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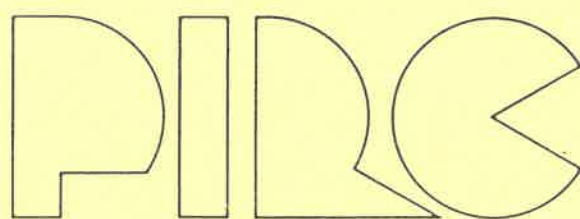
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C O N F E R E N C E

Thursday, 3 June 1982

Ulster Polytechnic

DEVELOPMENT OF A NON-INVASIVE METHOD OF NEONATAL SCREENING FOR
CONGENITAL DISLOCATION OF THE HIP

G H Cowie, B A Bogues, R A B Mollan, G W Kernohan ⁺

1 INTRODUCTION

Since the time of Hippocrates (around 300 BC) dislocation of the femoral head out of the acetabulum has been recognised as a deformity that a child can be born with or at least develop soon after birth but may not be diagnosed until the child has commenced walking

Initially diagnosis was by clinical methods of

- 1 Restriction of hip abduction
- 2 Limb shortening
- 3 Telescoping of the limb
- 4 Asymmetrical skin creases in the groin and thigh
- 5 Mainly by the affected child walking or "waddling" with a limp

In 1935 an Italian, Ortolani developed a clinical test for neonates to identify hips that were dislocated at birth. This test helped to decrease the age of recognition of the CDH and hence treatment was begun earlier with a much better prognosis. It must be emphasised that the test was only useful for a hip that is out of joint at birth.

In 1962 Barlow, a Manchester surgeon modified Ortolani's test to develop a test to identify a hip that could be dislocated or subluxed at birth.

It must be noted that both tests are very subjective relying on the experience of the examiner and what he or she feels with the examining hands.

Using these tests units in Britain and Sweden reported a decrease in the number of infants who presented with late dislocation. They however used a small number of experienced examiners in a small number of maternity hospitals.

In Northern Ireland where there is about 25,000 - 30,000 live births per year, there was a wide variety in the experience of the examiners and a large number of maternity units. Williamson reported a study of the period 1960 - 1970; she noted no decrease in the number of children appearing with late dislocation despite adequate neonatal testing.

Cowie in 1981 reported the period 1972 - 1978. Again as Table 1 shows there was no real decrease in the numbers of late CDH occurring despite the introduction of a Child Health Record and Card System which asked health visitors (trained SRNs) to test

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the hips for abnormalities. Table 2 shows the age of diagnosis. So this was the problem - despite apparently adequate clinical tests there was no decrease in the incidence of late CDH. The tests appear difficult to standardise and are extremely subjective. Could a more objective method be developed - we hope in the remainder of this paper to show the development of such a harmless, non-invasive method.

2 METHODS AND MATERIALS

The method depends on the detection of vibration emission from the hip joints. Initial work on emission from joints had been carried out by one of the authors (R A B Mollan) and Dr G McCullagh from the Ulster Polytechnic. Three Piezoelectric accelerometers were used, one attached to the skin in the region of each anterior superior iliac spine and the third is placed in a grooved board on which the neonate lies during testing. This transducer has the neonate's sacrum placed on it and should detect emission from either hip.

Ortolani's and Barlow's tests are now performed.

The emission detected is amplified by B & K Charge Amplifiers and recorded on magnetic tape by an F M tape recorder. This is shown in the first picture.

Visual display of the emission is by one of two methods -

- 1 a four-channel mingograph (the fourth channel acting as a marker)
- 2 channel by channel display by a B & K 2031 Narrow Band Spectrum Analyser.

We found the best way to display the emission was to run the tape out via the mingograph and identify the various 'clicks' and 'clunks' After localisation of these the tape was played through the 2031 Narrow Band Spectrum Analyser.

We found the best way to display the emission was to run the tape out via the mingograph and identify the various 'clicks' and 'clunks' After localisation of these the tape was played through the 2031 to look more closely at the pattern of a waveform and its frequency. The tape was played back at one tenth speed to obtain better resolution. Initially copies of the various noises were obtained using a B & K X-Y recorder.

However with a programme developed by one of the co-authors, George Kernohan, a microprocessor has been incorporated on the display and analysis side to allow for improved analysis of the emission. This is shown in picture 2.

The programme has several uses -

- 1 to allow for storage of all relevant noises on floppy discs

- in the form of the waveform
- 2 to allow the 'clicks' and 'clunks' to be sent back to the 2031 for analysis and to be displayed on a print-out
 - 3 to allow certain parameters of the 'clicks' and 'clunks' to be determined. The parameters we are interested in are the acceleration range, the engergy, the peak frequency and the amplitude at peak frequency.

3 RESULTS

Up to the present time we have had referred to us for testing a total of two hundred and sixty children approximately. These can be split into three various groups of - 165 clicks; 26 late dislocations; 14 unstable hips at birth.

Some 55 neonates who were found to have no hip abnormality on clinical testing were tested to act as a control group.

The figures numbers 1 - 5 show the waveform of the emission from the various hip conditions - a click: a clunk of an unstable hip at birth diagnosed by Barlow's test and requiring conservative treatment of a plastic abduction nappy splint: a clunk of late dislocation being reduced and dislocated after adductor tenotomy and prior to plastering.

All late dislocations produce a similar pattern to the one shown as do all the unstable hips.

Clicks however vary in their waveform.

Figures number 6 - 8 show the frequency analysis of the above waveforms. The click has a peak frequency of about 140 Hz whilst the clunks have peak frequencies of 30 - 40 Hz.

So far three children born with a click have produced on emission a waveform similar to that of the unstable hip with a low peak frequency. Two of these when check by x-ray of the pelvis showed subluxation of the hip requiring treatment. Other children with clicks and restricted abduction have shown low peak frequencies (around 60 - 80 Hz) and on check x-ray the hips have been equivocal - no treatment was commenced but careful review was carried out.

At present analysis of the clicks is being carried out by the statisticians and we hope to determine the mean values of the parameters for the click.

4 CONCLUSION

We are confident that this method can identify hips that are dislocated, or are dislocatable at birth or who are at risk of developing dislocation/subluxation through the first months of life. It is true that the examiner must perform the clinical tests but the present equipment is felt to be an aid to the

inexperienced examiner. Definite proof can be shown by x-ray but to x-ray a whole generation would not be without its hazards both genetically and financially.

G H Cowie is in receipt of an R V H Fellowship

'LATE' CONGENITAL DISLOCATION OF THE HIP

BY YEAR OF BIRTH

YEAR	NUMBER	INCIDENCE PER 10,000 LIVE BIRTHS
1972	31	10.5
1973	19	6.9
1974	25	9.3
1975	26	10.1
1976	26	10.0
1977	21	8.2
1978	26	9.9

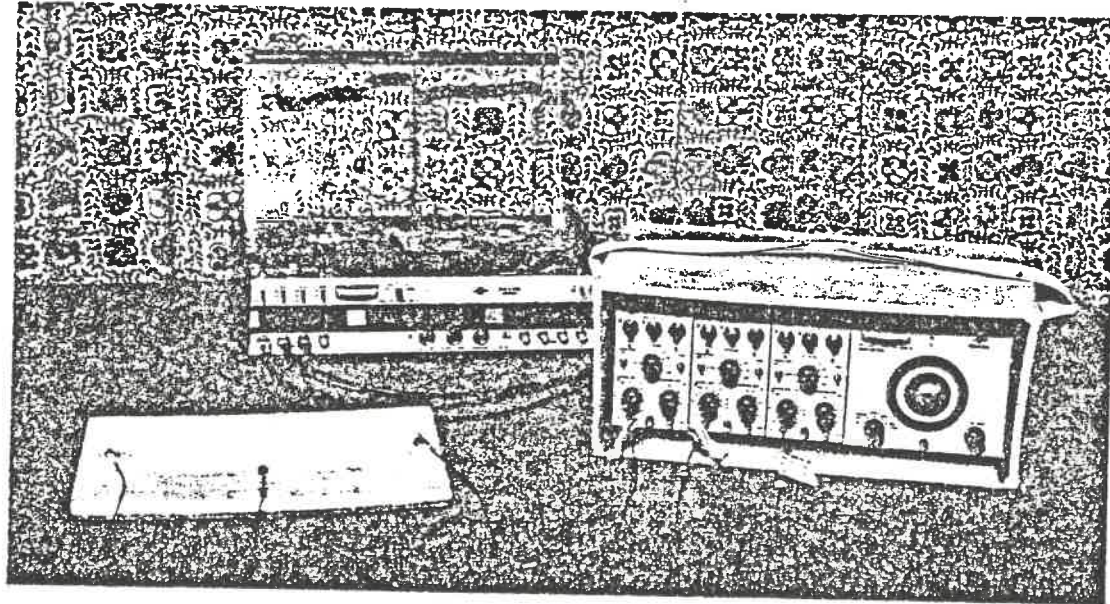
TABLE 1

'LATE' CONGENITAL DISLOCATION OF THE HIP

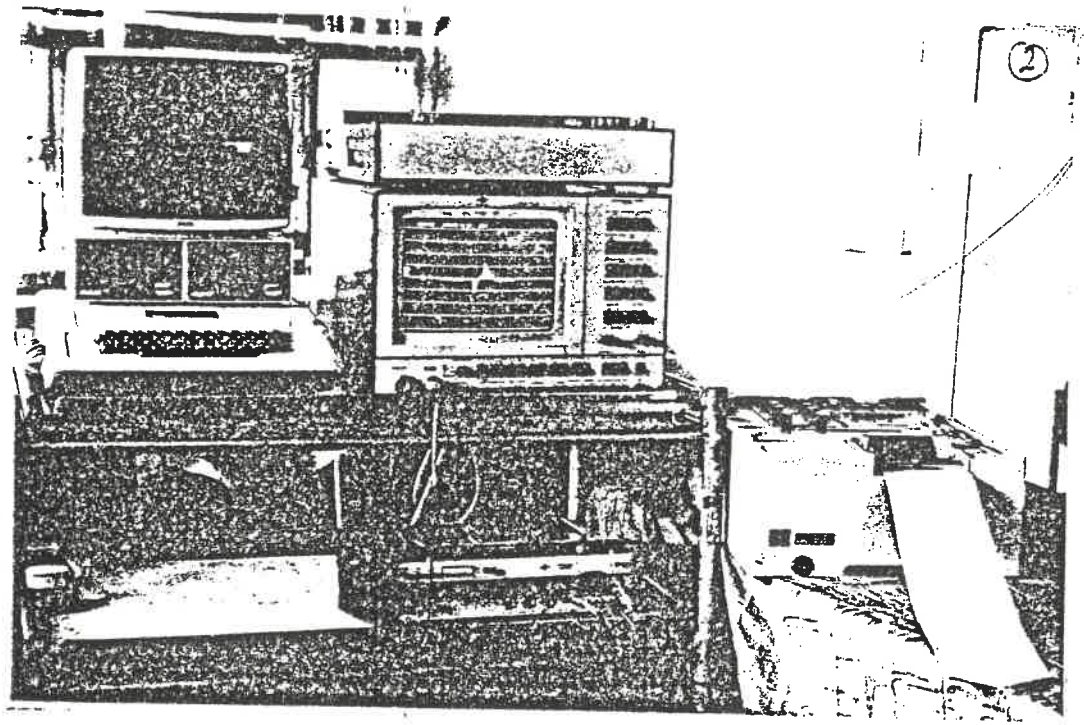
BY AGE AT DIAGNOSIS

AGE	NUMBERS	(%)
6 - 11 months	44	25.3
12 - 17 months	49	28.2
18 - 23 months	38	21.8
24 months	10	19.0
Not known	10	5.7
TOTAL	174	100.0

TABLE 2

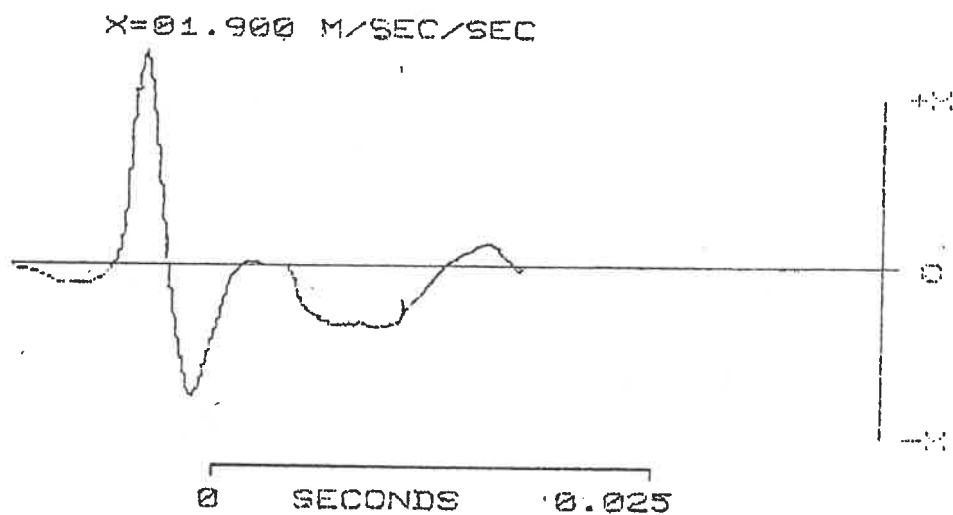


PHOTOGRAPH 1



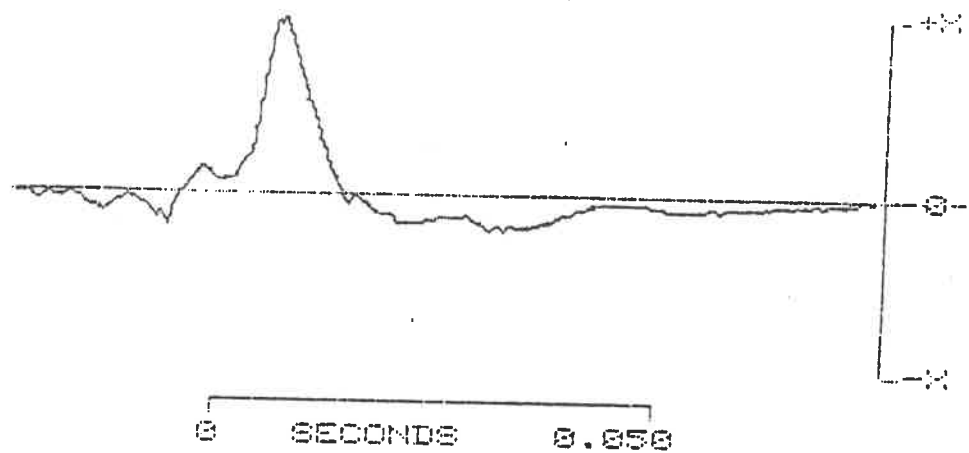
PHOTOGRAPH 2

NUMBER OF CHILDREN EXAMINED	255
Clicks	160
Unstable at Birth	14
Late C D H	26
Normals	55

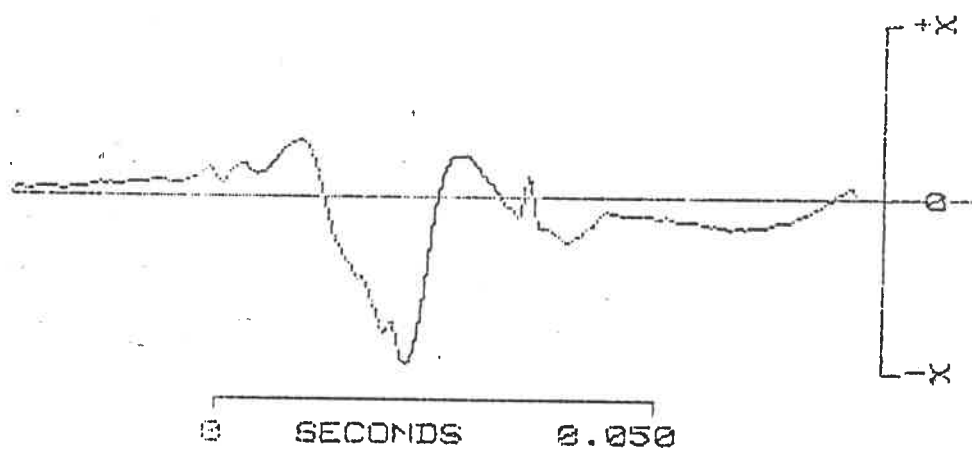


"HIP" CLICK

FIGURE 1

$X=06.013 \text{ M/SEC/SEC}$ 

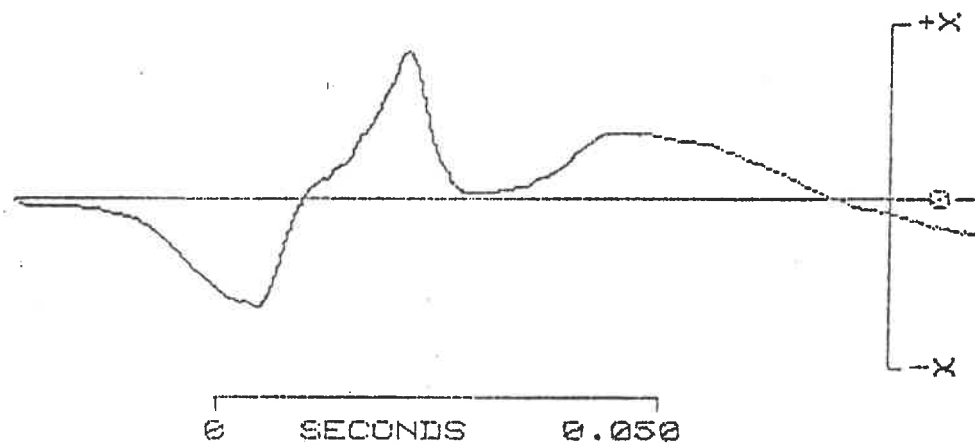
UNSTABLE HIP REDUCTION

FIGURE 2 $X=06.013 \text{ M/SEC/SEC}$ 

UNSTABLE HIP DISLOCATION

FIGURE 3

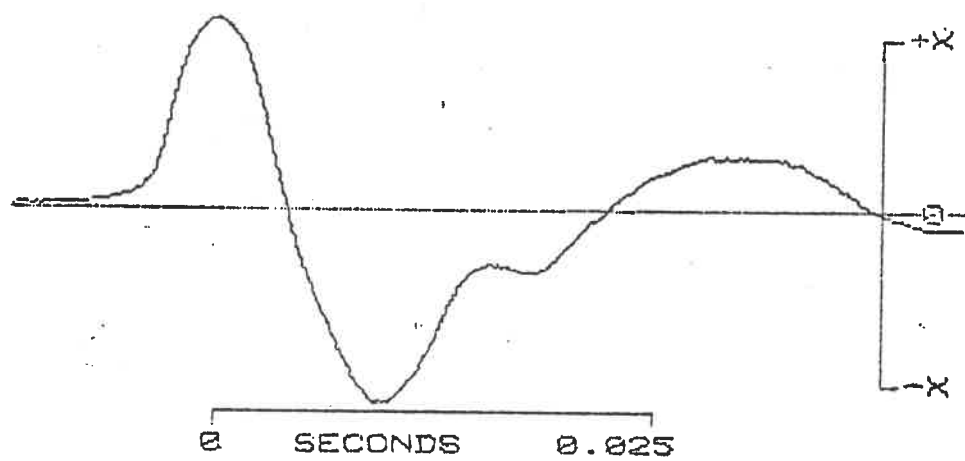
$X=06.013 \text{ M/SEC/SEC}$



LATE CDH DISLOCATION

FIGURE 4

$X=06.013 \text{ M/SEC/SEC}$



LATE CDH REDUCTION

FIGURE 5

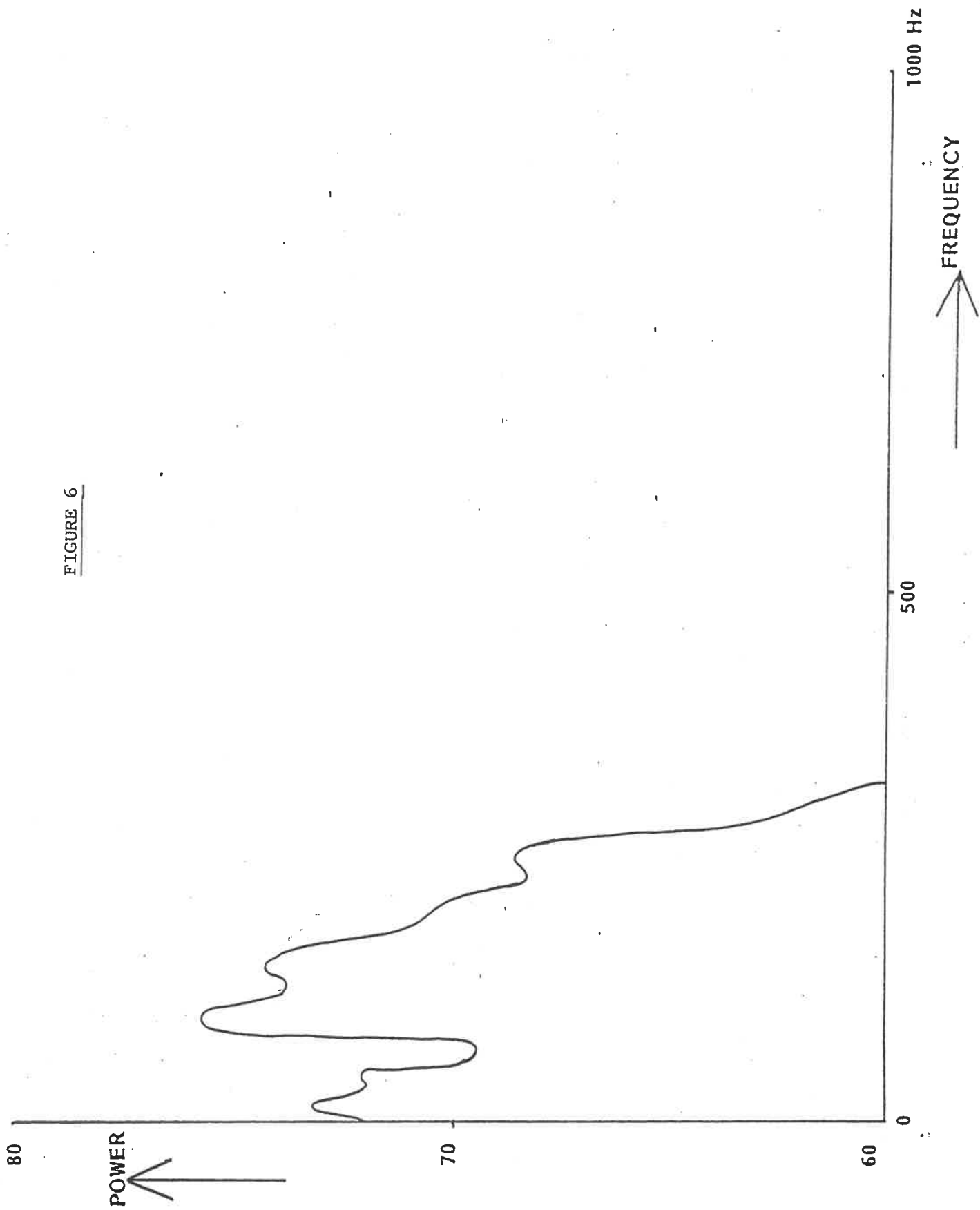
FIGURE 6

FIGURE 7

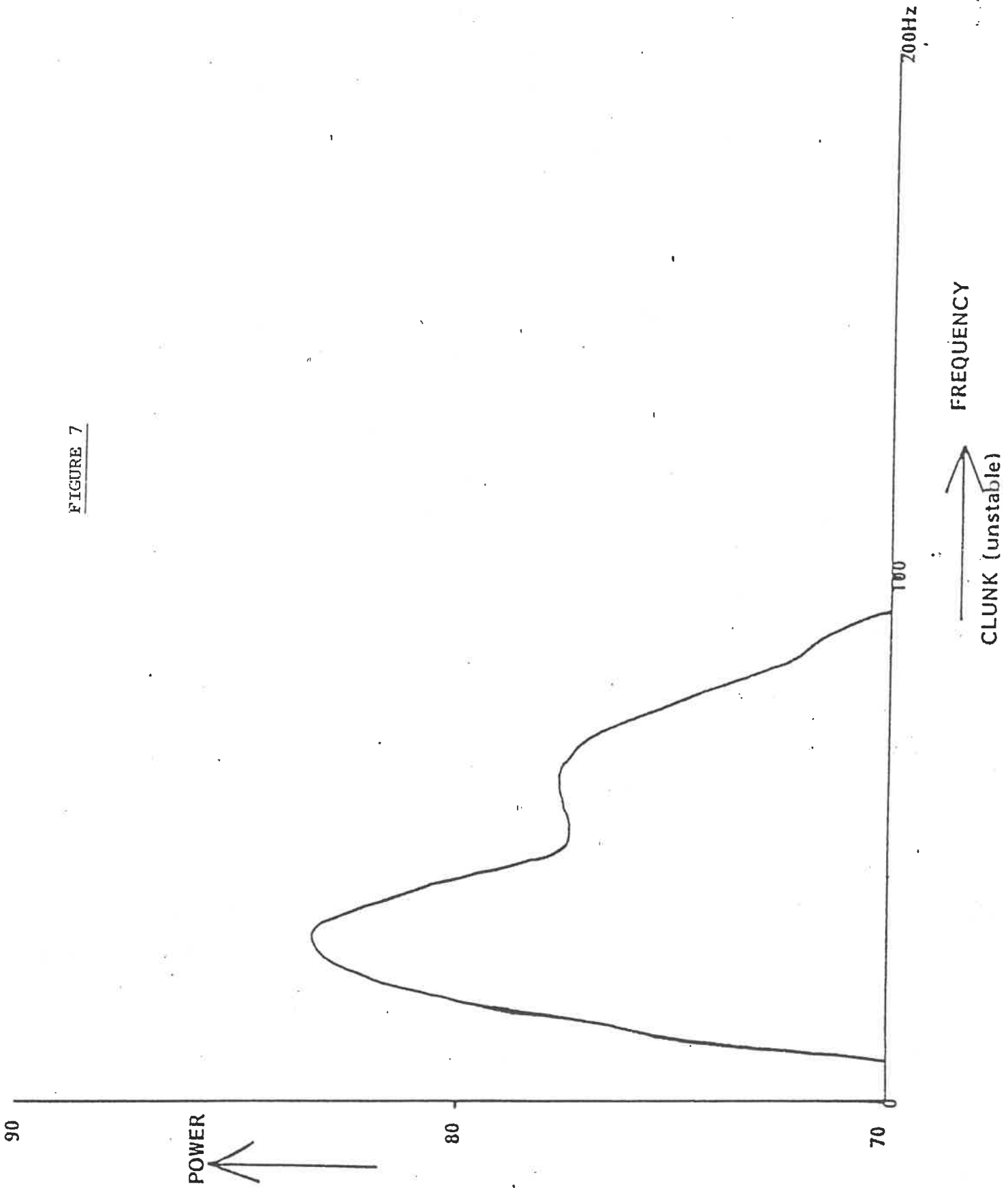


FIGURE 8

