JAOA

ORIGINAL CONTRIBUTION

Osteopathic Manipulative Treatment in Prenatal Care: A Retrospective Case Control Design Study

Hollis H. King, DO, PhD; Melicien A. Tettambel, DO; Michael D. Lockwood, DO; Kenneth H. Johnson, DO; Debra A. Arsenault, DO; Ryan Quist, PhD

The use of osteopathic manipulative treatment (OMT) during pregnancy has a long tradition in osteopathic medicine. A retrospective study was designed to compare a group of women who received prenatal OMT with a matched group that did not receive prenatal OMT. The medical records of 160 women from four cities who received prenatal OMT were reviewed for the occurrence of meconium-stained amniotic fluid, preterm delivery, use of forceps, and cesarean delivery. The randomly selected records of 161 women who were from the same cities, but who did not receive prenatal OMT, were reviewed for the same outcomes.

The results of a logistic regression analysis were statistically reliable, X^2 (4, N = 321) = 26.55; $P < .001$, indicating that the labor and delivery outcomes, as a set, were associated with whether OMT was administered during pregnancy. According to the Wald criterion, prenatal OMT was significantly associated with meconium-stained amniotic fluid (Z = 13.20, $P < .001$) and preterm delivery (Z = 9.91; $P < .01$), while the use of forceps was found to be marginally significant (Z = 3.28; $P = .07$). The case control study found evidence of improved outcomes in labor and delivery for women who received prenatal OMT, compared with women who did not. A prospective study is proposed as the next step in evaluating the effects of prenatal OMT.

Dr King conducts a clinical practice in San Diego, Calif, and was associate professor of osteopathic manipulative medicine at Western University of Health Sciences College of Osteopathic Medicine of the Pacific in Pomona, Calif, where Dr Quist is a biostatistician in the Center for Academic and Professional Enhancement. Dr Tettambel at the time of data collection was in private practice in Chicago, Ill, and professor of osteopathic manipulative medicine at Midwestern University's Chicago College of Osteopathic Medicine in Downers Grove, Ill. She is now professor at the Kirksville College of Osteopathic Medicine of A. T. Still University of Health Sciences in Kirksville, Mo, where Dr Lockwood is Chair of Osteopathic Manipulative Medicine. Dr Johnson is director of the family practice residency at Eastern Maine Medical Center in Bangor, Me. Dr Arsenault at the time of the data collection was on duty at the Balboa Naval Medical Center, Department of Obstetrics and Gynecology in San Diego, Calif.

Address correspondence to Hollis H. King, DO, PhD, 5445 Oberlin Dr, Suite #100, San Diego, CA 92121-1704.

E-mail: hhkingdo@westernu.edu

The use of osteopathic manipulative treatment (OMT) during pregnancy has a long tradition but minimal systematic examination of applications and outcomes. During the first half of the 20th century, osteopathic medical literature included thorough discussions of the applications of OMT in prenatal care. Many articles contained descriptions of specific OMT techniques (eg, Conner[1] in 1928). Typical of articles that cited case studies were discourses on how osteopathic management could improve postpartum recovery,[2] reduce nausea and vomiting associated with pregnancy,[3] and increase the percentage of mothers who could successfully nurse their babies.[4]

A few of the articles published at that time included extensive data. In 1911, Whiting[5] tabulated results from 223 women, 125 of whom received prenatal OMT and 98 of whom did not receive prenatal OMT. She reported an average of 9 hours and 54 minutes of labor for the primipara women who received prenatal OMT and 6 hours and 19 minutes for multipara women who received prenatal OMT, compared with 21 hours and 6 minutes for the primipara women and 11 hours and 41 minutes for the multipara women who did not receive prenatal OMT.

In 1918, Hart[6] reported on 100 women he delivered, all of whom received "osteopathic management." The reported average duration of labor among the 100 women was 9 hours and 20 minutes for primapara women and 5 hours for multipara women, compared with 15 hours and 9 hours, respectively, for women outside the control group who had not received prenatal OMT and that these were the "generally accepted averages in these cases." Hart also reported only three deliveries using forceps among the control group that received OMT, compared with estimates "by the authorities at between 6% and 18%" among women not receiving OMT.

Jones[7] cited the 1932 obstetrical report compiled by S.V. Robuck, DO, of the Clinical Research Committee of the A.T. Still Research Institute. In this series of 13,816 women receiving OMT and delivered by osteopathic physicians, "thirty mothers died which is a mortality rate of 2.2 per thousand living births, compared with 6.8 per thousand rate in Caucasian mothers quoted from government bulletins."

The second half of the 20th century also produced a large number of articles on the applications of OMT in pre-

natal care, with the same approximate number of articles about OMT technique, case studies, and studies with larger numbers of subjects involved than in studies conducted in the first half of the century. Comprehensive descriptions of the use of OMT in prenatal care reflecting current obstetric standards were published by Wood in 1951,[8] Jones in 1952,[9] Zink and Lawson in 1979,[10] and Tettambel in 1997.[11] Using a sample of 8 postdate gravidas who had not received prenatal OMT and were demonstrating uterine inertia, Gitlin and Wolf[12] were able to demonstrate uterine contraction initiation by application of osteopathic cranial manipulation, leading, in one case, to delivery within 24 hours.

Empirically oriented articles on OMT in obstetrics with larger subject samples published in the second half of the century had a recurring theme of pain reduction during pregnancy and labor. In a sample of 500 women, Guthrie and Martin[13] found 352 women who had pain in the lumbar area that appeared to be strongly associated with abnormal fetal presentation. They used OMT to the lumbar area, which resulted in significantly reduced pain, compared with placebo OMT to the thoracic spine, which produced no relief of pain, as measured by the need for analgesic medication during labor.

In a prospective study of 97 pregnant women, Brady et al[14] found statistically significant pain reduction in a group of 45 women who received OMT, compared with 52 women in a group not receiving OMT. Tettambel[11] described other research on low back pain during pregnancy and elaborated on the osteopathic concept of viscerosomatic reflexes as related to treating pregnant women. Her article illustrated possible applications of OMT during pregnancy, using such techniques as Chapman's reflexes[15] and outlined indications and contraindications for using OMT during pregnancy.

A review of medical literature published outside of the osteopathic medical profession revealed little on the application of OMT during pregnancy, with no report of labor and delivery outcomes in those few reports. Two well-illustrated technique articles, however, reported the beneficial application of OMT in prenatal care for the reduction of pain. Both studies were generated by physicians in family practice with training in manual medicine.[16,17] The retrospective study by Daly et al[16] reviewed 100 consecutive pregnancies, 23 in which the women reported pain, with 11 of the 23 meeting diagnostic criteria for sacroiliac subluxation. "After manipulative therapy, 10 of the 11 women (91%) had relief of pain and no longer exhibited signs of sacroiliac subluxation."[16] McIntyre and Broadhurst[17] reported a series of 38 pregnancies, 20 in which the women reported low back pain; 17 had sacroiliac joint area pain, and 3 had iliolumbar ligament pain. After receiving three treatments with "mobilising technique" and home exercise, 15 had no pain, and the rest had a greater than 50% improvement in their pain.

Numerous articles have been written on the prevention and treatment of back pain during pregnancy. Typical of most is a focus on etiology,[18,19] recommendations regarding exercises,[20-22] and sacroiliac belts[19,23] to reduce low-back pain. One article even advises against using OMT, unless it is accompanied by muscle training and relaxation training to increase muscle control.[19]

A pilot study was done to systematically examine the relationship between prenatal OMT and outcomes of labor and delivery.[24] The medical records of women who received prenatal OMT were reviewed, and the labor and delivery outcomes of meconium-stained amniotic fluid, preterm delivery (PTD), umbilical cord prolapse (UCP), use of forceps, and cesarean delivery were recorded. These outcomes were selected because of their frequency of occurrence, the ease of ascertaining occurrence from medical records, and the possible relation to structural biomechanics affected by OMT.[24] Researchers tabulated these occurrence rates in a cohort of women who received prenatal OMT and compared them with data from an article that included averages for the same outcomes, as determined by metaanalysis. These data included data from North American and other developed countries with comparable standards of obstetrical practice. The metaanalysis-derived averages for the occurrence of MSAF, PTD, forceps use, and cesarean deliveries were uniformly higher than the occurrence of these outcomes in the cohort of women who received prenatal OMT.

The purpose of the current study was to obtain data appropriate for statistical analysis to test the hypothesis that prenatal OMT has a beneficial effect on the outcomes of pregnancy, labor, and delivery.

Methods

Medical records from four centers were reviewed for the occurrence of meconium-stained amniotic fluid, PTD (less than 37 weeks' gestation), UCP, use of forceps, and cesarean delivery. All subjects in this study, whether or not they received prenatal OMT, signed consent forms allowing their medical records to be reviewed for research purposes in accordance with the institutional guidelines for privacy of the respective medical center. At each of the four medical centers, consent was obtained as part of the admission process, and records were reviewed by physicians participating in the research or by their residents and research assistants.

Criteria for determining the presence of the dependent variables in a given chart were established in accordance with standard of practice regarding chart recording of such events. All dependent variables were considered present if mention was made in the record without regard to degree of meconium-stained amniotic fluid, extent of the PTD, or type of forceps. The occurrence of cesarean delivery was easily documented. The random selection process, which accessed all records in each center, was limited only by an attempt to have both groups (receiving OMT and not receiving OMT) drawn from the same time period. Each reviewer randomly selected every second or third record from a list of births in an approximate period.

Table 1
Average Age, Number of Times Received Osteopathic Manipulative Treatment (OMT), Male-Female Child Ratio, and Percentage of Primagravida Women by Center for Each Condition for Women Who Did and Did Not Receive OMT

Center	No. of Women	Average Age, y	Avg No. of Times Received OMT	Male-Female Ratio	Primagravida, No. (%)
Group Who Received OMT					
Chicago	50	28.5 (16-40)	2.8 (1-4)	22/28 (M = 44%)	14 (28)
Kirksville	44	26.6 (19-38)	4.3 (1-11)	21/23 (M = 48%)	17 (39)
Maine	21	24.7 (18-33)	⩾1	12/9 (M = 57%)	9 (43)
San Diego	45	31.5 (16-42)	5.0 (1-18)	29/16 (M = 64%)	19 (42)
Total	**160**	**28.32 (16-42)**	**4.0**	**84/76 (M = 52%)**	**59 (37)**
Group Who Did Not Receive OMT					
Chicago	50	27.8 (18-37)	0	22/28 (M = 44%)	14 (28)
Kirksville	44	26.5 (16-42)	0	21/23 (M = 48%)	15 (34)
Maine	21	23.3 (19-31)	0	14/7 (M = 67%)	9 (43)
San Diego	46	27.7 (17-36)	0	26/20 (M = 57%)	28 (60)
Total	**161**	**26.89 (16-42)**	**0**	**82/79 (M = 51%)**	**66 (41)**

The four centers were the following:

- **Ravenswood Hospital, Chicago, Illinois**
  The medical records of 50 women who received prenatal OMT and 50 women who did not were randomly selected from the same database, a group of obstetrics and gynecology practices in which Tettambel (coauthor) was a member of the medical staff. Further, subjects who received OMT had this therapy delivered by Tettembel, while subjects who did not receive OMT were patients in Tettambel's practice, and medical records that were reviewed were of women delivered by Tettambel. Women who received prenatal OMT delivered between January 5, 1997, and June 26, 1998, while women who did not receive OMT delivered between November 11, 1996, and June 25, 1998.
- **Northeast Regional Medical Center, Kirksville, Missouri**
  The medical records of 44 women who received prenatal OMT and 44 women who did not were randomly selected from the center's database. Subjects were the patients of physicians on the staff at the Kirksville College of Osteopathic Medicine of A. T. Still University of Health Sciences, with reviews carried out by fellows in the Department of Osteopathic Manipulative Medicine. Women who received prenatal OMT delivered between February 16, 1997, and May 26, 1998, while women who did not receive OMT delivered between January 2, 1997, and April 27, 1998.
- **Eastern Maine Medical Center, Bangor, Maine**
  The medical records of 21 women who received prenatal OMT were randomly selected. These women were part of a study of the effects of OMT on low back pain during pregnancy, conducted by the Department of Family Practice at the Eastern Maine Medical Center by Johnson (coauthor). A research assistant randomly selected the medical records of 21 women from the same database who did not receive prenatal OMT. Women who received prenatal OMT delivered between June 25, 1997, and March 26, 1998, while women who did not receive OMT delivered between June 8, 1997, and March 5, 1998.
- **Balboa Naval Medical Center, San Diego, California**
  The medical records of 45 women who received prenatal OMT were selected from the family practice of King (coauthor), with all subjects providing permission for their records to be reviewed. The medical records of 46 women who did not receive prenatal OMT were randomly selected from those who delivered at the Balboa Naval Medical Center in San Diego, Calif, and reviewed by a coauthor Arsenault (coauthor). Subjects who received prenatal OMT delivered between July 12, 1999, and August 20, 1991. Those subjects who did not receive OMT delivered between December 17, 1991, and October 19, 1996.

Nature of OMT

Medical records revealed the number of times OMT was administered, except for the records of subjects from the Eastern Maine Medical Center. The types of manipulation used varied, depending on the needs of the patient as determined by osteopathic structural examination. Virtually all OMT methods were applied, including muscle energy; myofascial release; ligamentous articular strain; balanced membrane tension; high-velocity, low amplitude thrust; strain counter-strain; and osteopathy in the cranial field. In the samples drawn from Ravenswood Hospital (Chicago) and the Balboa Naval Medical Center (California), OMT was administered by one physi-

Table 2
Number of Deliveries with Osteopathic Manipulative Treatment, Prenatal Care, and Postnatal Care by Center

Center	N	MSAF, No. (%)	PTD, No. (%)	UCP, No. (%)	Use of Forceps, No. (%)	CSD, No. (%)
Received OMT						
Chicago	50	3 (6)	2 (4)	0 (0)	0 (0)	9 (18)
Kirksville	44	4 (9)	3 (7)	0 (0)	5 (11)	5 (11)
Maine	21	3 (14)	0 (0)	0 (0)	2 (10)	3 (14)
San Diego	45	2 (4)	1 (2)	0 (0)	3 (7)	9 (20)
Total	**160**	**12 (8)**	**6 (4)**	**0 (0)**	**10 (6)**	**26 (16)**
Did Not Receive OMT						
Chicago	50	13 (26)	6 (12)	0 (0)	1 (2)	3 (6)
Kirksville	44	6 (14)	4 (9)	0 (0)	6 (14)	15 (34)
Maine	21	4 (19)	2 (10)	0 (0)	2 (10)	1 (5)
San Diego	46	11 (24)	7 (15)	0 (0)	8 (17)	10 (22)
Total	**161**	**34 (21)**	**19 (12)**	**0 (0)**	**17 (11)**	**29 (18)**

OMT indicates osteopathic manipulative treatment; MSAF, meconium-stained amniotic fluid; PTD, preterm delivery; UCP, umbilical cord prolapse; CSD, cesarean section delivery.

cian, while in the Northeast Regional Medical Center (Missouri) and Eastern Maine Medical Center (Maine) subjects, manipulations were administered by different staff physicians and residents.

Results

Table 1 summarizes study participants with regard to age, number of times OMT was administered, male to female child ratio, and percentage of primagravidas by center and for each group. These reported totals and averages were the only uniform data available for each of the participants. Medical records did not consistently provide such data as ethnicity, socioeconomic status, and other factors in prenatal care.

The data in *Table 2* suggest similarity between the centers with regard to average age, age range, male versus female offspring, and primagravida status. Across the sites, differences in the proportion of male to female births did not reach the conventional $P < .05$ level (X^2 (3) = 7.46; $P = .06$). However, there were significant differences across sites in the proportion of primagravida births (X^2 (3) = 10.92; $P < .05$) and in the ages of the mothers (F(3,317) = 11.00; $P < .05$). The presence of these differences does not necessarily confound the tests of initial hypotheses, except that it could be argued that the findings are generalizable to a more diverse population.

The more important test needed to explore for potential confounds is whether differences in demographic conditions exist between those who receive OMT, compared with those who do not. Such differences suggest an alternative explanation for an association between OMT and more favorable outcomes. For example, if older women had more complications of pregnancy, labor, and delivery, and those who did not receive OMT tended to be older, it could be that the relationship attributed to the use of OMT was actually attributable to age.

Analyses that compared subjects who received OMT with those who did not indicate that there were no significant differences in the sex, X^2 (1, N = 321) = 0.03, ns, or primagravida status, X^2 (1,N = 321) = 1.30, ns. However, there were significant differences in the age of the women (F(1,319) = 5.06; $P < .05$). Those who received OMT (M = 28.32; SD = 5.86) were significantly older than those who did not receive OMT (M = 26.89; SD = 5.48). The literature indicates that older women are likely to have more complications of pregnancy, labor, and delivery. The fact that those gravidas who received OMT were older, and still sustained fewer complications of labor and delivery than those who did not receive OMT, is remarkable. If older women were more likely to have more complications of pregnancy, labor and delivery, and those who received OMT tended to be older, then one would conclude that it would be even harder to obtain favorable results.

Table 2 presents the prevalence of meconium-stained amniotic fluid, PTD, UCP, the use of forceps, and cesarean delivery for mothers who received and did not receive OMT during pregnancy. A logistic regression analysis was conducted to establish whether a relationship existed between the use of OMT during pregnancy and the occurrence of the five labor and delivery outcomes considered. Data revealed that there were no cases of UCP; therefore, this predictor was not included in the statistical analyses. After controlling for mothers' ages, a test of the full model with the four remaining outcome measures was statistically reliable (X^2 (4, N = 321) = 26.55; $P < .001$), indicating that the labor and delivery out-

Table 3
Logistic Regression Analysis of the Association Between Osteopathic Manipulative Treatment During Pregnancy and Outcomes of Labor and Delivery

Factor	B	SE	Wald Test	Odds Ratio	95% CI for Odds Ratio	
					Lower	Upper
Age	.05	.02	5.5*	1.10	1.01	1.09
MSAF	1.32	.36	13.20†	3.76	1.84	7.68
PTD	1.61	.50	9.91‡	4.72	1.80	12.42
Use of forceps	.79	.43	3.28§	2.20	0.94	5.15
CSD	.29	.32	0.84	1.34	.72	2.48
(Constant)	-4.91	1.05	21.66†			

*$P<.05$.
†$P<.001$.
‡$P<.01$.
§$P=.07$.
MSAF indicates meconium-stained amniotic fluid; PTD, preterm delivery; CSD, cesarean section delivery.

comes, as a set, were associated with whether OMT was administered during pregnancy. The resulting model accurately discerns between women who received OMT and, therefore, would have fewer implications of labor and delivery, and those who did not 62% of the time. When age was included, the model was accurate 64% of the time.

Table 3 presents regression coefficients, Wald statistics, odds ratios, and 95% confidence ratios for age and each of the four pregnancy, labor, and delivery outcomes. According to the Wald criterion, the use of OMT during pregnancy is significantly associated with meconium-stained amniotic fluid ($Z = 13.20$; $P < .001$) and PTD ($Z = 9.91$; $P < .01$). There was a marginally significant ($P = .07$) relationship between OMT and the use of forceps ($Z = 3.28$). An interpretation of the odds ratios indicates that failing to receive OMT during pregnancy increased the probability of meconium-stained amniotic fluid by a multiple factor of 3.76 and increased the probability of PTD by a factor of 2.20.

Despite slight variations in procedures for selecting study participants, the pattern of results remains fairly constant across the study centers (*Table 1*). Osteopathic manipulative treatment is consistently associated with lower rates of meconium-stained amniotic fluid, PTD, and the use of forceps.

Discussion

Results of the study support the hypothesis that prenatal OMT may reduce the occurrence of some complications of pregnancy, labor, and delivery. The results also confirm the osteopathic medical practice of providing prenatal OMT whenever possible.[1-9] Even with a modest sample size, the logistic regression coefficients, especially for meconium-stained amniotic fluid and PTD, are strong ($P < .001$ and $P < .01$, respectively). Further research by prospective study of this possible benefit of prenatal OMT is indicated.

The level of significance in the study was also remarkable given that the average age of women in the group that received OMT was significantly higher than the group that did not receive OMT. Reference texts in obstetrics and gynecology[25] and typical articles[26] on the topic of high-risk pregnancy cite significantly higher risk for the older gravidas. As the increased likelihood of meconium-stained amniotic fluid, PTD, and use of forceps ranges from between two and four times greater without prenatal OMT, the argument becomes even more compelling for greater application of prenatal OMT in training and practice settings involved with women's health, an aspect of health care policy currently emphasized by the American Osteopathic Association, becomes even more compelling.

The results also reflect labor and delivery outcomes from different centers, with regionally different approaches to obstetric practices typically found in large, multicenter studies.[27] This and the fact that there were a number of osteopathic physicians providing the OMT suggest further validity to the findings and confidence in the application of OMT in prenatal care. As few as one or two OMT visits in the prenatal period appeared to have benefit with regard to labor and delivery outcome.

An analysis of occurrence rates for meconium-stained amniotic fluid, PTD, use of forceps, and cesarean delivery in published literature was made by King.[24] In that study, meconium-stained amniotic fluid occurred between 7% and 24% of the time, with an average of 15%. Preterm delivery range occurred between 7% and 15% of the time, with an average of 10%. Use of forceps range occurred between 14% and 26% of the time, with an average of 20%, while cesarean delivery

occurred between 12% and 28% of the time, with an average of 21%.

In *Table 1*, it is noted that the average rate for meconium-stained amniotic fluid for the group that did not receive OMT is higher than that reported in the literature but within the ranges reported. The use of forceps average for the group that did not receive OMT is lower than the average and lower than the range reported in the literature, which may reflect obstetric practice differences by Tettambel (co-author), who reported only one instance of forceps use out of the 100 deliveries done by her and reported in the current study. The rate for the prenatal OMT group was still lower, though only marginally statistically significant.

Comparisons of data in the current study with data in the literature were reported here to show that current study data were mostly comparable to occurrence data for these labor and delivery outcomes.

We acknowledge that socioeconomic and cultural factors have been found to have an effect on the outcomes of labor and delivery due to differences in prenatal care.[28] Unfortunately, such useful data were not available in the current study. It is recommended that future research take such factors into account as much as possible. This consideration is one of the limitations of a retrospective case control design study and reflects the need to have this question addressed by a prospective design study.

Despite the limitations noted, the current data reflect support for improved health outcomes in the application of OMT during prenatal care.

Acknowledgment

Data collection for this study was supported in part by an intramural research grant from the Western University of Health Sciences, Pomona, California.

References

1. Conner WJ. The mechanics of labor as taught by Andrew Taylor Still. *J Am Osteopath Assoc*. 1928;27:853-858.

2. Schaeffer FE. Osteopathic obstetrics. *J Am Osteopath Assoc*. 1935;35:540-542.

3. Taylor GW. The osteopathic management of nausea and vomiting of pregnancy. *J Am Osteopath Assoc*. 1949;48:581-582.

4. Dooley W. Osteopathy's contribution to prenatal care. *J Am Osteopath Assoc* 1946;46:6-7.

5. Whiting LM. Can the length of labor be shortened by osteopathic treatment? *J Am Osteopath Assoc*. 1911;11:917-921.

6. Hart LM. Obstetrical practice. *J Am Osteopath Assoc*. 1918;609-614.

7. Jones M. Osteopathy and obstetrical mortality and stillbirth and infant mortality: Symposium on osteopathy in obstetrics chaired by S.V. Robuck, DO. *J Am Osteopath Assoc*. 1933;33:350-353.

8. Wood LR. Prenatal management including osteopathic manipulation. *J Am Osteopath Assoc*. 1951;50:168-170.

9. Jones M. The value of routine manipulation in pregnancy. *J Am Osteopath Assoc*. 1952;51:554-557.

10. Zink JG, Lawson WB. Pressure gradients in the osteopathic manipulative management of the obstetric patient. *Osteopathic Annals*.1979;7:208-214.

11. Tettambel MA. Obstetrics. In Ward RC, ed. *Foundations for Osteopathic Medicine*. Baltimore, Md: Williams & Wilkins; 1997:349-361.

12. Gitlin RS, Wolf DL. Uterine contractions following osteopathic cranial manipulation—A pilot study. *J Am Osteopath Assoc*. 1992;92:1183.

13. Guthrie RA, Martin RH. Effect of pressure applied to the upper thoracic (placebo) versus lumbar areas (osteopathic manipulative treatment) for inhibition of lumbar myalgia during labor. *J Am Osteopath Assoc*. 1982;82:247-251.

14. Brady RE, Rottman J, Kappler RE, Veith EK. Osteopathic manipulation to treat musculoskeletal pain associated with pregnancy [abstract]. *J Am Osteopath Assoc*. 1997;97:479.

15. Owens C. *An Endocrine Interpretation of Chapman's Reflexes*. 2nd ed. Chatanooga, Tenn: Chatanooga Printing & Engraving Co; 1937.

16. Daly MD, Frame PS, Raposa PA. Sacroliliac subluxation: A common, treatable cause of low-back pain in pregnancy. *Fam Pract Res J*. 1991;11:149-159.

17. McIntryre IN, Broadhurst NA. Effective treatment of low back pain in pregnancy. *Aust Fam Physician: Reason*. 1996;25 Suppl 2:S65-S67.

18. Hainline B. Low-back pain in pregnancy. In Devinsky O, Feldman E, Hainline B, eds. *Neurological Complications of Pregnancy*. New York: Raven Press; 1994.

19. Östgaard HS. Assessment and treatment of low back pain in working pregnant women. *Semin Perinatol*. 1996;20:61-69.

20. Fast A, Shapiro D, Ducommun EJ, Friedmann LW, Bouklas T, Floman Y. Low-back pain in pregnancy. *Spine*. 1987:12:368-371.

21. Fast A, Weiss L, Ducommun EJ, Medina E, Butler JG. Low-back pain in pregnancy: Abdominal muscles, sit-up performance, and back pain. *Spine*. 1990;15:28-30.

22. Noren L, Östgaard S, Neilsen TF, Östgaard HC. Reduction of sick leave for lumbar back and posterior pelvic pain in pregnancy. *Spine*. 1997;18:2157-2160.

23. Franklin ME, Conner-Kerr T. An analysis of posture and back pain in the first and third trimesters of pregnancy. *J Orthop Sports Phys Ther*. 1998;28:133-138.

24. King H. Osteopathic manipulative treatment in prenatal care: Evidence supporting improved outcomes and health policy implications. *AAO Journal*. 2000;10:25-33.

25. Sokol RJ, Jones TB, Pernoll ML. Methods of pregnancy assessment for pregnancy at risk. In DeCherney AH, Pernoll ML, eds. *Current Obstetrics and Gynecologic Diagnosis and Treatment*. 8th ed. Norwalk, Conn: Appleton & Lange; 1994:275-305.

26. Bobrowski RA, Bottoms SF. Underappreciated risks of the elderly multipara. *Am J Gynecol*. 1995;172:1764-1770.

27. Wiswell TE, Gannon CM, Jacob J, Goldsmith L, Szyld E, Weiss K, et al. Delivery room management of the apparently vigorous meconium-stained neonate: Results of the multicenter, international collaborative trial. *Pediatrics*. 2000;105:1-7.

28. Krueger PM, Scholl TO. Adequacy of prenatal care and pregnancy outcome. *J Am Osteopath Assoc*. 2000;100:485-492.