

## Article

# Neonatal screening and selective sonographic imaging in the diagnosis of developmental dysplasia of the hip

Choudry, Qas A. and Paton, Robin W.

Available at <http://clock.uclan.ac.uk/23154/>

*Choudry, Qas A. and Paton, Robin W. (2018) Neonatal screening and selective sonographic imaging in the diagnosis of developmental dysplasia of the hip. The Bone & Joint Journal, 100-B. pp. 806-810. ISSN 2049-4394*

It is advisable to refer to the publisher's version if you intend to cite from the work.  
<http://dx.doi.org/10.1302/0301-620X.100B6.BJJ-2017-1389.R1>

For more information about UCLan's research in this area go to <http://www.uclan.ac.uk/researchgroups/> and search for <name of research Group>.

For information about Research generally at UCLan please go to <http://www.uclan.ac.uk/research/>

All outputs in CLoK are protected by Intellectual Property Rights law, including Copyright law. Copyright, IPR and Moral Rights for the works on this site are retained by the individual authors and/or other copyright owners. Terms and conditions for use of this material are defined in the <http://clock.uclan.ac.uk/policies/>



**Neonatal clinical hip joint screening in combination with selective sonographic hip joint imaging in the diagnosis of developmental dysplasia of the hip (DDH).**

Journal:	<i>The Bone &amp; Joint Journal</i>
Manuscript ID	BJJ-2017-1389.R1
Manuscript Type:	Original Article
Keywords:	Hip joint instability, Developmental Dysplasia of the Hip (DDH),, Screening,, Positive Predictive Value(PPV).

SCHOLARONE™  
Manuscripts

**Abstract:**

**Aim:** A prospective cohort study statistically evaluating the effectiveness of the neonatal hip instability, screening program.

**Methods:** A 4-year observational assessment of the neonatal clinical hip joint instability, screening program. All births underwent an Ortolani/Barlow manoeuvre within 72 hours of birth and positive cases were referred to the 'one stop' DDH, hip screening clinic (clinical and sonographic hip joint assessment). The results of this study were compared with previous published studies from this unit.

**Results:** There were 124 neonates referred as a positive Ortolani/Barlow manoeuvre, clunk positive or 'unstable'. There were only 5 cases of clinical hip instability confirmed in the 'one stop' clinic. Sonographically, there were 92 neonates with Graf Type I, 12 with Graf Type II and 20 Graf Type IV hips. Clinically, the Positive Predictive value (PPV) in the clinical neonatal hip screening programme was calculated as 4.0% and sonographically the PPV was 16.1%.

**Conclusion:** Compared to previous published 10 year and 15 year studies from our unit, there has been a marked deterioration in the PPV in those referred as clinical hip instability. There appears to be a paradox of rising referrals but a decreasing PPV combined with increasing surgical intervention rates for DDH.

## Introduction

Developmental dysplasia of the hip is a spectrum of disorders ranging from mild hip dysplasia to irreducible hip dislocation [1]. In England, NIPE committee (Neonatal Infant Physical Examination) is responsible for screening guidelines. These consist of universal clinical hip instability screening within the first 72 hours post-natally, a General Practitioner / Health Care Professional clinical hip joint assessment at 6 weeks [2] and at 4 to 6 weeks a sonographic assessment of 'at risk' cases (breech presentation and strong family history of pathological hip dysplasia and dislocation).

The Ortolani and Barlow manoeuvres are the internationally accepted techniques to identify clinical neonatal hip instability [3,4]. Despite the high specificity of both tests, traditionally the sensitivity of this clinical screening has been calculated as 60%[5]. Previously published literature from our unit suggested that the quality of the hip screening had remained reasonably static over 10 to 15 years [6,7]. Duppe et al, in Sweden demonstrated deterioration in the results of their clinical hip screening programme which was attributed to increasing numbers of practitioners undertaking the clinical hip screening manoeuvres [8]. Anecdotally, it was felt that there had been a recent deterioration in the quality of referrals to our specialist DDH screening clinic.

The aim of this study is to assess the positive predictive value of the initial screening clinical hip examination (as defined by positive Barlow/ortolani manoeuvre, clunk, hip instability) by non-expert compared with an expert in hip screening, either finding a positive provocation test or Graf Type IV ultrasound scan at approximately 2 weeks.

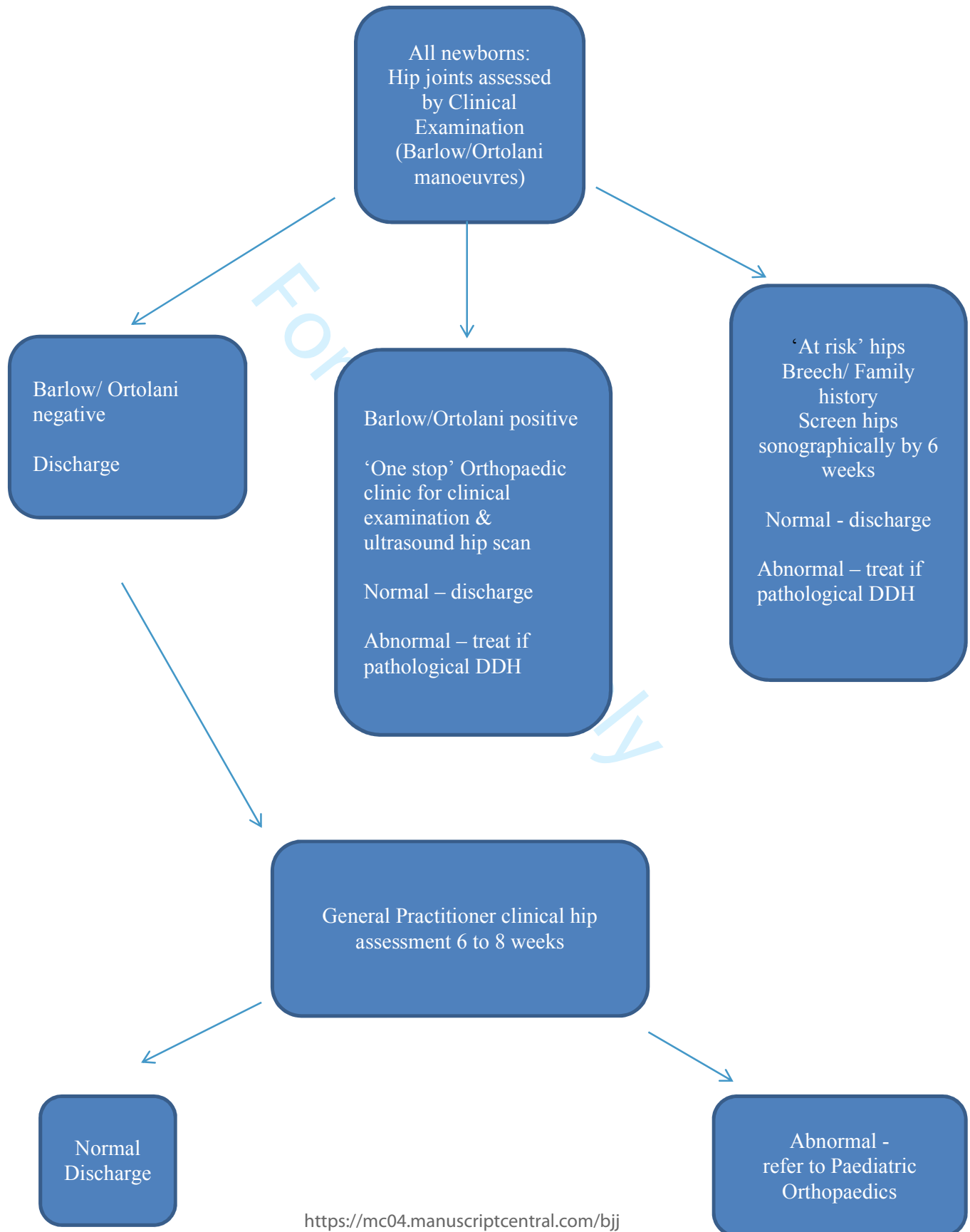
Previous studies have investigated the association of certain clinical signs with pathological DDH (asymmetrical skin creases, limited hip abduction and clicky hips) and their association with pathological DDH. These associations were not investigated in this study [9,10,11].

## Patients & Methods

A prospective longitudinal observational study performed at the Royal Blackburn Teaching Hospital from 1<sup>st</sup> January 2012 to 31<sup>st</sup> December 2015 inclusive. The current birth rate is slightly over 7,000 live births per year with a current total population of 530,000 in the 5 districts covered (children and adults). Since 1992, all cases of neonatal instability referred to the 'one stop' DDH hip joint screening clinic have been clinically assessed and the hip joints sonographically imaged by the senior author. The information is prospectively recorded on individual data sheets that is transferred to a spreadsheet and is adapted into a database. All cases of neonatal hip instability identified in the district were referred directly to this clinic by the Paediatric department or by midwives using an agreed proforma. The clinical neonatal hip joint examination was undertaken by differing health professionals ranging from newly qualified medical doctors [foundation doctors, doctors not in training, midwives and Advanced Nurse Practitioners (ANPs)]. All had received training in neonatal hip joint examination.

Inclusion criteria included; a positive provocative test (Ortolani and/or Barlow), patients referred with a positive 'clunk' on the Ortolani manoeuvre and hip joints referred as positive for 'instability' (Figure 1).

**Figure 1: Flow diagram for the assessment & referral of potential neonatal hip joint instability (DDH screening)**



1  
2  
3  
4  
5 Exclusion criteria included referrals to the clinic for reasons other than potential  
6 neonatal hip joint instability i.e. 'at risk' factors, clicky hips, asymmetrical skin  
7 creases, limitation of hip joint abduction (bilateral and unilateral) and primary  
8 neurological or syndromic hip pathology. The diagnosis of DDH does not include  
9 neurological or syndromic causes, as these cases are secondary to a primary  
10 pathology [12]. Patients not referred through the neonatal hip joint screening  
11 programme were deemed 'late' presentations and were excluded from the primary  
12 analysis of neonatal instability, though 'late' presentation cases of irreducible hip  
13 dislocation requiring surgical intervention were recorded in order to calculate the  
14 sensitivity of the study.  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28

29 In the 'one stop' clinic the hip joints were clinically assessed using the Ortolani and  
30 Barlow manoeuvres. Sonographic imaging of the hip was classified according to  
31 modified Graf and Harcke classification (Table 1) [13,14,15].  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

**Table 1: Modified Graf and Harcke sonographic classification of the hip joint.**

	Alpha angle	Hip joint (position of the femoral head in the acetabulum)
<b>Graf Type I</b>	> 60 degrees	Congruous
<b>Graf Type II</b>	43 – 60 degrees	Congruous
<b>Graf Type III</b>	< 43 degrees	Congruous
<b>Graf Type IV</b>	Any degree	Subluxated or dislocated

The outcome measures of this study were an unstable hip [a positive provocative test in clinic (Ortolani or Barlow manoeuvre) or a sonographic Graf Type IV hip joint]. It is accepted in some quarters that a positive sonographic Graf Type IV scan may over diagnose the condition when compared to a clinical Ortolani/ Barlow positive manoeuvre and may be a flawed outcome measure [6].

Sensitivity, specificity and Positive Predictive Value (PPV) were calculated for both the clinical and the sonographic assessment. In the sonographic group an assumption was made that all referred clinically unstable hip joints would be expected to have 'on the balance of probabilities' a Graf Type IV sonographic image on primary hip examination. Without this assumption the sonographic PPV would not be able to be calculated. Birth rates for the districts covered by the East Lancashire Hospital NHS Trust were obtained from the Office for National Statistics.



1  
2  
3  
4 A separate prospective spreadsheet based was maintained for the number of cases  
5 of irreducible hip dislocation, subluxation and hip dysplasia cases that required  
6 surgical intervention (Closed reduction, open reduction, femoral osteotomy and  
7 pelvic osteotomy). For the purposes of statistical analysis for this study, a false  
8 negative result was an irreducible hip dislocation that presented 'late' after the  
9 neonatal screening period (outcome measure). Data was collected prospectively on  
10 and for at least 18 months after the end of the study in order to identify all cases of  
11 irreducible hip dislocation born within the 4-year study period.  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23

24 A separate card index system was maintained prospectively on all cases diagnosed  
25 with sonographic hip abnormalities and or Pavlik harness treatment (within the 4-  
26 year study period). This was a cross checking system, separate to the primary  
27 database, in order to identify and separate, early from late diagnosed pathological  
28 cases.  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38

## 39 **Results**

40  
41 Between 1<sup>st</sup>. January 2012 and 31<sup>st</sup> December 2015, 124 patients were referred  
42 through the 'one stop clinic' with clinical hip instability: 100 as positive Ortolani/  
43 Barlow manoeuvres, 15 unstable and 9 clunks. There were 28,241 live births.  
44  
45  
46  
47  
48  
49

50 The mean age at assessment in the 'one stop' clinic' was 16.1 days (95% CI+/- 2.1)  
51 in those who did not fail to attend (FTA) their first appointment. These neonates  
52 were seen and clinically assessed by the treating expert within 4 weeks of the  
53 referral (NIPE guideline).  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5 Ten cases FTA their initial appointment and attended at a later date. Mean age at  
6  
7 assessment of these cases was 73.5 days (95% CI+/- 17.5). All these patients had  
8  
9 normal clinical examinations with the following ultrasound findings. Nine Graf Type I  
10  
11 hips and 1 Graf Type II hip. All hip abnormalities resolved and did not require  
12  
13 treatment.  
14  
15

16  
17  
18 On clinical assessment in this 'one stop' clinic by the senior author, only 5 patients  
19  
20 over the 5 years demonstrated a positive provocative test.  
21  
22

23  
24  
25 On sonographic assessment, 92 patients (74.1%) had a Graf Type I hip joint and a  
26  
27 normal hip joint on clinical examination. These patients were discharged from the  
28  
29 clinic. Eighteen neonates presented initially with a Graf Type II hip joint with a normal  
30  
31 clinical hip joint examination. Twelve of the 18 Graf Type II hips resolved to normal  
32  
33 Graf Type I hip joints spontaneously, with 6 deteriorating and progressing to Graf  
34  
35 Type IV hip joints. Fourteen Graf Type IV hip joints were diagnosed at the initial clinic  
36  
37 appointment (20 Graf Type IV including the 6 Graf Type II hips that progressed to  
38  
39 Graf Type IV). Graf Type IV hips were treated by Pavlik harness and the majority  
40  
41 resolved, although 7 hip joints progressed and required later surgical intervention (1  
42  
43 closed reduction and 6 open reductions of the hip joints).  
44  
45  
46

47  
48  
49 From 2012 to 2015 the rate of surgical intervention for irreducible hip dislocation and  
50  
51 dysplasia in DDH was 1.1 per 1000 live births compared to 0.62 per 1000 from 1997-  
52  
53 2006 [6]. The rate of surgery for irreducible dislocation increased to 0.96 per 1000  
54  
55 compared to 0.51 per 1000 over the same time periods [6].  
56  
57  
58  
59  
60

Compared to the previous 15 years, the mean yearly referral number of clinical hip instability, increased from 13.4 to 31 (3.18 referrals per 1000 live births has increased to 4.4 per 1000 live births).

The PPV for clinical assessment and sonographic assessment was calculated. The PPV for clinical Ortolani/ Barlow positive in the 'one stop hip clinic' was 4.0% (5/124). If referrals for 'instability' are excluded and clunks and Ortolani/Barlow positive are calculated the PPV would still be only 5.0% (5/100). The PPV for sonographic assessment (proportion of patients referred with instability that were found to have a Graf Type IV hip on imaging) was 16.1% (20/124). The sensitivity of the clinical assessment was 18.5% and in the sonographic assessment was 47.6%. The specificity of the clinical and sonographic assessment was 99.6%. The results are summarised in Tables 2 and 3.

**Table 2: Results of clinical examination and sonographic imaging in the 'one stop' clinic**

	Definition	Number
True negatives	Normal hips which were not referred	Clinical = 28,095 Sonographic = 28,095
True positives	Referred as unstable hips and were diagnosed as unstable in the 'one stop' clinic	Clinical = 5
		Sonographic = 20
False negatives	Irreducible hip joint dislocation not referred in the neo-natal period; "late dislocations"	22
False positives	Referred as unstable hips but were diagnosed as stable in the 'one stop' clinic	Clinical = 119
		Sonographic = 104

**Table 3: Comparison of 3 sonographic and clinical screening studies.**

	Current Study	Mace et al 2015	Paton 2011
Time period of study	2012 – 2015 (4 years)	1997 – 2011 (15 years)	1997 – 2006 (10 years)
Sensitivity (sonographic)	47.6%	77%	72%
Sensitivity (clinical)	18.5%	62%	66%
Specificity (sonographic)	99.6%	99.8%	99.9%
Specificity (clinical)	99.6%	99.8%	99.8%
PPV (sonographic)	16.1%	47%	68%
PPV (clinical)	4.0%	24%	28%

## Discussion

Screening for the early detection of pathological DDH is a controversial subject [16,17,18]. There is no international consensus [2,19,20,21].

Evidence is lacking that this NIPE screening programme has resulted in a true reduction in late presenting dislocation rates in pathological DDH in England [6,22,23,24,25]. In the UK, despite a hip screening programme instituted in 1969, over 60 percent of irreducible hip dislocations present late, often after the age of 1 year [22].

The overall rate of surgery irreducible hip dislocation prior to selective sonographic

1  
2  
3 hip joint screening in the UK was between 0.5 and 0.8 per 1000 live births [23,24,25].  
4  
5 However, Duppe et al in Sweden and Myers et al in New Zealand have shown a  
6  
7 significant reduction in the numbers and rates of surgery for pathological DDH when  
8  
9 a small group of well trained, experienced hip joint examiners undertake the primary  
10  
11 clinical neonatal hip joint screening [8,26]. A recent study from Australia has  
12  
13 recorded a concerning increase in irreducible hip dislocation rates [27].  
14  
15  
16  
17  
18

19 In the UK, concern has been expressed on those who are currently responsible for  
20  
21 undertaking the neonatal hip joint examination. They have varying degrees of  
22  
23 training and clinical experience. Recently, there has been a switch to stand alone  
24  
25 'birthing centres', resulting in more births out with the traditional hospital maternity  
26  
27 unit. It is not clear if these changes may have affected the effectiveness of the  
28  
29 screening programme [28].  
30  
31  
32  
33

34 The natural history of resolution of neonatal hip instability has been well documented  
35  
36 in the literature. Gardiner & Dunn and Barlow have reported that 71% of clinically  
37  
38 unstable hips stabilise within 2 weeks and 88% stabilise by the first month post-  
39  
40 nately without treatment [4,29]. This may be a limitation to the objective nature of  
41  
42 this study. However, as most of the hip joints in this study were assessed in the 'one  
43  
44 stop' clinic close to 2 weeks post-natally it would be expected that the clinical PPV  
45  
46 would be between 20 to 30% and the sensitivity to be between 60 to 70%, based on  
47  
48 published studies [5,6,7].  
49  
50  
51

52 Our previous published data had shown that the PPV and sensitivities for neonatal  
53  
54 hip instability screening remained reasonably static over 10 to 15 years [6,7] Table 3.  
55  
56  
57  
58  
59  
60

1  
2  
3 The PPV in this current clinical neonatal hip examination programme, has fallen to  
4 4.0% compared to 24 to 28% in previous studies. The PPV of sonographic Graf Type  
5 IV imaging, has fallen to 16.1% compared to 49% and 68% in the previous studies  
6 [6,7]. Although the referral criteria of hip instability and the pathways in the previous  
7 2 studies are the same, unidentified subtle differences and confounding factors in  
8 data collection could make direct comparison with this study less robust than  
9 expected. The clinical hip examinations and sonographic hip imaging was  
10 undertaken by the same examiner. This increases the likely hood of unintentional  
11 bias though this was unavoidable in this study as the clinic was consultant based  
12 only. The senior author however has over 20 years of sonographic hip imaging  
13 experience and his ultrasonography image quality and interpretation have been  
14 independently validated as accurate at a national level (NIPE committee, a sub-  
15 group of the National Screening Committee).

16  
17  
18 Neonatal clinical hip screening in the UK appears fragmented with numerous  
19 stakeholders. Guidance in England is the responsibility of Public Health England  
20 [30]. Local health commissioning is the responsibility of the Clinical Commissioning  
21 Groups (CCG) and the hospital neonatal clinical hip examination/ screening is the  
22 responsibility of the Paediatric department. In the community ('birthing centres'),  
23 midwives and nurses undertake the neonatal hip screening. Due to the low incidence  
24 of true clinical hip instability (Ortolani/Barlow positive) many undertaking the clinical  
25 hip screening will have little experience of exposure to true hip joint instability  
26 (positive provocative manoeuvres). It is of concern, that this current study identified  
27 an apparent increase in the operative rate for irreducible hip dislocation DDH of 0.96  
28 per 1000 live births over a 4-year period, compared to 0.51 per 1000 live births in the  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 same institution in a 10-year period [6]. An additional possible driver of the increase  
4  
5 in referrals and of false positives may be the fear of litigation.  
6

7 There is continuing controversy on if universal or selective sonographic hip  
8  
9 screening is cost effective [12, 13, 14,15, 16,17]. Woodacre et al [31] calculated the  
10  
11 cost of closed or open reduction hip joint procedures varied from £4,352 to £7.052  
12  
13 per case. This is compared with approximately £41 for a hip ultrasound scan plus  
14  
15 and additional £156 for a 'one stop clinic with hip joint sonographic imaging  
16  
17 performed by a Consultant Orthopaedic Surgeon [9]. If universal ultrasound scanning  
18  
19 is undertaken in all neonates, by the radiological department alone, the cost in our  
20  
21 service would be approximately £290,000 per year.  
22  
23

24 The medical negligence cost of delayed diagnosis that later requires surgery ranges  
25  
26 from £120,000 to £488,000 (out of court settlements)[32,33].  
27

28 However the early detection of pathological DDH does not prevent all surgical  
29  
30 intervention as some cases do not respond to treatment in the Pavlik harness [7,34 ].  
31  
32  
33  
34  
35  
36  
37

### 38 **Conclusion**

39  
40 The results of our study mirror the Swedish experience [8]. There appears to be a  
41  
42 paradox of increasing referrals of neonatal hip instability combined with a decreasing  
43  
44 PPV and an increase in surgical intervention for DDH. The large number of  
45  
46 examiners of different backgrounds and experience undertaking neonatal hip  
47  
48 screening for instability may be associated with an increase in false positive and  
49  
50 false negative referrals. It is important to limit hip screening for DDH to a small group  
51  
52 of trained and experienced individuals, for maximum effectiveness, if the resources  
53  
54 allow. No National audit has been undertaken since the changes in the NIPE  
55  
56  
57  
58  
59  
60

1  
2  
3 guidelines for neonatal hip screening were enacted in 2004. Is it not time to  
4  
5 undertake a National audit to compare the current incidence of irreducible hip  
6  
7 dislocation and pathological hip dysplasia to the results of the MRC study of 1998 in  
8  
9 order to evaluate if the current NIPE screening policy in England is effective or not?  
10  
11 [22]  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22

### 23 **References:**

- 24  
25 1. Klisic PJ, Congenital dislocation of the hip – a misleading term: brief report. J  
26 Bone Joint Surg. 71-B (1): 136, 1989
- 27  
28 2. NHS Newborn & Infant Physical Examination programme (NIPE)  
29 newbornphysical.screening.nhs.uk
- 30  
31 3. Ortolani M, Un segno poco noto e sua importanza per la diagnosi precoce di  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153  
154  
155  
156  
157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175  
176  
177  
178  
179  
180  
181  
182  
183  
184  
185  
186  
187  
188  
189  
190  
191  
192  
193  
194  
195  
196  
197  
198  
199  
200  
201  
202  
203  
204  
205  
206  
207  
208  
209  
210  
211  
212  
213  
214  
215  
216  
217  
218  
219  
220  
221  
222  
223  
224  
225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242  
243  
244  
245  
246  
247  
248  
249  
250  
251  
252  
253  
254  
255  
256  
257  
258  
259  
260  
261  
262  
263  
264  
265  
266  
267  
268  
269  
270  
271  
272  
273  
274  
275  
276  
277  
278  
279  
280  
281  
282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312  
313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343  
344  
345  
346  
347  
348  
349  
350  
351  
352  
353  
354  
355  
356  
357  
358  
359  
360  
361  
362  
363  
364  
365  
366  
367  
368  
369  
370  
371  
372  
373  
374  
375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413  
414  
415  
416  
417  
418  
419  
420  
421  
422  
423  
424  
425  
426  
427  
428  
429  
430  
431  
432  
433  
434  
435  
436  
437  
438  
439  
440  
441  
442  
443  
444  
445  
446  
447  
448  
449  
450  
451  
452  
453  
454  
455  
456  
457  
458  
459  
460  
461  
462  
463  
464  
465  
466  
467  
468  
469  
470  
471  
472  
473  
474  
475  
476  
477  
478  
479  
480  
481  
482  
483  
484  
485  
486  
487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501  
502  
503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543  
544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569  
570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595  
596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631  
632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668  
669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696  
697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717  
718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862  
863  
864  
865  
866  
867  
868  
869  
870  
871  
872  
873  
874  
875  
876  
877  
878  
879  
880  
881  
882  
883  
884  
885  
886  
887  
888  
889  
890  
891  
892  
893  
894  
895  
896  
897  
898  
899  
900  
901  
902  
903  
904  
905  
906  
907  
908  
909  
910  
911  
912  
913  
914  
915  
916  
917  
918  
919  
920  
921  
922  
923  
924  
925  
926  
927  
928  
929  
930  
931  
932  
933  
934  
935  
936  
937  
938  
939  
940  
941  
942  
943  
944  
945  
946  
947  
948  
949  
950  
951  
952  
953  
954  
955  
956  
957  
958  
959  
960  
961  
962  
963  
964  
965  
966  
967  
968  
969  
970  
971  
972  
973  
974  
975  
976  
977  
978  
979  
980  
981  
982  
983  
984  
985  
986  
987  
988  
989  
990  
991  
992  
993  
994  
995  
996  
997  
998  
999  
1000
5. Jones D, An assessment of the value of examination of the hip in the  
newborn. J Bone Joint Surg 59-B, 318-22, 1977
6. Paton RW, Does selective ultrasound imaging of 'at risk' hips and clinically  
unstable hips in Developmental Dysplasia of the hip (DDH) produce an  
effective screening programme. PhD Thesis, University of Lancaster  
uk.bl.ethos.618306, 2011
7. Mace J, Paton RW, Neonatal clinical screening of the hip in the diagnosis of  
developmental dysplasia of the hip. A 15 year prospective longitudinal study.  
Bone Joint J. 97-B (2), 265-9, 2015



- 1  
2  
3 8. Duppe H, Danielsson LG, Screening of neonatal instability and of  
4 developmental dislocation of the hip. A survey of 132,601 living newborn  
5 infants between 1956 and 1999, *J Bone Joint Surg* 84-B (6), 878-85, 2002  
6  
7
- 8 9. Nie K, Rymaruk S, Paton RW, Clicky hip alone is not a true risk factor for  
9 developmental dysplasia of the hip. *BJJ*, 99-B (11): 1533-1536, 2017  
10  
11
- 12 10. Choudry Q, Goyal R, Paton RW, Is limitation of hip abduction a useful clinical  
13 sign in the diagnosis of developmental dysplasia of the hip. *Arch Dis Child*  
14 98(11): 862-6, 2013  
15  
16  
17
- 18 11. Anderton M, Paton RW, Isolated asymmetrical skin creases and their  
19 association with pathological developmental dysplasia of the hip: A 21 year  
20 observational longitudinal study. *BJJ* 99-B (Supp 11): 15, 2017  
21  
22  
23  
24  
25
- 26 12. Bialik V, Bialik GM, Blazer S et al, Developmental dysplasia of the hip: a new  
27 approach to incidence. *Pediatrics* 103 (1): 93-9, 1999  
28  
29
- 30 13. Graf R, Scott S, Farkas P et al, Manual for hip sonography. Edition Stolzalpe,  
31 1999  
32  
33
- 34 14. Harcke HT, Clarke NM, Lee MS, Borns PF, MacEwan GD, Examination of the  
35 infant hip with real time ultrasonography. *J Ultrasound Med*, 3(3): 131-7, 1984  
36  
37
- 38 15. Rosendahl K, Markestad T, Lie RT, Ultrasound in the early diagnosis of  
39 congenital dislocation of the hip: significance of hip stability versus acetabular  
40 morphology *Pediatr. Radiol.* 22(6): 430-3, 1992  
41  
42
- 43 16. AAOS, Detection and non-operative management of Pediatric developmental  
44 dislocation of the hip in infants up to six months of age, AAOS.org, 2014  
45  
46
- 47 17. Cochrane review: Shorter D, Hong T, Osborn DA, Screening programmes for  
48 developmental dysplasia of the hip in newborn infants. *Evid. Based Child*  
49 *Health* 8(1): 11-54, 2013  
50  
51
- 52 18. Shipman SA, Helfand M, Meyer V et al, Screening for developmental  
53 dysplasia of the hip: a systemic literature review for the US preventative  
54 services task force. *Pediatrics* 117(3): e557-76, 2006  
55  
56  
57  
58  
59  
60

- 1  
2  
3 19. Rosendahl K, Markestad T, Lie RT, Ultrasound screening of Developmental  
4 Dysplasia of the Hip in the neonate: the effect on treatment rate and  
5 prevalence of late cases, *Pediatrics* 94(1): 47-52, 1994  
6  
7
- 8 20. Holen KJ, Tegnander A, Bredland T, et al, Universal or selective screening of  
9 the neonatal hip using ultrasound? A prospective, randomised trial of 15,529  
10 newborn infants. *J Bone Joint Surg* 84-B(6): 886-90, 2002  
11  
12
- 13 21. Jones D, Dezateux CA, Danielsson LG et al, Topic for debate: At the  
14 crossroads – neonatal detection of developmental Dysplasia of the Hip. *J*  
15 *Bone Joint Surg.* 82-B(2): 160-4, 2000  
16  
17
- 18 22. Robinson R, Effective screening in child health, *BMJ* 316(7124): 1-2, 1998  
19  
20
- 21 23. Barnard AA, O'Hara JN, Bazin S et al, An improved screening system for the  
22 early detection of congenital dislocation of the hip. *J Pediatr. Orthop* 7(3): 277-  
23 82, 1987  
24  
25
- 26 24. Macnicol MF. Results of a 25-year screening programme for neonatal hip  
27 instability. *J Bone Joint Surg Br.* 1990; 72:1057–1060.  
28  
29
- 30 25. Godward S, Dezateux C, Surgery for congenital dislocation of the hip in the  
31 UK as a measure of outcome of screening. MRC Working Party on congenital  
32 dislocation of the hip. Medical Research Council. *Lancet* 351 (9110): 1149-52,  
33 1998  
34  
35
- 36 26. Myers J, Hadlow S, Lynskey T, The effectiveness of a programme for  
37 neonatal hip screening over a period of 40 years: a follow up of the New  
38 Plymouth experience. *J Bone joint Surg.* 91-B (2), 245-8, 2009  
39  
40
- 41 27. Struder K, Williams N, Antoniou G et al, Increase in late diagnosed  
42 developmental dysplasia of the hip in South Australia: risk factors, proposed  
43 solutions. *Med J Aust* 204 (6): 240, 2016  
44  
45
- 46 28. Sewell MD, Rosendahl K, Eastwood DM. Developmental dysplasia of the hip.  
47 *BMJ*; 339:b4454, 2009  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

- 1  
2  
3 29. Gardiner HM, Dunn PM, Controlled trial of immediate splinting versus  
4 ultrasonographic surveillance in congenitally dislocatable hips. *Lancet* 336  
5 (8730): 1553-6, 1990  
6  
7  
8 30. Newborn and infant physical examination (NIPE) screening: programme  
9 handbook 2016/17. PHE publications gateway number: 2015772, 2016  
10  
11  
12  
13 31. Woodacre T, Dhadwal A, Ball T, Edwards C, Cox PJA, The cost of late  
14 detection of developmental dysplasia of the hip, *J Child Orthop* 8(4): 325-332,  
15 2015  
16  
17  
18  
19 32. IrwinMitchell Solicitors.  
20 [https://www.irwinmitchell.com/newsandmedia/2014/november/high-court-](https://www.irwinmitchell.com/newsandmedia/2014/november/high-court-judge-approves-settlement-from-nhs-trust-that-delayed-diagnosing-babys-dislocated-hip-jq-713746)  
21 [judge-approves-settlement-from-nhs-trust-that-delayed-diagnosing-babys-](https://www.irwinmitchell.com/newsandmedia/2014/november/high-court-judge-approves-settlement-from-nhs-trust-that-delayed-diagnosing-babys-dislocated-hip-jq-713746)  
22 [dislocated-hip-jq-713746](https://www.irwinmitchell.com/newsandmedia/2014/november/high-court-judge-approves-settlement-from-nhs-trust-that-delayed-diagnosing-babys-dislocated-hip-jq-713746)  
23  
24  
25  
26  
27  
28 33. BoyesTurner, Medical Negligence Solicitors.  
29 [https://www.boyesturnerclaims.com/site/news/birth-injury-news/undetected-](https://www.boyesturnerclaims.com/site/news/birth-injury-news/undetected-hip-dysplasia-488k-compensation)  
30 [hip-dysplasia-488k-compensation.](https://www.boyesturnerclaims.com/site/news/birth-injury-news/undetected-hip-dysplasia-488k-compensation)  
31  
32  
33  
34 34. Choudry Q, Paton RW, Pavlik harness treatment for pathological  
35 developmental dysplasia of the hip: Meeting the standard. *J Ped Orthop B*  
36 26(4): 293-7, 2017  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60