PAPERS AND ORIGINALS

Kielland's forceps: association with neonatal morbidity and mortality

MALCOLM L CHISWICK, DAVID K JAMES

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Summary and conclusions

The incidence of certain neonatal complications associated with the use of Kielland's forceps was analysed retrospectively in liveborn singleton babies delivered at this hospital between January and December 1976. The neonatal mortality rate attributable to use of the forceps was 34.9 per 1000. The incidences of delayed onset of respiration (17.4%), birth trauma (15.1%), and abnormal neurological behaviour—namely, apathy or irritability or both—(23.3%) significantly exceeded those in a matched group of babies born spontaneously. Fetal asphyxia played a major part in the aetiology of neonatal complications. Babies on whom Kielland's forceps were used, however, had a significantly greater incidence of abnormal neurological behaviour even in the absence of fetal asphyxia (14.3%), and in all of these babies the abnormal behaviour was transient and did not necessitate admission to the special-care baby unit.

Neither maternal height nor the infant's birth weight or occipitofrontal head circumference influenced the occurrence of neonatal complications. The results also suggest that neither the speed of cervical dilatation nor the timing of engagement of the fetal head is of help in predicting the occurrence of neonatal complications after the use of Kielland's forceps.

Introduction

The use of Kielland's forceps was first described at the beginning of the century. Much debate has taken place about their efficacy and safety,¹⁻⁵ although serious maternal injury is rare with

proper use. The relatively high perinatal mortality rate associated with the use of forceps in general is well recognised,⁶⁻⁸ but little information is available on neonatal morbidity after Kielland's rotational forceps delivery. The admission of babies to special-care baby units (SCBU) is deprecated because of the hazards of separation from the mother, so that routine admission of certain babies born by forceps will probably become a thing of the past. In our unit, for example, which is situated in a university maternity hospital that caters for a disproportionately high number of "at-risk" pregnancies, only 10-12% of newborn babies are admitted to the SCBU. Thus the implications of neonatal morbidity associated with the use of Kielland's forceps might go unrecognised if affected babies, perhaps with minor complications, are nursed in maternity wards.

We decided to investigate the incidence of certain neonatal complications resulting after the use of Kielland's forceps and examine some factors that might determine their occurrence.

Patients and methods

We reviewed the neonatal and maternal case histories of 86 consecutive liveborn singleton babies delivered by Kielland's forceps or emergency caesarean section after attempted Kielland's forceps delivery (study group) at this hospital between January and December 1976. The incidence of certain neonatal complications was compared with that in 86 babies born by spontaneous vertex vaginal delivery during the same year (control group), who were carefully matched against babies in the study group for maternal age, parity, marital state and ethnic origin, social class,⁹ gestational age, and whether labour was induced or of spontaneous onset. The influence of various antenatal and intrapartum factors on the occurrence of neonatal complications after the use of Kielland's forceps was analysed.

All mothers received conventional antenatal care in the hospital clinic. The most commonly used agent for the relief of pain during labour in both groups was a combination of pethidine (100 mg) and promethazine (25 mg) given intramuscularly. Epidural anaesthesia was used at the mother's request, in the presence of extreme maternal fatigue, when labour was prolonged beyond 12 hours, or when pregnancy was complicated by pre-eclamptic toxæmia or hypertension. The fetal heart rate was continuously monitored during labour in all pregnancies complicated by threatened miscarriage, pre-eclamptic toxæmia, hypertension, antepartum haemorrhage, and fetal growth retardation and when labour was conducted under epidural anaesthesia. When cardiotocography equipment was available fetal monitoring

St Mary's Hospital, Whitworth Park, Manchester M13 0JH

MALCOLM L CHISWICK, MD, MRCP, consultant neonatal paediatrician
DAVID K JAMES, MB, DCH, senior house officer in obstetrics and neonatal paediatrics (now registrar in obstetrics and gynaecology, Wythenshawe Hospital, Manchester M23 9LT)

was also performed in uncomplicated pregnancies. Altogether 77 (90%) of the babies in the study group and 75 (87%) of the controls were monitored during labour. The term fetal asphyxia was applied whenever cardiotocography showed an abnormal fetal heart rate pattern.^{10,11} Cervical dilatation was assessed by the midwife or obstetrician by serial vaginal examinations during labour and the results plotted on a partogram.¹²

Factors that precipitated the use of Kielland's forceps in the 86 deliveries were a prolonged second stage of labour (49 cases), prolonged second stage and fetal asphyxia (17), and fetal asphyxia alone (15); in five cases this information was not available. A prolonged second stage was arbitrarily defined as lasting over 60 minutes in primigravidae and over 30 minutes in multigravidae. Delivery was conducted under pudendal block or epidural anaesthesia and carried out only by a registrar, consultant, or senior house officer who had received experience under supervision. The operator was asked to record in the case notes whether there was any operative difficulty that required the use of excess force to facilitate delivery.

The baby's respiratory activity, heart rate, and colour were routinely recorded one, five, and 10 minutes after birth. All babies who were not breathing regularly by one minute received intermittent positive-pressure ventilation (IPPV), and those deemed to be severely asphyxiated at the moment of birth were given IPPV immediately. Babies received conventional care in the maternity ward or SCBU if indicated. All babies were routinely examined on the first day of life and again just before discharge. Occipitofrontal head circumference of each baby was measured with a fibreglass tape measure in the first 24 hours of life. Serum bilirubin estimations were carried out at the discretion of the resident paediatrician.

Delayed onset of respiration was defined as the absence of spontaneous regular breathing at one minute or the need for IPPV from the moment of birth. *Birth trauma* was recorded in the presence of a cephalhaematoma or facial or brachial plexus nerve palsies or when a torn tentorium was found at necroscopy. *Abnormal neurological behaviour* was defined as apathy or the presence of the irritability syndrome,¹³ as determined by the resident paediatrician. Apathetic babies were those who were slow to feed and lethargic and who had a paucity of spontaneous movements, generalised hypotonia, and a weak cry. Babies with the irritability syndrome had generalised hypertonia and intermittent tremulous movements of the limbs, particularly the arms. Many of these babies had a high-pitched cry. *Jaundice* was recorded when the total serum bilirubin concentration exceeded 170 $\mu\text{mol/l}$ (9.9 mg/100 ml) or phototherapy or exchange transfusion had been given.

Student's *t* test was used to compare mean values between groups, and the χ^2 test with Yates's correction to compare frequencies between groups.

Results

There were three neonatal deaths from tentorial tears in the study group, and a fourth baby died in the neonatal period from a major congenital malformation. Each of the babies with a torn tentorium showed signs of fetal asphyxia, and two were delivered by emergency caesarean section after "failed forceps." There were no neonatal deaths among the controls. Thirteen babies in the study group were admitted to the SCBU compared with only five of the controls, but this difference was not significant. There were, however, significant differences between the two groups in the incidences of delayed onset of respiration (15 cases in the study group compared with 3 among the controls— $P < 0.01$), birth trauma (13 cases compared with 3— $P < 0.01$), and abnormal neurological behaviour (20 cases compared with 2— $P < 0.001$); jaundice was also more common in the study group (16 cases compared with 7), but not significantly so. Thus the incidence of abnormal neurological behaviour was 10 times higher among babies delivered by Kielland's forceps (23.3%) than among those delivered spontaneously (2.3%).

Maternal analgesia—In the study group there was a greater incidence of the use of general anaesthesia (20.0% of cases) among mothers of babies who developed abnormal neurological behaviour than among those whose babies were normal (3.0%) ($P < 0.05$ —table I). Nevertheless, the use of pethidine and epidural analgesia, singly or in combination, was not associated with a significantly greater incidence of abnormal neurological behaviour in babies in the study group. The mean time interval between pethidine administration and delivery in mothers of babies who developed abnormal neurological behaviour ($8.3 \pm \text{SD } 5.4$ hours) did not differ significantly from that in mothers who gave birth to normal babies (6.5 ± 4.0 hours). There was no apparent association between the use of a particular type

TABLE I—Types of analgesia used during labour on mothers in study group whose infants were normal or developed abnormal neurological behaviour

Type of analgesia	No (%) of mothers whose infants developed abnormal neurological behaviour	No (%) of mothers whose infants were normal
Pethidine and promethazine/pudendal block	4 (20.0)	23 (34.8)
Pudendal block alone	2 (10.0)	2 (3.0)
Pethidine and promethazine/epidural	6 (30.0)	18 (27.3)
Epidural alone	4 (20.0)	23 (34.8)
General anaesthesia	4 (20.0)	2 (3.0)*
Total	20 (100.0)	66 (100.0)

* $P < 0.05$.

of analgesia and the development of apathy or irritability or both forms of abnormal behaviour.

Fetal asphyxia occurred in 37 babies in the study group but in only 14 of the controls ($P < 0.001$). The hypothesis was therefore tested that fetal asphyxia per se played a major part in the aetiology of neonatal complications after the use of Kielland's forceps. In support of this the incidences in the study group of delayed onset of respiration (11 cases (29.7%) among those with fetal asphyxia compared with 4 (8.2%) among those without— $P < 0.005$), birth trauma (11 cases (29.7%) compared with 2 (4.1%)— $P < 0.005$), and abnormal neurological behaviour (13 cases (35.1%) compared with 7 (14.3%)— $P < 0.05$) were all significantly greater when there was preceding fetal asphyxia. When babies in the study and control groups with fetal asphyxia were excluded, the incidences of delayed onset of respiration (4.1% and 2.8%) and birth trauma (8.2% and 4.2%) showed no appreciable difference. Nevertheless, 7 (14.3%) of the 49 babies in the study group with no evidence of fetal asphyxia compared with only 1 (1.4%) of the 72 controls developed abnormal neurological behaviour ($P < 0.02$).

Operative difficulty—In 11 cases in the study group (12.8%) the degree of operative difficulty was not recorded. The incidence of all neonatal complications after these births (5 cases; 45.5%), however, did not differ significantly from that (37 cases; 49.3%) after the 75 births on which operative information was available. Altogether 24 of these 75 births were attended by operative difficulty and 51 were not, and 16 (66.7%) and 21 (41.2%) of the infants respectively had neonatal problems. This difference was not significant.

Parity and induction of labour—Sixty-five mothers in the study group (75.6%) were primigravidae, and 43 mothers in the group had labour induced. Although the incidence of all neonatal complications after the use of Kielland's forceps was greater in babies of primigravidae than in those of multigravidae, the difference was not significant. There was also a slightly higher incidence of neonatal complications in the study group after induced labour than after spontaneous onset of labour.

Maternal and infant size—In the study group the primigravidae were significantly shorter than the multigravidae (mean heights $159.0 \pm \text{SD } 5.2$ cm and 162.0 ± 5.9 cm respectively— $P < 0.05$). Primigravidae whose infants developed complications, however, were of similar mean height to those whose babies were normal. Comparison of babies in the study group who did and did not develop complications showed no significant difference in mean birth weight, ratio of maternal height to birth weight, occipitofrontal head circumference, or ratio of maternal height to occipitofrontal head circumference (table II).

TABLE II—Maternal and infant size in study group and occurrence of neonatal complications

	Cases in which infants had neonatal complications		Cases in which infants were normal	
	No	Mean $\pm$ SD	No	Mean $\pm$ SD
Height of primigravidae (cm)	30	158.8 ± 4.7	35	159.4 ± 5.9
Birth weight (g)	37	3352 ± 447	49	3288 ± 479
Occipitofrontal head circumference (cm)	36	35.1 ± 1.4	45	35.3 ± 1.4
Ratio of maternal height to birth weight (primigravidae)	30	4.9 ± 0.6	35	5.0 ± 0.7
Ratio of maternal height to occipitofrontal head circumference (primigravidae)	29	4.5 ± 0.2	33	4.5 ± 0.2

Cervical dilatation and engagement of fetal head—The mean duration between engagement of the fetal head and the onset of labour, and the mean time taken for the cervix to dilate from 4 to 7 cm and from 7 to 10 cm, did not differ significantly in the study group between babies who developed neonatal complications and those who did not (table III).

TABLE III—Antepartum events and occurrence of neonatal complications in study group

	Cases in which infants had neonatal complications		Cases in which infants were normal	
	No	Mean $\pm$ SD	No	Mean $\pm$ SD
Interval between engagement of fetal head and onset of labour (weeks)	36	1.25 $\pm$ 1.93	45	1.57 $\pm$ 0.91
Dilatation of cervix from 4 to 7 cm (hours):				
Primigravidae	27	3.9 $\pm$ 1.9	32	3.6 $\pm$ 3.3
Multigravidae	6	2.4 $\pm$ 0.9	13	2.3 $\pm$ 1.1
Dilatation of cervix from 7 to 10 cm (hours):				
Primigravidae	30	3.3 $\pm$ 2.1	34	2.9 $\pm$ 2.0
Multigravidae	7	2.0 $\pm$ 1.1	13	2.5 $\pm$ 0.7

Discussion

The neonatal mortality rate attributable to the use of Kielland's forceps (34.9 per 1000) was two and a half times greater than the uncorrected rate among all babies born in the hospital during the same year. The first and second reports of the 1958 British Perinatal Mortality Survey^{6, 7} drew attention to a threefold greater mortality rate after rotational forceps deliveries than after occipitoanterior forceps deliveries. A considerable neonatal morbidity rate associated with the use of Kielland's forceps may not be readily appreciated when most affected babies do not require admission to a SCBU. Thirteen babies in the study group (15.1%) were admitted to the SCBU, which only slightly exceeded the incidence of admissions to the SCBU of all babies born at the hospital during 1976 (12.0%).

The incidence of bruising was not specifically studied; some facial bruising from the use of Kielland's forceps is probably acceptable and difficult to quantify. The twofold greater incidence of jaundice in the study group was probably accounted for by a greater incidence of bruised babies from use of the forceps.

The incidences of delayed onset of respiration, birth trauma, and abnormal neurological behaviour were four to 10 times greater in the study group than among the controls; however, a definite, positive influence of fetal asphyxia on the occurrence of delayed onset of respiration and birth trauma was apparent. Indeed, when babies with fetal asphyxia were excluded there was no longer a significant difference in the incidence of delayed onset of respiration and birth trauma between babies in the study group and the controls. It is not surprising that fetal asphyxia was associated with delayed onset of respiration, but that it should positively influence the occurrence of birth trauma is difficult to explain. Possibly in breech delivery the occurrence of fetal asphyxia and the associated reduction of muscle tone in the neck region renders the cervical cord more susceptible to injury during a manipulative delivery.¹⁴ A similar explanation might apply to brachial plexus injury in the present study if fetal asphyxia were associated with a reduction in the tone of muscles surrounding the shoulder and neck. Brachial plexus injury, however, occurred in only one of the 11 babies in the study group who suffered both fetal asphyxia and birth trauma. The remaining babies had cephalhaematomas, tentorial tears, and facial palsies. Possibly the occurrence of fetal asphyxia in these babies led the operator to use undue haste and force, thereby leading to injury. Operative difficulty requiring the use of excess force was reported in nine of the 11 cases of birth trauma associated with fetal asphyxia, but a

subjective assessment of the force used in carrying out a forceps delivery is not reliable. Interestingly, however, operative difficulty was reported in two-thirds of cases in which any neonatal complication developed, and in one-third of those in which no complications occurred. There are, of course, cogent reasons why the use of excess force might be associated with delayed onset of respiration, abnormal neurological behaviour, and jaundice as well as birth trauma.

The incidence of abnormal neurological behaviour was 10 times greater in the study group even when those babies with fetal asphyxia were excluded. Most babies who had an abnormal behaviour pattern were nursed with their mothers in the maternity wards, and the abnormality was brought to the attention of the paediatrician by the mother or midwife and confirmed clinically. It is most unlikely that the abnormal behaviour pattern was primarily caused by exposure of the fetus to analgesics or anaesthetics. The only significant association with the occurrence of abnormal neurological behaviour was the use of general anaesthesia. When a general anaesthetic was used, however, fetal asphyxia was always present and had led to the forceps delivery being abandoned in favour of emergency caesarean section. In contrast, none of the mothers whose babies developed abnormal neurological behaviour in the absence of fetal asphyxia received a general anaesthetic.

Another argument against a dominant influence of analgesics and anaesthetics on abnormal neurological behaviour was the fact that the use of individual agents was not associated with a consistent type of abnormal behaviour pattern. It is unlikely that the abnormal neurological behaviour was a result of cephalopelvic disproportion or prolonged labour because neither the various indices of maternal and infant size nor the speed of cervical dilatation appeared to influence the incidence of abnormal neurological behaviour. It seems that in some babies it was the use of Kielland's forceps per se that led to abnormal neurological behaviour. All babies in the study group who developed abnormal behaviour in the absence of preceding fetal asphyxia were normal by seven days, and it is speculative that the use of Kielland's forceps caused transient cerebral oedema.

None of the measurements of maternal and infant size in the study group of babies who had neonatal complications differed significantly from corresponding measurements in those babies who were normal. Hence if "mechanical factors" do influence the occurrence of neonatal complications after the use of Kielland's forceps, those factors cannot solely be explained in terms of maternal height and the infant's birth weight or occipitofrontal head circumference. Furthermore, our results suggest that neither the speed of cervical dilatation nor the timing of engagement of the fetal head is of help in predicting the occurrence of neonatal complications after the use of Kielland's forceps.

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