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ORIGINAL ARTICLE

Neonatal outcomes following a tight nuchal cord

E Henry[1,2], RL Andres[2,3,4] and RD Christensen[2,5]

[1]Institute for Healthcare Delivery Research, Salt Lake City, UT, USA; [2]Women and Newborn's Clinical Program, Intermountain Healthcare, Salt Lake City, UT, USA; [3]Department of Obstetrics and Gynecology, University of Utah, Salt Lake City, UT, USA; [4]Department of Maternal Fetal Medicine, McKay-Dee Hospital Center, Ogden, UT, USA and [5]Division of Neonatology, Intermountain Healthcare, Mckay-Dee Hospital Center, Ogden, UT, USA

Objective: The best practices for the care of a neonate born after a tight nuchal cord have not been defined. As a step toward this, we compared the outcomes of neonates born after a tight nuchal cord vs those born after a loose nuchal cord vs those born after no nuchal cord.

Study Design: This was a retrospective comparison using electronic data of all deliveries during a 6-year period (2005 to 2010) in a multihospital healthcare system in the western United States. At the time of delivery, each birth was recorded as having a tight nuchal cord, a loose nuchal cord or no nuchal cord. Nuchal cord was defined as a loop of umbilical cord $\geqslant 360^{\circ}$ around the fetal neck. 'Tight' was defined as the inability to manually reduce the loop over the fetal head, and 'loose' as the ability to manually reduce the loop over the head.

Result: Of 219 337 live births in this period, 6.6% had a tight nuchal cord and 21.6% had a loose nuchal cord. Owing to the very large number of subjects, several intergroup differences were statistically significant but all were judged as too small for clinical significance. For instance, those with a tight nuchal cord had a very slightly older gestational age, a very slightly lower birth weight, a preponderance of male fetuses, primagravid women, singleton pregnancies and shoulder dystocia (all $P<0.001$). Term neonates with a tight nuchal cord were slightly more likely to be admitted to a Neonatal Intensive Care Unit (6.6% vs 5.9% admission rate, $P=0.000$). Those with a tight nuchal cord were not more likely to have dopamine administered or blood hemoglobin measured on the first day, nor were they more likely to receive a transfusion or to die. The subset of very low birth weight neonates with a tight nuchal cord, compared with those with no nuchal cord, were of the same gestational age and birth weight, with the same Apgar scores, and were not more likely to have severe intraventrucular hemorrhage, retinopathy of prematurity or periventricular leukomalacia, or to die.

Conclusion: The presence of a tight nuchal cord is not uncommon, occurring in 6.6% of over 200 000 consecutive live births in a multihospital health system. No differences in demographics or outcomes, judged as clinically significant, were associated with a tight nuchal cord. Thus, we speculate that the best practices for neonatal care after a tight nuchal cord do not involve an obligation to conduct extra laboratory studies or extra monitoring solely on the basis of the report of a tight nuchal cord.

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Introduction

'Nuchal cord' has been defined as a $\geqslant 360^{\circ}$ wrapping of the umbilical cord around the fetal neck.[1–3] At the time of birth, nuchal cords are sometimes labeled as being either 'tight ' or 'loose' depending on whether the loop can be manually reduced over the fetal head.[2,3] Two reports in the 1980s described hypovolemic shock and anemia in neonates delivered after a tight nuchal cord.[4,5] The proposed mechanism causing shock/anemia was partial cord compression, with impaired fetal blood flow through the umbilical vein, because of its relatively thin wall, but unimpeded arterial flow from the fetus to the placenta. It was proposed that in this way the fetal/placental blood volume becomes reproportioned away from the fetus and into the placenta.[4,5]

Nuchal cords at term are common, with incidence reports ranging from 15 to 34% of births;[1–3,6,7] however, only a small but unreported fraction of these are tight. Moreover, the odds that a tight nuchal cord will result in subsequent neonatal hypovolemia, anemia or other problems are not known. Thus, it is not clear whether clinicians caring for a neonate born after a tight nuchal cord should specifically monitor for certain problems or outcomes.

Following the two reports of hypovolemia and anemia after a tight nuchal cord,[4,5] several studies reported a wide range of findings and outcomes. Published neonatal outcomes have included fetal demise,[8] physiological or neurodevelopmental impairment,[9–13] increased risk of cerebral palsy[13,14] and no clinical problems at all.[15–18] Consequently, interpretations of the significance of a tight nuchal cord at birth vary widely, with

Correspondence: Dr RD Christensen, Division of Neonatology, Intermountain Healthcare, Mckay-Dee Hospital Center, 4403 Harrison Blvd, Ogden, UT 84403, USA.
E-mail: rdchris4@ihc.com
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opinions ranging from this being a potentially lethal problem for the neonate to it being a normal and benign perinatal occurrence.[15] Collins *et al*.[3] proposed that studies using very large cohort groups are needed to assess the true risks of a tight nuchal cord. We reasoned that the data resources of Intermountain Healthcare could provide useful insights into this issue. Specifically, in our data marts, information regarding nuchal cord is kept on every delivery, including whether, if present, it was tight or loose. We speculated that by linking that information with the electronic data marts for the neonatal courses any associations between tight nuchal cord and neonatal hypovolemia, anemia or other problems could be evaluated statistically using large sample sizes.

Methods

This was a retrospective analysis of clinical and laboratory data existing in Intermountain Healthcare data repositories. The Intermountain Healthcare Institutional Review Board approved the study as a deidentified data-only investigation not requiring written consent of the individuals.

The experimental approach was to first collate the records of all live births in any Intermountain Healthcare hospital between the dates 1 January 2005 and 31 December 2010, and then to separate these into three categories: tight nuchal cord, loose nuchal cord and no nuchal cord. We then used specific electronic data sources to identify demographic and clinical features of the pregnancies and neonates in these three groups. These included ICD9, Case Mix (the billing, coding and financial data mart used by Intermountain Healthcare) and the extended Vermont–Oxford database.

Gestational age was determined by obstetrical assignment, unless this was changed by the neonatologist on the basis of gestational age assessment (physical examination and neurological/neurodevelopmental findings). The Vermont/Oxford definitions[19] were used for severe intraventricular hemorrhage (IVH grade $\geqslant 3$), severe retinopathy of prematurity (ROP stage $\geqslant 3$) and periventircular leukomalacia (PVL).

The program used for data collection was a modified subsystem of 'clinical workstation'. Clinical workstation is a web-based electronic medical record application that stores demographic and clinical information, such as history, physical examination results, laboratory data, problem lists and discharge summaries. 3M Company (Minneapolis, MN, USA) approved the structure and definitions of all data points for use within the program.

For neonates <1500 g birth weight, we sought associations between nuchal cord and diagnoses previously said to be more common after nuchal cord: namely IVH, ROP and PVL. For each of these diagnoses, the effect size of having a tight nuchal cord was estimated by calculating odds ratios (95% confidence interval (CI)) for subsequently diagnosing IVH, ROP or PVL, using logistic regression (Statit, Corvallis, OR, USA). Means and s.d.'s were used to express values in groups that were normally distributed. Differences in categorical variables were assessed using the χ^2 test. A Student's *t*-test was used to assess continuous variables. Statistical significance was set as $P<0.05$.

Results

Of 219 337 live births during this 6-year period, 6.6% were charted as having a tight nuchal cord and 21.6% as having a loose nuchal cord. As shown in Table 1, several intergroup differences were statistically significant. For instance, those with a tight nuchal cord had a very slightly older gestational age but a very slightly lower birth weight, compared with the loose and the no nuchal cord groups. However, we judged that the differences shown in Table 1 are not likely to be clinically recognizable in any given infant because they are so minimal. For instance, male fetuses, primagravid women, singleton pregnancies and cases with shoulder dystocia were more likely to have a tight nuchal cord, but these differences were all very small.

Clinical findings in the 219 337 neonates are shown in Table 2, and are listed according to tight nuchal cord, loose nuchal cord or no nuchal cord. Term neonates with a tight nuchal cord were slightly more likely to be admitted to a Neonatal Intensive Care Unit. It is not likely that hypovolemia or anemia were more common among those with a tight nuchal cord. For instance, those with a tight nuchal cord were not more likely to have dopamine administered or blood hemoglobin concentration measured on the first day, nor were they more likely to receive a RBC transfusion during the first day or during the first 5 days or to die.

Very low birth weight (<1500 g) neonates were analyzed separately from the total group, as shown in Table 3.[12] Very low birth weight neonates with a tight nuchal cord were of the same gestational age and birth weight, with the same 1- and 5-min Apgar scores, and were not more likely to have severe IVH, ROP, PVL or to die in the hospital. Logistic regression, with 'tight nuchal cord' as the dependent variable, indicated no higher odds ratio of developing ROP (odds ratio 1.001, $P=0.489$), IVH (odds ratio 1.106, $P=0.400$) or PVL (odds ratio 1.914, $P=0.108$).

Discussion

In 1985, Sheperd *et al*.[4] reported that five of the 27 neonates born after a tight nuchal cord developed anemia, and three of the five neonates had signs consistent with hypovolemia, manifest by hypotension necessitating RBC transfusion. In addition, they reported that four of the 20 neonates born with a loose nuchal cord developed asymptomatic anemia later during the hospital course. Two years later, Vanhaeserbrouck *et al*.[5] reported two term infants with a tight nuchal cord born with life-threatening hypovolemic shock. Both were pale and tachycardic with weak pulses, poor capillary perfusion and hypotension, which improved after RBC

Table 1 Demographic features of pregnancies/neonates with a tight, loose or no nuchal cord, born in an Intermountain Healthcare hospital during the period 1 January 2005 through 31 December 2010

	Tight nuchal cord (n = 14 481)	*Loose nuchal cord (n = 47 364)*	*No nuchal cord (n = 157 492)*	P-*value tight vs loose nuchal cord*	P-*value tight vs no nuchal cord*
Gestational age at birth (weeks)	39.0	38.9	38.7	0.000	0.000
Weight at birth (g)	3258	3302	3279	0.000	0.000
Gender (% M)	54.0%	54.3%	50.3%	0.451	0.000
Maternal race (% W)	83.6%	85.7%	82.3%	0.000	0.000
Primagravida (%)	34.3%	32.3%	33.0%	0.000	0.002
Twin or higher multiple (%)	1.8%	2.4%	3.8%	0.000	0.000
Shoulder dystocia (%)	2.7%	1.8%	1.8%	0.000	0.000

Abbreviations: M, male; W, white.

Table 2 Clinical findings in neonates born after tight, loose or no nuchal cord born in an Intermountain Healthcare hospital during the period 1 January 2005 through 31 December 2010

	Tight nuchal cord (n = 14 481)	*Loose nuchal cord (n = 47 364)*	*No nuchal cord (n = 157 492)*	P-*value tight vs loose nuchal cord*	P-*value tight vs no nuchal cord*
Term patients admitted to a NICU (% yes)	6.6%	5.3%	5.9%	0.000	0.001
Birth weight <1500 g (% yes)	7.1%	7.6%	10.6%	0.051	0.000
Dopamine in first 24 h (% yes)	0.44%	0.31%	0.63%	0.017	0.006
Hgb measured in first 24 h (% yes)	18.1%	16.2%	18.7%	0.000	0.070
RBC transfusion in first 24 h (% yes)	0.20%	0.10%	0.34%	0.004	0.005
RBC transfusion in first 5 days (% yes)	0.53%	0.33%	0.82%	0.001	0.000
Died in hospital (% yes)	0.06%	0.04%	0.22%	0.730	0.000

Abbreviations: Hgb, hemoglobin; NICU, Neonatal Intensive Care Unit; RBC, red blood cells.

Table 3 Features of VLBW neonates (<1500 g birth weight) with a tight, loose or no nuchal cord

	Tight nuchal cord (n = 70)	*Loose nuchal cord (n = 184)*	*No nuchal cord (n = 1751)*	P-*value tight vs loose nuchal cord*	P-*value tight vs no nuchal cord*
Gestational age (weeks)	29.4	29.8	28.9	0.364	0.174
Birth weight (g)	1080	1149	1058	0.082	0.549
Apgar score @ 1 min	5.2	5.6	5.1	0.248	0.675
Apgar score @ 5 min	7.2	7.8	7.2	0.048	0.887
IVH grade ⩾3	12.9%	5.4%	10.7%	0.045	0.575
ROP stage⩾2	15.7%	12.0%	14.4%	0.426	0.758
PVL	7.1%	2.7%	3.8%	0.105	0.153
Died in hospital	5.7%	3.3%	11.6%	0.369	0.129

Abbreviations: IVH, intraventricular hemorrhage; PVL, periventricular leukomalacia; ROP, retinopathy of prematurity.
Patients were included in the analysis only if they were born in an Intermountain Healthcare hospital during the period 1 January 2005 through 31 December 2010.

transfusion. Fetal/maternal hemorrhage was not evident, as the Kleihauer–Betke test was negative, and no other source, other than tight nuchal cord, was found to explain the hypovolemic shock.

The best practices have not yet been identified for the care of a neonate born after a tight nuchal cord. Jackson *et al.*[17] conducted a survey of midwives in England on practices and perceptions related to nuchal cord. No consistent practices were identified, and they concluded that future studies are needed to define the risks of a tight nuchal cord and to determine the best practices in dealing with these risks. Defining best practice partly depends on the expected clinical problems, and the means of preventing adverse outcomes associated with these problems. As a step toward defining best practice after a tight nuchal cord, we used the Intermountain Healthcare multihospital databases to examine outcomes of

219 337 consecutive live births during a recent 6-year period. We were unable to find clinically meaningful differences between pregnancies in which a tight nuchal cord occurred and in those in which it did not occur. Moreover, we did not find clinically significant differences in outcomes of these neonates, nor in the subset of very low birth weight neonates delivered after a tight nuchal cord.

We recognize limitations in our study; all problems associated with retrospective data analyses certainly apply to our report. Specifically, we are not certain of the charting veracity of 'tight' and 'loose' nuchal cord. Tightness of a nuchal cord is more likely a spectrum rather than a dichotomous variable, but our charting calls for a decision to be made between 'tight', 'loose' and 'none'. This electric charting is the responsibility of the nurse present at the time of delivery, who is instructed to verify the finding with the delivering physician or midwife before entering this information. Despite what we believe are reasonably clear instructions, we recognize that charting errors occur. In addition, we did not analyze the number or loops of umbilical cord around the fetal neck, as variable, because we found this to be charted inconsistently. Wang *et al.* reported a fetal demise with eight complete nuchal cord loops and suggested the possibility that multiple loops might be more significant than a single or double loop.[20] In addition, we recognize that among the over 14 000 deliveries in our series with a tight nuchal cord, a small number might have indeed had hypovolemia and anemia requiring early vasopressors and/or a RBC transfusion. However, it appears to us that any such cases were not more likely among those with tight nuchal cord than among those with loose nuchal cord, or among those with no nuchal cord.

Our interpretation of this present large data set analysis is that a tight nuchal cord at birth is not associated with clinically meaningful adverse outcomes for the newborn infant. This conclusion, based on 219 337 consecutive live births in a single healthcare system, is the same as that reached by Cohain[15] after compiling research based on a total of 182 492 births. On this basis, we speculate that individuals providing care for neonates are not obligated to routinely order extra laboratory tests, or conduct extra monitoring, solely because of the report of a tight nuchal cord.

Conflict of interest

The authors declare no conflict of interest.

References

1 Collins JH, Geddes D, Collins CL, De Angelis L. Nuchal cord: a definition and a study associating placental location and nuchal cord incidence. *J La State Med Soc* 1991; **143**: 18–23.
2 Murray M, Huelsmann G. *Labor and Delivery Nursing: Guide to Evidence—Based Practice*. Springer Publishing: New York, NY, USA, 2008, p 129.
3 Collins JH, Collins CL, Collins CC. Silent Risk: issues about the human umbilical cord. accessed from: http://www.preginst.com/pucp.html, Accessed 16 April 2012.
4 Shepherd AJ, Richardson CJ, Brown JP. Nuchal cord as a cause of neonatal anemia. *Am J Dis Child* 1985; **139**: 71–73.
5 Vanhaesebrouck P, Vanneste K, de Praeter C, Van Trappen Y, Thiery M. Tight nuchal cord and neonatal hypovolaemic shock. *Arch Dis Child* 1987; **62**: 1276–1277.
6 Schäffer L, Burkhardt T, Zimmermann R, Kurmanavicius J. Nuchal cords in term and post term deliveries—do we need to know? *Obstet Gynecol* 2005; **106**: 23–28.
7 Rhoades DA, Latza U, Mueller BA. Risk factors and outcomes associated with nuchal cord. A population-based study. *J Reprod Med* 1999; **44**: 39–45.
8 Verdel MJ, Exalto N. Tight nuchal coiling of the umbilical cord causing fetal death. *J Clin Ultrasound* 1994; **22**: 64–66.
9 Shrestha NS, Singh N. Nuchal cord and perinatal outcome. *Kathmandu Univ Med J (KUMJ)* 2007; **5**: 360–363.
10 Jauniaux E, Ramsay B, Peellaerts C, Scholler Y. Perinatal features of pregnancies complicated by nuchal cord. *Am J Perinatol* 1995; **12**: 255–258.
11 Hankins GD, Snyder RR, Hauth JC, Gilstrap III LC, Hammond T. Nuchal cords and neonatal outcome. *Obstet Gynecol* 1987; **70**: 687–691.
12 Dhar KK, Ray SN, Dhall GI. Significance of nuchal cord. *J Indian Med Assoc* 1995; **93**: 451–453.
13 Nelson KB, Grether JK. Potentially asphyxiating conditions and spastic cerebral palsy in infants of normal birth weight. *Am J Obstet Gynecol* 1998; **179**: 507–513.
14 Clapp III JF, Lopez B, Simonean S. Nuchal cord and neurodevelopmental performance at 1 year. *J Soc Gynecol Investig* 1999; **5**: 268–272.
15 Cohain JS. Nuchal cords are necklaces, not nooses. *Midwifery Today Int Midwife* 2010; **93**: 46–48.
16 Greenwood C, Impey L. The association of nuchal cord with cerebral palsy is influenced by recording bias. *Early Hum Dev* 2002; **68**: 15–19.
17 Jackson H, Melvin C, Downe S. Midwives and the fetal nuchal cord: a survey of practices and perceptions. *J Midwifery Womens Health* 2007; **52**: 49–55.
18 Jefford E, Fahy K, Sundin D. The nuchal cord at birth: what do midwives think and do? *Midwifery Today Int Midwife* 2009; **89**: 44–46.
19 *Manual of Operations*. Release 13.2. Vermont Oxford Network Database: Burlington, VT, USA, 2009, 55 and 74.
20 Wang Y, Le Ray C, Audibert F, Wagner MS. Management of nuchal cord with multiple loops. *Obstet Gynecol* 2008; **112**(2 Part 2): 460–461.