C-reactive protein: what to expect after bony hip surgery for non-ambulatory children and adolescents with cerebral palsy

Running head

CRP after bony hip surgery in children with CP

Authors

Alastair G DICK [a] – Orthopaedic Specialty Registrar

Nicholas MAGILL [b] – Research Student

Thomas C H WHITE [a]- Locum Consultant Orthopaedic Surgeon

Michail KOKKINAKIS [a]- Consultant Orthopaedic Surgeon

Fabian NORMAN-TAYLOR [a]- Consultant Orthopaedic Surgeon

Affiliations

a - Evelina London Children's Hospital, Westminster Bridge Road, London, SE1 7EH, UK

b - Institute of Psychiatry, Psychology and Neuroscience. 16 De Crespigny Park, SE5 8AF, UK

Corresponding Author

Alastair G Dick

Department of Orthopaedics

Evelina London Children's Hospital

Guy's & St Thomas' NHS Foundation Trust

Westminster Bridge Road

London

SE1 7EH

alastair.dick@nhs.net

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Abstract

Objectives

Bony hip reconstruction surgery in children with severe cerebral palsy (CP) is associated with high complication rates, usually post-operative chest and urinary tract infections. C-reactive protein (CRP) level is commonly used as an indication of infection; an understanding of its normal post-operative trends is crucial to allow early identification of abnormal levels and possible infection. Our aim was to describe the trends in CRP following bony hip surgery in children who had an uneventful post-operative course, on the basis that the children for whom CRP does not follow this course are likely to have a bacterial infection.

Methods

A retrospective review was performed of 155 children with CP having bony hip surgery between 2012 and 2016. The median age was 9.9 years (interquartile range 6.6-12.7). One hundred (64.5%) patients had a Gross Motor Function Classification System rating of V. All CRP levels measured in routine post-operative care were recorded, and medical records were examined for post-operative infective complications. The CRP levels of patients with clinically proven infections were excluded in order to describe what to expect in the absence of infection.

Results

Mean CRP peaked on the third post-operative day at 81mg/L in those who had no post-operative infection. Twenty-five patients (16.1%) had a post-operative infection; their mean CRP was higher on all post-operative days and peaked at 128 mg/L on the third post-operative day.

Conclusions

An understanding of the normal post-operative trends in CRP allows identification of those with abnormally raised levels. Post-operative CRP is consistently higher in children with an infective complication. We recommend that the CRP should be routinely checked following bony hip surgery in children with CP, and a careful search for infection undertaken in those with a raised level.

Keywords

Hip Dislocation
Cerebral Palsy
C-reactive Protein
Postoperative Complications

Introduction

Subluxation and dislocation of the hip has been reported in up to 60% of non-ambulatory children with cerebral palsy (CP) [1]. Severe subluxation or dislocation can cause pain, seating problems and issues with perineal hygiene [2,3]. Surgery is indicated in cases of severe or progressive subluxation and aims to maintain reduced, pain free hips using a combination of soft tissue releases, proximal femoral and pelvic osteotomies [2] . Hip reconstruction surgery has been shown to result in a lasting reduction in pain intensity and frequency in children with CP [4]. A recent systematic review is supportive of the usage of combined pelvic and femoral reconstruction over isolated femoral osteotomy [5]. Surgery, especially combined pelvi-femoral hip reconstruction, can be extensive and has been reported to have complication rates as high as 81% [6]. Complications are more common following surgery in those with more severe disease as classified by the Gross Motor Function Classification System (GMFCS) [7]. Medical complications including post-operative urinary tract infection and respiratory complications are more common in CP than non CP children undergoing hip osteotomies [8]. Many children with severe CP are unable to communicate the symptoms associated with post-operative infection and thus diagnosis and treatment may be delayed.

It is NHS England policy to promote the early detection of infection in order to prevent sepsis [9]; and there is current National Institute for Health and Care Excellence (NICE) guidance on the early identification of infections, including the measurement of C-reactive protein (CRP) in children [10], although no diagnostic CRP level has been proposed.

C-reactive protein (CRP) is an acute phase serum protein synthesised in the liver that rises rapidly in response to inflammation [11]. CRP is commonly used as an indicator of infection and response to treatment. Póvoa et al found a CRP of greater than 50mg/L to be highly suggestive of sepsis [12]. Interpretation of CRP as a marker of infection in the post-operative period can be challenging as the inflammation of surgical trauma itself will increase the CRP [13,14]. An understanding of the usual CRP response to surgery is crucial to allow the clinical team to identify the abnormally increased response that may occur with post-operative infection.

The post-operative kinetics of CRP have been described in the paediatric population in a relatively small cohort across a broad range of pan-specialty procedures [15] and in a small number of children undergoing a range of orthopaedic procedures [16]. We could find no description in the literature of the trends of CRP following bony hip surgery in children with severe CP.

The aim of our study was to identify the trends of CRP following bony hip surgery in children and adolescents with CP. We aimed to describe the expected trend in post-operative CRP levels so that those individuals with a post-operative infection can be detected more easily.

Methods

We performed a retrospective review of all children with CP undergoing bony hip surgery for hip subluxation/dislocation at our tertiary referral children's hospital between April 2012 and December 2016. All children received intravenous antibiotic prophylaxis at induction with cefuroxime or teicoplanin if allergic to penicillin. We recorded all CRP levels that had been measured as part of routine care in the first five post-operative days. We examined the medical records for evidence of post-operative infective complications. Post-operative infection was defined on the clinical assessment of a paediatrician in combination with appropriate microbiological or radiological findings. Patients were placed in one of two groups defined by the presence or absence of a post-operative infective complication.

Statistical analyses were undertaken using SPSS (Version 24.0, IBM Corporation, Armonk, NY, USA). The mean CRP and standard deviation for each post-operative day were calculated. Chi squared test was used to assess statistical significance for categorical data.

Ethical approval was not required as the study was retrospective and all data analysed were already collected in the course of normal clinical care.

Results

One hundred and fifty-five patients' records were included in the study with a median age of 9.9 (inter-quartile range 6.6-12.7). There were 103 males (66.5%) and 52 females (33.5%). Demographics of the cohort are in Table 1. Procedures performed were 14 unilateral derotation varus osteotomies (DVRO) (9.0%), 47 bilateral DVROs (30.3%), 36 unilateral pelvi-femoral reconstructions (23.2%), 26 bilateral pelvi-femoral reconstructions (16.8%), 18 revision hip reconstructions (11.6%), 13 proximal femoral resections (8.4%) and one shelf procedure (0.6%). There were 25 cases complicated by post-operative infection (16.1%). Of these infections, there were 18 lower respiratory tract infections (LRTI), 2 urinary tract infections (UTI), 3 combined LRTI and UTI, 1 gastrointestinal infection and 1 surgical site infection. The demographics of those with a post-operative complication are presented in Table 2. There was no significant difference in post-operative infection rate between those undergoing unilateral procedures (13/77, 16.9%) and bilateral procedures (12/78, 15.4%) (p=0.80). All patients with a post-operative infection had a GMFCS of V. One patient had a pre-operative CRP of 45 mg/L, all others had a pre-operative CRP of less than 8mg/L. Mean post-operative CRP was higher on every post-operative day in those with an infective complication. CRP peaked on the third post-operative day at 81mg/L in those without an infective complication and 128 mg/L in those with an infective complication before trending towards normal. The trends in post-operative CRP level are presented in Table 3 and Figure 1 and 2.

Discussion

This study describes the normal CRP changes seen after bony hip surgery in CP patients. It demonstrates that the CRP peaks on the third post-operative day then declines towards baseline. This pattern is similar to that reported in the adult literature including patients undergoing total hip arthroplasty [17–20]. Limpisvasti et al described the trends of post-operative CRP in 22 children undergoing a range of elective orthopaedic procedures (without post-operative infective complication) finding a peak on day 3 averaging 73mg/L [16]. We report slightly higher absolute levels of CRP than their study, and this may reflect the extensive nature of CP bony hip surgery. We also note a broad range of CRP between patients. This may in part

relate to whether or not the child had bilateral procedures, and whether or not an acetabuloplasty was performed; there were not enough patients included to ascertain whether there are statistically significant differences between these procedures.

We report an increased CRP level in those with post-operative infections on all of the first five post-operative days. Baez et al described the post-operative kinetics of CRP in 103 paediatric patients undergoing a broad range of pan-speciality surgical procedures and found a rise of 110mg/L in 48 hours to be predictive of infection [15]. We report an overall rate of post-operative infective complications of 16.1%; this is similar to that reported in the recent large series of CP hip reconstructions by Rutz and colleagues of 15.7% [4]

Limitations

The study did not include the participants' pre-operative medical co-morbidities, and although the GMFCS level gives a reasonable indication of what they were likely to be, we cannot comment on how they may have affected the trends in post-operative CRP. The study was retrospective and relied on blood tests taken as part of routine care. CRP was measured routinely pre- and post-operatively, but the number of patients having the test reduced with each post-operative day. A higher proportion of patients in the infection group had their CRP checked throughout their admission, and this could result in bias.

Conclusion

An understanding of the normal post-operative trends in CRP allows identification of those with abnormally raised levels. Post-operative CRP is consistently higher in patients with an infective complication. These data support the routine post-operative monitoring of CRP in this patient group. We recommend that the CRP should be routinely checked following bony hip surgery in non-ambulant paediatric

patients with CP, and a careful search for infection undertaken in those with a raised level, with the early involvement of paediatric colleagues and consideration of antibiotic therapy.

Tables and figures

Demographics		
Age in years (n=155)		
- Median [IQR]	9.9	[6.6-12.7]
	n	**(%)**
Age group (n=155)		
- 0-5	22	(14.2)
- 5-10	57	(36.8)
- 10-15	53	(34.2)
- 15-20	23	(14.8)
Gender (n=155)		
- Male	103	(66.5)
- Female	52	(33.5)
GMFCS (n=155)		
- I	0	(0.0)
- II	2	(1.3)
- III	3	(1.9)
- IV	50	(32.3)
- V	100	(64.5)
Procedure (n=155)	**n**	**(%)**
- Unilateral DVRO	14	(9.0)
- Bilateral DVRO	47	(30.3)
- Unilateral hip reconstruction	36	(23.2)
- Bilateral hip reconstruction	26	(16.8)
- Revision hip reconstruction(s)	18	(11.6)
- Proximal femoral resection(s)	13	(8.4)
- Shelf	1	(0.6)
Unilateral or bilateral (n=155)	**n**	**(%)**
- Unilateral	77	(49.7)
- Bilateral	78	(50.3)
Post operative infective status (n=155)		
No post-operative infection	**130**	(83.9)
Post-operative infection	**25**	(16.1)
- LRTI	18	(11.6)
- UTI	2	(1.3)
- LRTI + UTI	3	(1.9)
- Gastrointestinal infection	1	(0.6)
- Surgical site infection	1	(0.6)

Table 1 – Demographics of cohort. Abbreviations – GMFCS, Gross Motor Function Classification System; DVRO, derotation varus osteotomy; LRTI, lower respiratory tract infection; UTI, urinary tract infection.

Operation	Age	Infection
Bilateral DVRO, bilateral acetabuloplasty	4.2	LRTI
Bilateral DVRO	3.5	UTI, LRTI
Left open reduction, DVRO, acetabuloplasty	4.7	LRTI
Left revision DVRO, triple osteotomy	11.1	LRTI
Bilateral DVRO, left acetabuloplasty	5.3	LRTI
Bilateral DVRO	9.3	LRTI, UTI
Bilateral DVRO, left acetabuloplasty	11.5	LRTI
Right open reduction, DVRO, acetabuloplasty	6.9	LRTI
Bilateral DVRO	9.9	LRTI, UTI
Bilateral DVRO, left acetabuloplasty	10.1	LRTI
Left DVRO, acetabuloplasty	15.1	LRTI
Bilateral DVRO, left acetabuloplasty	4.5	LRTI
Bilateral DVRO	6.6	LRTI
Left DVRO, acetabuloplasty	12.1	Surgical site
Bilateral DVRO	4.8	Enterocolitis
Right DVRO, acetabuloplasty	13.3	LRTI
Left open reduction, DVRO, acetabuloplasty	6.8	UTI
Bilateral DVRO	5.4	LRTI
Left revision open reduction, DVRO, acetabuloplasty	10.9	LRTI
Right open reduction, DVRO, acetabuloplasty	11.1	LRTI
Bilateral DVRO, right acetabuloplasty	9.3	LRTI
Right revision DVRO	7.2	LRTI
Right DVRO, right pelvic osteotomy	18.7	UTI
Left revision DVRO, acetabuloplasty	12.5	LRTI
Right proximal femoral resection	12.4	LRTI

Table 2 - Demographics of child -operative comren with postplications (all had a GMFCS of V)

Abbreviations – GMFCS, Gross Motor Function Classification System; DVRO, derotation varus osteotomy; LRTI, lower respiratory tract infection; UTI, urinary tract infection.

	No infective complication (n=130)		Infective complication (n=25)	
	CRP checked (%)	CRP (mg/L) Mean (SD)	CRP checked (%)	CRP (mg/L) Mean (SD)
Day 1	106 (81.5)	31.4 (29.3)	24 (96.0)	44.9 (28.4)
Day 2	68 (52.3)	79.3 (56.6)	21 (84.0)	107.5 (65.0)
Day 3	40 (30.8)	81.0 (62.1)	18 (72.0)	128.1 (91.2)
Day 4	24 (18.5)	74.7 (60.2)	15 (60.0)	112.2 (79.4)
Day 5	6 (4.6)	57.0 (36.4)	14 (56.0)	102.2 (77.0)

Table 3 – Post-operative mean CRP and standard deviation for each post-operative day. *CRP checked* refers to the proportion of children who had a CRP level performed on that post-operative day.

Figure legends

Figure 1 – Post-operative trend in CRP in those patients with no post-operative infective complication. Data are shown as mean +/- standard error of the mean.

Figure 2 – Post-operative trends in CRP comparing those patients with a post-operative infective complication and those without. Data are shown as mean +/- standard error of the mean.

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Figure 1

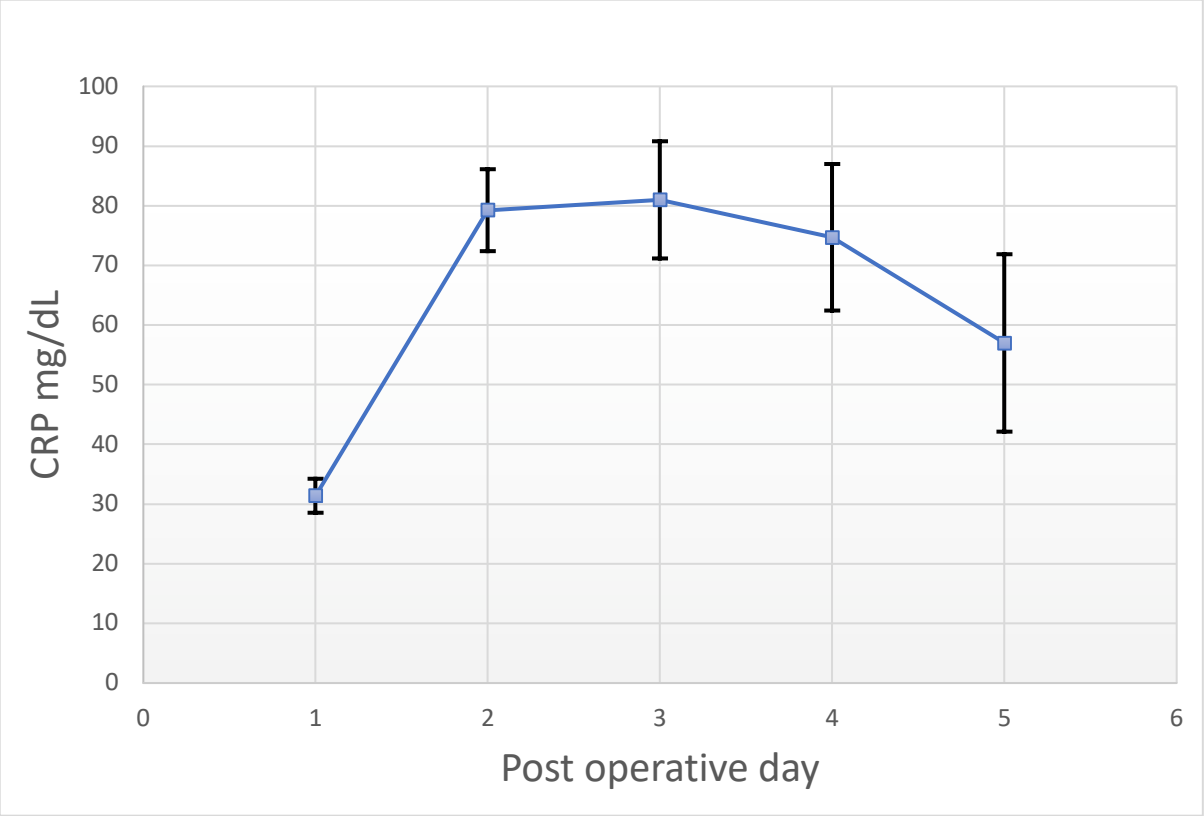
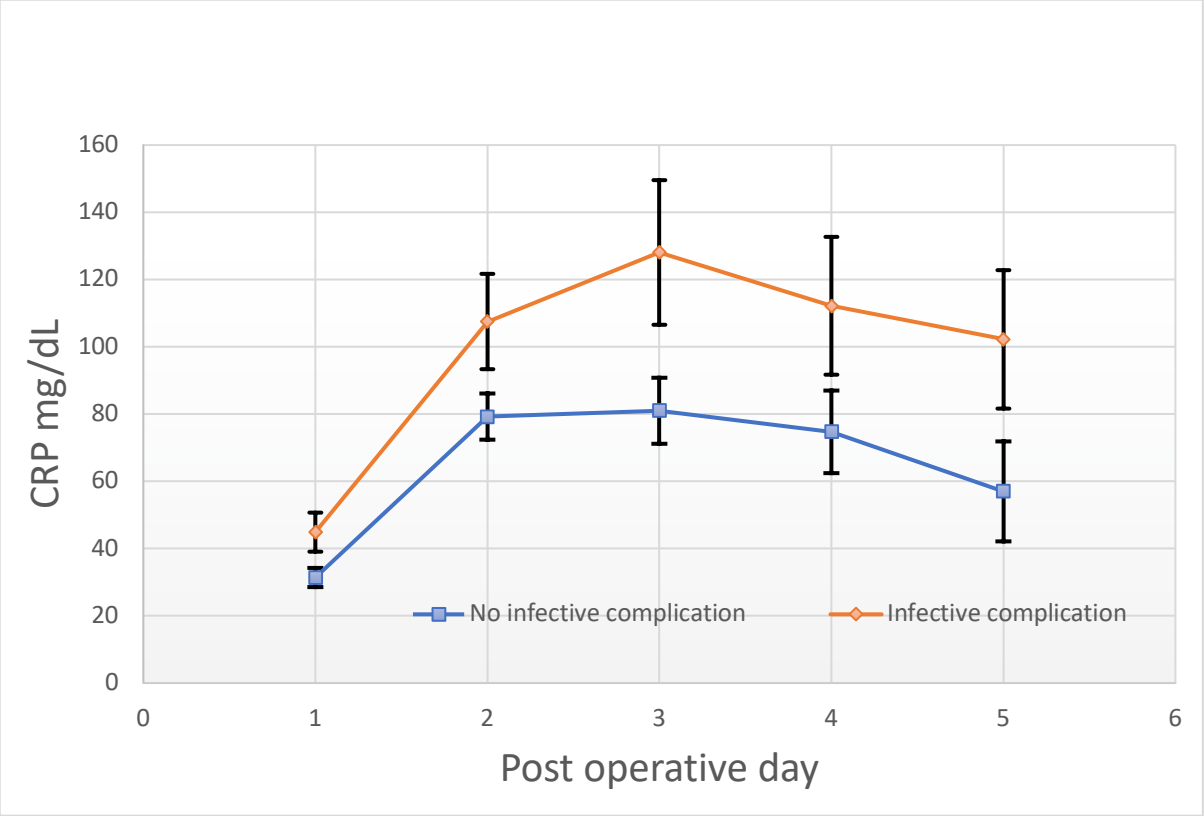

100
90
80
70
60
50
40
30
20
10
0
CRP mg/dL
0
1
2
3
4
5
6
Post operative day

Figure 2


160
140
120
100
80
60
40
20
0
CRP mg/dL
0
1
2
3
4
5
6
Post operative day
No infective complication
Infective complication