced by a plasty passed through a tunnel dug in the ulna, it ties the radial neck with moderate tightening and returns to fix itself. Plasty can be taken from different sites: the triceps fascia [26], the forearm fascia [21], the annular ligament debris, the long palmar muscle, fascia lata.

This technique has been able to give some success, but the tension to be given to the reconstituted ligament is difficult to measure [9]; if it is too tight, it promotes stiffness, if it is too loose, it encourages recurrence. In the series included in our study, 50% of patients underwent the procedure.

The disadvantage is that this technique requires prolonging the incision at the proximal portion of the scar. In the series of Garg *et al.* [10] a comparison was made between ligamentoplasty according to the Bell-tawse procedure, and reconstruction of the ring ligament from the long palmar muscle. The authors concluded that the latter offers more radial head stability.

There are several types of ulnar osteotomy ranging from the simple ulnar diaphyseal osteotomy to the fracture site; hyper-corrective proximal osteotomy of the ulna; plane-oblique osteotomy; transverse osteotomy. The latter has the advantage of correcting all dislocation situations of the radial head. In our study; Eighty-six per cent of the patients underwent the procedure, and the hyper-corrective proximal transverse osteotomy with angulation-distraction-elongation was the most common. Osteosynthesis of the osteotomy site was performed by targeted plaques in most cases. Garg *et al.* [10], Horri *et al.* [27], and Inoue and Shionoya [19] compared the hyper-corrective osteotomy of Bouyala and the simple osteotomy, they concluded that the results obtained by the first are better. Megahed *et al.* [27] modified the Bouyala osteotomy by performing a "V" osteotomy followed by flexion-elongation; according to them, this modification offers more

stability to the operating site and reduces the risk of nonunion.

The radial osteotomy [28, 29] is an osteotomy of shortening and derotation of the radius below the insertion of the pronator teres, its goal is to maintain the radial head in place by the tension that gives the square ligament, The upper fragment is fixed in pronation or supination according to the luxation direction. It is mainly used to treat congenital dislocation of the radial head.

This gesture was performed in 2.3% of cases included in our study, and always in combination with other surgical procedures. The resection of the radial head is a last resort treatment that should be performed very rarely and as late as possible, only has its place when the radial head is irreducible and dystrophic [30].

Most realizes an association of these different surgical techniques for a better result.

- The intervention of Bouyala [8]: Was the most widespread surgical procedure in our study; was performed in more than three quarters of the cases included (76.5%). this procedure was associated with ligamentoplasty in 41.7% of cases, and without ligamentoplasty in 34.8% of cases.
- Bloody reduction of the radial head with reconstruction of the ring ligament was the most practiced procedure after the intervention of Bouyala, its utilization rate was 7%.
- Ulnar osteotomy with closed reduction of the radial head: About 5% of the patients included in our study were treated by this procedure. Lädermann et al [31] and Song et al [32] believe that this procedure can give a perfect reduction of the radial head without arthrolysis.
- Ilizarove procedure [9]: practiced in 19 patients (3.14% of cases) in the series of Bor *et al*. [33] and Chaudhari and Rathode [34], it has the advantage of being practically percutaneous, but requires learning Ilizarove's material. It allows a gradual elongation of the ulna with reduction of the radial head with closed focus.

CONCLUSION

The neglected Monteggia lesion still represents a therapeutic challenge in pediatric traumatology despite the variety of techniques proposed for its management, the proof is the increased rate of postoperative complications even in recent series.

The ideal treatment remains preventive by making an accurate diagnosis of the recent Monteggia lesion before their transition to chronicity. Management of neglected lesions should be as early as possible. The intervention of Bouyala with or without ligamentoplasty is the technique most used to treat these lesions (76.5% of cases).

The comparison of the surgical procedures used in the treatment of the neglected lesion of Monteggia, has shown that the intervention of Bouyala without ligamentoplasty is the best option; it yielded the highest average Kim score and the lowest postoperative complication rate.

The addition of ligamentoplasty to the intervention of Bouyala decreased the average score of Kim and increased the rate of complications postoperatively, its use should not be systematic and must be decided intraoperatively according to the stability of the radial head after reduction.

CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

Contribution des auteurs

All authors have contributed to the writing of this manuscript, have all read and approved the final version.

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