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The Impact of Amniotomy on Induction of Labor: An Integrative Review

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THE IMPACT OF AMNIOTOMY ON INDUCTION OF LABOR: AN INTEGRATIVE REVIEW

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Abstract

Background/Purpose: There is clear evidence available that refutes the practice of routine amniotomy in the spontaneously laboring patient. Amniotomy is an intervention that disrupts a normal physiologic birth and therefore should be utilized judiciously. With a number of individuals undergoing induction of labor, it is important to consider the impact of amniotomy on labor progression as well as on maternal and neonatal outcomes and further determine if it should be an intervention routinely utilized. This integrative review examines the available evidence regarding amniotomy in labor induction.

Methods: A literature search was conducted in January 2022 in CINHAL and PubMed with a ten-year date range of 2012 to January 2022. This search yielded a review of 11 articles. Studies included were randomized controlled trials and retrospective cohort studies.

Results: Early amniotomy results in a shorter labor duration compared to late or spontaneous amniotomy. Timing of amniotomy did not have a profound impact on maternal and neonatal outcomes including cesarean delivery in non-obese BMI individuals. When utilizing cervical ripening agents, amniotomy shortly after the agent results in a shorter labor duration. Initiation of oxytocin immediately after amniotomy also resulted in a shorter labor duration. Both early and delayed amniotomy increase the risk for cesarean delivery in individuals with obese BMI.

Discussion: Early amniotomy during labor induction was found to decrease labor duration without negatively impacting maternal and neonatal outcomes or increasing cesarean delivery rates in individuals with non-obese BMI and therefore, could be considered. Further research should be conducted to determine care of the patient with obese BMI undergoing induction of labor and if amniotomy can be safely utilized.

Keywords: amniotomy; labor, induced; obesity; cesarean section

The Impact of Amniotomy on Induction of Labor: An Integrative Review

Introduction

Artificial rupture of membranes (AROM), also known as amniotomy, is a procedure by which the provider intentionally breaks the amniotic sac. Amniotomy has come to be a routine part of labor management and is therefore significant to midwifery and the care of the intrapartum patient. The purpose of amniotomy is to shorten the length of labor and expedite delivery. While the exact mechanism is unknown, it is theorized that the rupture of membranes releases prostaglandins and increases the production of oxytocin leading to stronger contractions and cervical dilation (Smyth et al., 2013). Amniotomy does not come without risk. The major risks of amniotomy include cord prolapse, fetal heart rate abnormalities, potential increased risk for chorioamnionitis, and potential increased risk for cesarean delivery (De Vivo et al., 2020). As with any intervention in the intrapartum period, providers must question its effectiveness, necessity, safety, and be judicious in utilization of the intervention.

A Cochrane review by Smyth et al. (2013) found that routine amniotomy did not reduce the duration of labor nor did it decrease the incidence of cesarean delivery. Additionally, the American College of Obstetricians (ACOG, 2019) does not support routine amniotomy in the case of normal labor progression with no evidence of fetal deterioration. Amniotomy should be considered as an intervention that disrupts a normal, physiologic birth. With the available evidence, intrapartum providers should question routine amniotomy.

The purpose of amniotomy in the case of labor induction must be determined, as governing healthcare bodies do not make any recommendations in regards to amniotomy in this setting. With the frequency of labor induction, it is important to assess the methods we utilize, including amniotomy, in the process of induction. The purpose of this integrative review is to

determine how amniotomy impacts labor progression in labor induction. Additionally, this review will assess if amniotomy is an effective intervention to utilize in labor induction and determine the most appropriate timing for utilization. This review will also assess the impact of amniotomy on adverse maternal and neonatal outcomes. Lastly, this integrative review will also identify gaps where future research is indicated.

The results of this integrative review will be discussed through King's Theory of Goal Attainment. This theory explores interactions between a nurse and patient and how they come together to set and achieve goals. King's model has three interacting systems including personal, interpersonal, and social through which the results of this integrative review will be discussed.

Methods

This integrative review was guided by Whittemore and Knafl's methodology (2005). After identification of a specific problem pertinent to nurse-midwifery, a search process was initiated. A database search was conducted in January 2022 with review, selection, and data extraction completed in entirety by the primary author. The keyword search included the following terms with Boolean phrase AND/OR: amniotomy, artificial rupture of membranes, fetal membranes, labor induction, induction of labor. This search took place in two databases: CINAHL (n=420) and PubMed (n=752). Duplicate articles were removed, leaving a remaining 786 articles. A ten-year date range of 2012 to January 2022 was applied, narrowing the number of remaining articles down to 213. Inclusion criteria for these articles were randomized controlled trials, retrospective cohort studies, published in English, and specific research regarding amniotomy during the labor induction process. Exclusion criteria were applied including any articles with a focus on spontaneous labor, meta-analysis, systematic reviews, and qualitative research. A citation search as well as journal hand searching was conducted with the

same ten-year date range, which did not yield any further studies for inclusion. Journals searched included *Obstetrics and Gynecology*, *Journal of Midwifery and Women's Health*, *Journal of Perinatal Education*, as well as *Journal of Maternal-Fetal and Neonatal Medicine*. After abstract and a full-text review, 11 articles were selected for final review. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) provides a template for the search results as shown in Figure 1. The quality of these studies was reviewed utilizing John Hopkins' Evidence-Based Practice Research Appraisal. This tool evaluates evidence level based on the methodology of the study and the quality based on the generality and conclusiveness of results (Dang & Dearholt, 2018). An overview of each study's key findings and quality can be found in Table 1.

Results

The 11 included studies were conducted between the years of 2012 and 2020. The studies took place across the globe, including in the countries of the United States of America, India, Turkey, Egypt, Malaysia, Netherlands, and Canada. See Table 2 for study demographics. This is significant to consider as management of maternal and neonatal care differs amongst these countries; making it difficult for the results to be generalizable. Aside from two retrospective cohort studies, all studies included were randomized controlled trials. Each of the studies had inclusion criteria of term gestation, singleton pregnancy, cephalic presentation, and specifically researched the impact of amniotomy during the induction process. Reason for labor induction varied amongst the studies, but most frequently was kept broad to include both elective induction and medical induction. Two of the included studies researched specifically nulliparous individuals while all other studies included individuals of nulliparous status and multiparous status.

Early Versus Late Amniotomy

A major theme identified in these studies was the timing of amniotomy during the induction process. Therefore, it is important to compare the available research on early amniotomy versus late amniotomy. The specific timing and definition of early and late amniotomy did vary amongst studies. As many of the included studies were randomized controlled trials, early amniotomy occurred most often in individuals less than five centimeters dilated and the control group allowed spontaneous rupture of membranes or amniotomy after a specified period of time. Macones et al. (2012) found that nulliparous individuals who underwent early amniotomy, as defined as less than or equal to four centimeters, had an average of a two-hour shorter labor duration and a higher proportion delivered within 24 hours compared to late amniotomy. Additionally, Bala et al. (2017) found a reduction in delivery interval by four hours and a greater number of individuals delivered within 12 hours in those that underwent early amniotomy. In this study, induction of labor was initiated with amniotomy (early) and individuals were included if their Bishop score was 6 or greater (Bala et al., 2017). Many studies did not find a significance between early and late amniotomy and their relationship with cesarean delivery (Battarbee et al., 2016; Gagnon-Gervais et al., 2012; Macones et al., 2012; Makarem et al., 2013; Tan et al., 2013). Macones et al. (2012) had a cesarean section rate of 41% in the early amniotomy group compared to 40% in the standard amniotomy group. In contrast, delayed amniotomy of more than eight hours after oxytocin administration for induction of labor was found to be associated with increased likelihood of cesarean delivery (Battarbee et al., 2020b). In this study, 27.4% (n=308) of the delayed amniotomy group underwent cesarean delivery compared to 15.9% (n=152) in the non-delayed amniotomy group (Battarbee et al., 2020b).

Induction Agents and Amniotomy

As all of the studies took into consideration the impact of amniotomy on the labor induction process, it is important to discuss induction agents and timing of amniotomy. An overview of the findings can be found in Table 3. When utilizing Cervidil for cervical ripening, early amniotomy (at three centimeters) after Cervidil was found to decrease labor duration and increase the number of individuals delivered within 24 hours (Bostancı et al., 2017). In this study, 79 individuals or 91.9% of the early amniotomy group delivered within 24 hours compared to the control group where 35 individuals or 43.2% delivered within 24 hours ($p<0.05$) (Bostancı et al., 2017). Early amniotomy after foley balloon catheter use, as defined as amniotomy less than one hour after foley removal, was also found to result in a shorter labor duration and increased number of individuals delivered within 24 hours (Battarbee et al., 2016). Of the 273 individuals in the early amniotomy group, 117 or 42.9% had a vaginal delivery in less than 24 hours compared to 90 out of 273 (33%) in the group that did not receive early amniotomy ($p=0.02$) (Battarbee et al., 2016). Similar to other cervical ripening agents, early amniotomy at three centimeters after vaginal misoprostol use was correlated with a shorter labor duration (Makarem et al., 2013). Individuals in the early amniotomy group had a mean labor duration of 9.72 hours +/- 4.61 hours compared to 13.61 hours +/- 5.61 hours in the control group ($p=0.002$) (Makarem et al., 2013).

Aside from cervical ripening agents, it is valuable to consider the timing of amniotomy when utilizing oxytocin. Tan et al. (2013) found that immediate initiation of oxytocin after amniotomy had many positive outcomes including shorter amniotomy to delivery interval, higher delivery rate within 12 hours, and lower epidural anesthesia rate. In this study, the amniotomy to

delivery interval of the immediate initiation of oxytocin group was 5.3 hours +/- 3.1 hours compared to 6.9 hours +/- 2.9 hours in the delayed oxytocin group (Tan et al., 2013). Titulaer et al. (2019) found that immediate oxytocin after amniotomy reduced the median amniotomy to delivery interval by nine hours when compared to delayed oxytocin. In nulliparous individuals, amniotomy and concurrent oxytocin administration was associated with a shorter labor duration (Gangon-Gervais et al., 2012). Labor duration, as defined as oxytocin to delivery, was found to be 12.1 hours +/- 6.7 hours in individuals who received early amniotomy compared to individuals who had amniotomy delayed four hours with a labor duration of 15.4 hours +/- 5.6 hours ($p=0.03$) (Gangon-Gervais et al., 2012).

Obesity and Amniotomy

Obesity is an important consideration to the timing of amniotomy and benefit of amniotomy in the labor induction process. There were three studies included in this integrative review that considered the impact of body mass index (BMI) in relationship to amniotomy and the labor induction process. Pasko et al. (2018) found that early amniotomy amongst class III obese individuals posed an increased risk for cesarean delivery. Of the 107 individuals who underwent early amniotomy at less than four centimeters dilation, 54 individuals or 50.5% had cesarean delivery (Pasko et al., 2018). The most common indication for cesarean delivery was failed induction (Pasko et al., 2018). Battarbee et al. (2020a) found increasing risk for cesarean delivery with increasing BMI in individuals who undergo early amniotomy at less than four centimeters. They found no significant difference in adjusted odds of cesarean delivery in individuals of normal BMI regardless of timing of amniotomy, however, as maternal BMI increased above 27 there was significantly higher adjusted odds of cesarean delivery with early amniotomy (Battarbee et al., 2020a). While at the same time, delayed amniotomy is associated

with increased risk of cesarean delivery with increasing BMI (Battarbee et al., 2020b). The adjusted odds ratio for cesarean delivery with more than eight-hour delayed amniotomy compared to non-delayed amniotomy at a BMI of 30 was 1.58 (95% CI 1.24-2.03), 2.15 (95% CI 1.45-3.21) with a BMI of 40, and 2.93 (95% CI 1.54-5.57) for individuals with a BMI of 50 (Battarbee et al., 2020b). Overall, these studies do not provide clarity for determining when it amniotomy can safely and effectively be completed amongst individuals with an obese body mass index.

Impact of Amniotomy on Maternal and Neonatal Outcomes

Other components should be considered aside from amniotomy's impact on labor progression including maternal and neonatal outcomes. Macones et al. (2012) did not find any correlation to neonatal sepsis or NICU admission when comparing early amniotomy to standard care. Battarbee et al. (2016), similarly, did not find a difference in the rate of adverse maternal or adverse neonatal outcomes between early amniotomy and the control group. Early amniotomy after Cervidil did not increase adverse maternal or neonatal outcomes (Bostancı et al., 2017). Individuals with delayed amniotomy have been found to be more likely to deliver a neonate with a five-minute APGAR score less than seven and increased NICU admission rates (Battarbee et al., 2020b). Intrapartum fever occurred less frequently in nulliparous individuals who underwent early amniotomy versus late amniotomy (Gangon-Gervais et al., 2012). In the early amniotomy group 6% (n=2) experienced a fever of 38 degrees Celsius or higher compared to 25% in the late amniotomy group (n=9) (Gangon-Gervais et al., 2012). Aside from potentially shorter labor duration, there are additional benefits to amniotomy to consider. Early amniotomy leads to lower concentrations of oxytocin use and a reduced need for analgesia (Bala et al., 2017). In the early amniotomy group (n=75), the mean maximum oxytocin concentration was

30.05 +/- 15.78 and in the delayed amniotomy group (n=75), the mean maximum oxytocin concentration was 39.68 +/-16.8 (Bala et al., 2017). None of the individuals in the study received epidural analgesia, however, those in the delayed amniotomy group received 2.20 +/- 0.84 50mg tramadol injections compared to 1.59 +/- 0.66 in the early amniotomy group (Bala et al., 2017). Immediate oxytocin use after amniotomy has been found to decrease the amniotomy to delivery interval as well as reduce epidural analgesia rates (Tan et al., 2013). Epidural rates during labor in this study were 2.9% (n=3) in the immediate oxytocin group compared to 9.9% (n=10) in the four-hour delayed oxytocin group (Tan et al., 2013).

Discussion

This integrative review examined the impact of amniotomy during the labor induction process. The primary objective was to discover if amniotomy should be routinely completed during induction of labor and if so, when in the labor process should it be performed. The findings are suggestive of early amniotomy reducing labor duration while not impacting maternal and neonatal outcomes. Additionally, amniotomy at any stage of labor induction, has been proven to increase the risk of cesarean delivery in individuals with an obese BMI.

Incorporating King's Theory of Goal Attainment, there are three interacting systems, personal, interpersonal, and social, that can be incorporated into the care of the intrapartum patient when considering amniotomy. The provider must create a safe, welcoming environment to allow the process of labor induction to occur smoothly. The provider and patient should take time to come together to set mutual goals for the patient's care. It is the provider's responsibility to communicate appropriate information regarding amniotomy and respect the patient's labor preferences regarding if or when amniotomy should be performed. Through a shared-decision

making process, both the provider and patient can achieve a mutual goal of a healthy patient, delivery, and baby.

When discussing amniotomy with patients, providers should be reminded that in the case of spontaneous labor, evidence does not support routine amniotomy (Smyth et al., 2013). From the evidence of this integrative review, early amniotomy in the case of labor induction can be utilized to reduce overall labor duration with minimal risk of increased adverse outcomes. Additionally, when cervical ripening is indicated, amniotomy shortly following chosen ripening method has been found to decrease labor duration (Battarbee et al., 2016; Bostancı et al., 2017; Makarem et al., 2016). Oxytocin initiation within an hour of amniotomy has also been proven to result in a shorter labor duration (Gangon-Gervais et al., 2012; Tan et al., 2013; Titulaer et al., 2019). Early amniotomy with oxytocin use can also be correlated to decreased concentrations of oxytocin and decreased epidural use (Bala et al., 2017; Tan et al., 2013). However, if minimal intervention is the patient's goal, amniotomy may not be the solution as the benefit can be solely attributed to labor duration.

Supporting normal physiologic birth is a hallmark of nurse-midwifery care. Induction of labor is disruptive to this process, however, there are indications that necessitate induction of labor in an effort to reduce maternal and infant morbidity. It is important that obstetrical providers question interventions so as to respect physiologic birth as closely as possible. It is possible to support physiologic birth when induction is necessary or when complications arise (American College of Nurse-Midwives et al., 2013). Individuals undergoing an induction of labor can come together with their provider, through the process of shared-decision making, to determine if amniotomy would be intrusive or a positive step forward in the labor progression process. The results of this review find that AROM has a limited impact on adverse maternal

and neonatal outcomes, as well as a limited impact on cesarean delivery in non-obese BMI women. For this reason, providers may ultimately feel it is disruptive to the normal, physiologic birth.

Future research efforts should be guided towards amniotomy in the patient with an obese BMI. Specific research should be conducted to determine the optimal time to perform amniotomy during the labor induction process or if spontaneous rupture of membranes is preferred in the patient with an obese BMI. Additional research efforts could seek to determine a definitive cervical dilation that supports the shortest labor duration when amniotomy is performed during the labor induction process.

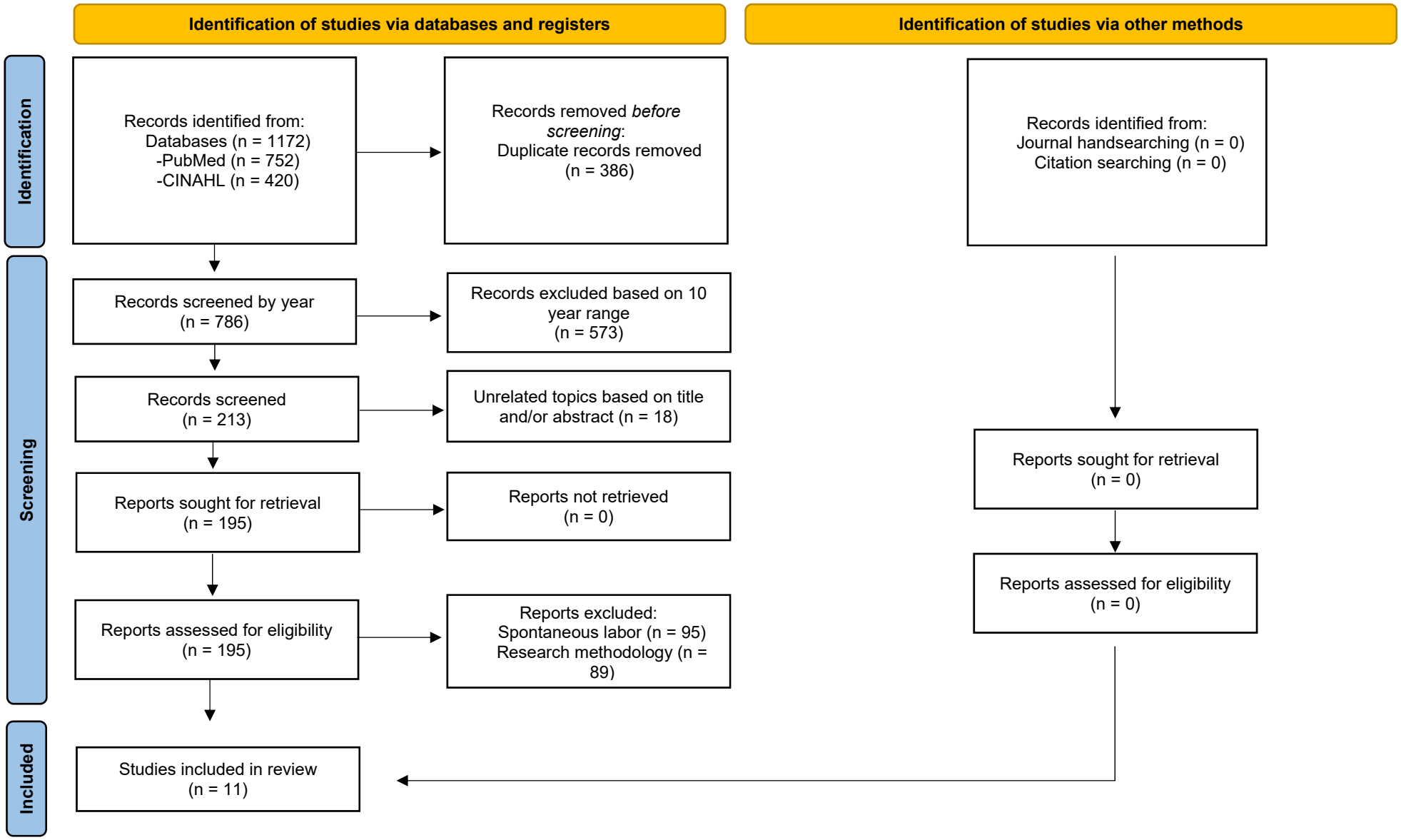
The limitations to the findings of this review are the differences in maternal and neonatal care in the countries where the research was conducted. For example, in one study, meconium stained amniotic fluid was an automatic indication for cesarean delivery causing the cesarean rate not to be statistically significant when reviewing this data set (Bala et al., 2017). This study also allowed for oxytocin titration up to 42mU/min with availability to increase up to 72mU/min if indicated (Bala et al., 2017). Neither of these practices are translatable to care in the United States. In Makarem et al. (2013), cesarean delivery was performed for failed induction if after four doses of misoprostol (200mcg received) active labor, undefined by the authors, was not achieved. Other limitations to discuss are two databases reviewed, two methodologies, small sample sizes, unblinded studies, and inability to generalize results to all populations. Lastly, this review is limited by one person conducting all screening and analysis.

Conclusion

This integrative review explored the impact of amniotomy in the labor induction process. It examined the impact of amniotomy at different points in labor induction to determine if and

when amniotomy can safely and efficiently be performed. The themes identified in the 11 studies reviewed were early versus late amniotomy, induction agents and amniotomy, obesity and amniotomy, and the impact of amniotomy on maternal and neonatal outcomes. Overall, early amniotomy completed during the labor induction has been found to decrease labor duration without impacting cesarean delivery rate, maternal outcomes, or neonatal outcomes. Obstetrical providers can utilize King's Theory of Goal Attainment when considering amniotomy for a patient undergoing labor induction. As with an intervention, providers should implement a shared-decision making process to determine if amniotomy should be utilized.

Figure 1 - PRISMA Flow Chart



Source: Page et al. (2020)

Table 1 – Literature Matrix Review

Source: Macones, G. A., Cahill, A., Stamilio, D. M., & Odibo, A. O. (2012). The efficacy of early amniotomy in nulliparous labor induction: A randomized controlled trial. *Obstetrical & Gynecological Survey*, *207*(5), 1-5. https://doi.org/10.1016/j.ajog.2012.08.032

Purpose/Sample	Design (Method/Instruments)	Results Continued	Strengths/Limitations
Purpose: The purpose of this study was to assess if early amniotomy (defined as less than or equal to 4 cm dilation) reduces the duration of labor, increases the number of nulliparous patients undergoing induction of labor delivering within 24 hours, and if early amniotomy increases maternal and neonatal infectious morbidities. **Sample/Setting:** -Inclusion criteria: nulliparity, singleton, term gestation, and a need for induction determined by treating provider -292 women assigned to the early amniotomy group + 293 women assigned to the standard treatment group -Occurring at Washington University in St. Louis and the University of Pennsylvania **Johns Hopkins Evidence Appraisal Evidence Level** **Strength:** Quantitative Level I (RCT) **Quality:** High	-Randomization occurred first via permuted block randomization -Early amniotomy group received amniotomy as soon as it could be safely completed -Timing of amniotomy in the standard treatment group was decided by treating providers -Primary outcome: initiation of induction to delivery time -Secondary outcome: proportion of women delivering within 24 hours of initiation of induction **Results:** -Average time from the start of induction to delivery was shortened by slightly greater than two hours in the early amniotomy group 19.0 hours versus 21.3 hours respectively (P=.04) -Higher proportion of women in the early amniotomy group were delivered within 24 hours of initiation of induction (68% vs. 56%; P=.002) -No difference in cesarean rate	-The rate of chorioamnionitis was increased numerically (not statistically) in the early amniotomy group (11.5% versus 8.5%; P=.22) -Two cases of cord prolapse in the early amniotomy group; none in standard treatment -There was no increase in the rate of confirmed or suspected neonatal sepsis or admission to the special care nursery or NICU in women who underwent early amniotomy compared with those who experienced standard care. **Conclusion:** The research team found that when comparing early amniotomy with late, early amniotomy resulted in a shortened labor duration by greater than two hours. Early amniotomy also increased the proportion of induced nulliparous women who were delivered within 24 hours.	**Strengths:** Randomization + large sample size + diverse patient population group with different indications for labor and various labor induction methods utilized allowing for generalizability + intervention that is easy to adopt **Limitations:** Unblinded study **Implications:** The authors found that early amniotomy, when deemed safe, may be a useful adjunct in nulliparous labor inductions and incorporated into induction algorithms.

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study. Clinical implications are discussed, but there are not specific research recommendations as a result of this study. The authors of this study identify research gaps on amniotomy timing exclusively in labor induction without concurrent use with oxytocin.

Source: Bala, A., Bagga, R., Kalra, J., & Dutta, S. (2017). Early versus delayed amniotomy during labor induction with oxytocin in women with bishop's score of ≥6: A randomized trial. *The Journal of Maternal-Fetal & Neonatal Medicine*, *31*(22), 2994-3001. https://doi.org/10.1080/14767058.2017.1362381

Purpose/Sample	**Design (Method/Instruments)**	**Results Continued**	**Strengths/Limitations**
Purpose: The purpose of this research study was to determine optimal timing of amniotomy during an induction of labor. **Sample/Setting:** In this prospective randomized study, there were 150 women who met inclusion criteria and participated. Inclusion criteria was singleton, term gestation, cephalic presentation, intact membranes, reactive nonstress test, and a Bishop's score of six or greater. The study took place in Chandigarh, India from July 2013 to December 2014 at the Post Graduate Institute of Medical Education & Research. **Johns Hopkins Evidence Appraisal Strength:** Quantitative Level I (RCT) **Quality:** Good	-randomized control trial with randomization occurring through a computer generated randomization table -Group one was identified as the early amniotomy group with IOL initiated by amniotomy and oxytocin administration 30-60 minutes after amniotomy -Group two was identified as the late amniotomy group with IOL initiation via oxytocin and amniotomy performed 4-8 hours later -the outcomes studied were the induction to delivery interval, cesarean rate, and maternal as well as neonatal outcome **Results** -Mean interval between oxytocin initiation and amniotomy in group two was 6.6 hours -Cesarean rate was higher in the early amniotomy group (10.7% versus 2.7%; $p<0.0495$) however, three women had a cesarean section exclusively for meconium stained fluid making the cesarean rate no longer statistically significant	-In the early amniotomy group the mean induction to delivery interval (7.35 hrs)was reduced by approximately 4 hours compared to the delayed amniotomy group (11.66 hrs) ($p=0.00$) -More women delivered within 12 hours in the early amniotomy group (86.7% versus 60%; $p=0.00$) -Early amniotomy group required lower concentrations of oxytocin and reduced need for analgesia **Conclusion:** In low risk patients with a favorable cervix, initiating induction with amniotomy followed by oxytocin has been found to reduce the induction to delivery interval as compared to amniotomy performed 4-8 hours after initiating IOL. Benefits of shortened induction to delivery interval was translated into a reduced need for oxytocin and labor analgesia.	**Strengths:** Randomized control trial + intervention that is easy to adopt **Limitations:** The study was conducted in India and there were a few practice differences that are not typical in the United States including allowing oxytocin to go up to 72mU/min, routine ampicillin administration following amniotomy, and cesarean delivery exclusively for meconium stained fluid. A limitation that the authors discuss is a higher Bishop's score in the early amniotomy group that may have contributed to a shortened induction delivery interval. Lastly, there was a small sample size. **Implications:** The authors discuss that a shortened induction to delivery interval results in better maternal and neonatal outcomes. In this study, early amniotomy resulted in a reduced induction to delivery interval by four hours.

Author Recommendations: The authors of this study do not make any specific recommendations nor do they identify research gaps.

Source: Bostancı, E., Eser, A., Yayla Abide, C., Kılıccı, C., & Kucukbas, M. (2017). Early amniotomy after dinoprostone insert used for the induction of labor: A randomized clinical trial. *The Journal of Maternal-Fetal & Neonatal Medicine*, *31*(3), 352-356. https://doi.org/10.1080/14767058.2017.1285893

Purpose/Sample	**Design (Method/Instruments)**	**Results Continued**	**Strengths/Limitations**
Purpose: The purpose of this research study was to determine if early amniotomy, after cervical ripening with dinoprostone, reduces the duration of labor or increases the rate of delivery within 24 hours. **Sample/Setting:** A total of 200 women met inclusion criteria and provided consent to participate in the study. Inclusion criteria for this study were singleton, term gestation, cephalic presentation, intact membranes, less than three contractions every ten minutes, normal fetal heart rate, modified Bishop's score of less than five, and presenting for labor induction. Research occurred at the Zeynep Kamil Maternity and Children's Training and Research Hospital between Augusts 2016 and October 2016. **Johns Hopkins Evidence Appraisal** **Strength:** Quantitative Level I (RCT) **Quality:** High	-Randomization occurred through a computer-generated randomization table -All patients were monitored with fetal monitoring before IOL and repeated at 2 hour intervals -In the early amniotomy group, amniotomy was performed at 3 cm and in the control group, amniotomy occurred spontaneously -Both groups received dinoprostone insert for induction -Vaginal examination was performed every hour -First outcome assessed was delivery within 24 hours of induction start -Second outcome assessed was length of time between induction and delivery **Results** -In this prospective, randomized clinical trial, early amniotomy was associated with shorter duration of labor and a statistically significant increase in	in the rate of vaginal delivery within 24h without an increase in adverse maternal or neonatal outcomes. -In the early amniotomy group, 79 (91.9%) women delivered within 24 hours as compared to the control group were 35 (43.2%) women delivered within 24 hours ($p<0.05$) -Average delivery duration in the early amniotomy group was 13.72 hours compared to 22.73 hours in the control group ($p<0.005$) **Conclusion:** In this study, the researching team found that early amniotomy, after ripening with a dinoprostone insert, provided a shorter overall length of vaginal delivery duration, a shorter latent phase of labor, and more vaginal deliveries within 24 hours without increasing the incidence of adverse maternal or neonatal outcomes.	**Strengths:** Randomized control trial + intervention that is easy to adopt **Limitations:** Unblinded study + trial taking place in only one hospital **Implications:** The results of the study indicated that early amniotomy after dinoprostone ripening is a safe and efficient method for speeding up delivery times without increasing cesarean rates

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study nor do they identify research gaps.

Source: Pasko, D. N., Miller, K. M., Jauk, V. C., & Subramaniam, A. (2018). Pregnancy outcomes after early amniotomy among class III obese gravidas undergoing induction of labor. *American Journal of Perinatology*, *36*(5), 449-454. https://doi.org/10.1055/s-0038-1675331

Purpose/Sample	**Design (Method/Instruments)**	**Results Continued**	**Strengths/Limitations**
Purpose: The purpose of this research study was to investigate the impact of early amniotomy in women with class III obesity undergoing induction of labor. **Sample/Setting:** A total of 285 women met inclusion criteria and provided consent to participate in the study. Inclusion criteria for this study were singleton, induction of labor between 37+0 and 41+6, and BMI of greater than or equal to 40kg/m2. There were 142 (49.8%) nulliparous and 143 (50.2%) multiparous women included in the study. Data was from January 2007 through February 2013. **Johns Hopkins Evidence Appraisal** **Strength:** Level III **Quality:** High	-Patients were categorized into either the early (<4cm) or late (greater than or equal to 4cm) amniotomy group -Primary outcome was the rate of cesarean delivery -Secondary outcome included length of labor and maternal/neonatal morbidity -A subgroup analysis was performed that examined the effect of parity **Results** -Early amniotomy was associated with prolonged labor (OR, 2.74; 95% CI, 1.27-5.96); however, this association was not significant after multivariable adjustment (aOR, 2.14; 95% CI, 0.94-4.91) -The rate of cesarean delivery was 50.5% in the early amniotomy group compared with 30.3% in the late amniotomy group (OR, 2.34; 95% CI, 1.43–3.84)	**Conclusion:** Early amniotomy among class III obese women, especially nulliparous women, undergoing labor induction was associated with an increased risk of cesarean delivery as well as prolonged labor although not statistically significant.	**Strengths:** Relatively large sample size + stratified by parity **Limitations:** Analysis was unable to account for potential confounding by indication + study took place over six years and may not reflect current labor practices **Implications:** In this retrospective cohort study, we found that early amniotomy in class III obese women undergoing induction of labor was associated with increased rates of cesarean delivery, especially among nulliparous women. Despite these observations, there were no significant differences in the maternal or neonatal morbidity composites.

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study nor do they identify research gaps.

Source: Battarbee, A. N., Palatnik, A., Peress, D. A., & Grobman, W. A. (2016). Association of early amniotomy after foley balloon catheter ripening and duration of nulliparous labor induction. *Obstetrics & Gynecology*, *128*(3), 592-597. https://doi.org/10.1097/aog.0000000000001563

Purpose/Sample	**Design (Method/Instruments)**	**Results**	**Strengths/Limitations**
Purpose: The purpose of this study was to examine the association between early amniotomy after cervical ripening with a foley balloon catheter and duration of labor induction. **Sample/Setting:** This study included 546 nulliparous women with a singleton viable gestation. All women underwent cervical ripening with a foley balloon inflated to 80cc. The study occurred between January 2010 and October 2013 at Northwestern Memorial Hospital. **Johns Hopkins Evidence Appraisal** **Strength:** Level III **Quality:** High	-All of those undergoing early amniotomy were matched to women in the control group according to health care provider type (midwife compared with physician), cervical examination after Foley removal (favorable [modified Bishop score five or greater] compared with unfavorable [less than five]), and indication for induction (fetal compared with maternal) in a one- to-one ratio. When more than one possible match for a woman with early amniotomy was available, random selection according to a computer-generated random number list was used for final selection. -Total of 473 eligible women underwent early amniotomy (defined as AROM less than 1hr after foley removal); the remaining 290 did not have early amniotomy; mean time from foley removal to amniotomy in the early amniotomy group was 0.006 hours compared with 4.17 hours in the control -Among these women, there were 273 in each group able to matched and comprised the final cohort of this study	**Results** -Early amniotomy was significantly associated with shorter duration from catheter removal to delivery 10.6 hours versus 13.8 hours (P<.001) -The frequency of cesarean delivery was not statistically significant between the two groups -Women who underwent early amniotomy were more likely to have a vaginal delivery within 24 hours 42.9% versus 33.0% (P=.02) -No significant differences in the rate of other maternal or neonatal outcomes **Conclusion:** The results of this study demonstrate that early amniotomy after foley balloon catheter removal in nulliparous labor induction was associated with a decreased duration of labor induction without any adverse effects such as infection, hemorrhage, or cesarean delivery.	**Strengths:** Relatively large sample size + study looking specifically at amniotomy timing after mechanical ripening with a foley balloon + study completed in a facility that uses standard protocols for labor induction and foley balloon management + matching women to intervention and control group to minimize bias **Limitations:** Analysis was unable to account for potential confounding + observational study **Implications:** The authors suggest implementing a more proactive approach to the management of labor induction after cervical ripening as a way to decrease the total duration of labor and resource utilization

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study nor do they identify research gaps.

Source: Makarem, M. H., Zahran, K. M., Abdellah, M. S., & Karen, M. A. (2013). Early amniotomy after vaginal misoprostol for induction of labor: A randomized clinical trial. *Archives of Gynecology and Obstetrics*, *288*(2), 261-265. https://doi.org/10.1007/s00404-013-2747-6

Purpose/Sample	**Design (Method/Instruments)**	**Results**	**Strengths/Limitations**
Purpose: The purpose of this study was to examine both the effectiveness as well as the safety of early amniotomy after vaginal misoprostol for induction of labor **Sample/Setting:** This study included 320 women with inclusion criteria of 36 weeks gestation or more, singleton, live fetus, cephalic presentation, AFI more than 5cm, reactive NST, and negative contraction stress test. The study took place at the Women's Health Center at Assuit University from September 2008 through December 2010 **Johns Hopkins Evidence Appraisal Strength:** Level I **Quality:** Good	-Randomized clinical trial -Women were assigned to either early or late amniotomy by a computer-generated randomization and allocation remained private until the time of intervention -Each of the participants received 50mcg of vaginal misoprostol administered by the senior resident -Administration was repeated every six hours until three or more uterine contractions of 40 seconds duration or longer averaged over ten minutes was achieved or for a maximum of four doses (200mcg) was reached -In the early amniotomy group, amniotomy was performed when the cervix was dilated 3cm -Amniotomy was avoided in the control group, unless deemed necessary by the senior resident -The primary outcome measured was vaginal delivery within 24 hours of initiation of induction -Secondary outcomes include induction to delivery interval, duration of labor, amniotomy to delivery interval, number of misoprostol doses administered,	requirement of oxytocin for labor augmentation, rates of chorioamnionitis, APGAR scores, neonatal infections, and NICU admissions **Results** -More women in the amniotomy group achieved delivery within 24 hours compared to the control group, but was not statistically significant (117 versus 105, p=0.15) -Women in the amniotomy group had a shorter labor duration compared to the control group (9.72 +/- 4.61 vs 13.61 +/- 5.61, p=0.002) approx. 4 hours -The mean duration from time of rupture to delivery was longer in the amniotomy group compared to the control group (3.28 +/- 1.73 vs. 2.22 +/- 0.80, p=0.04) -There were no statistical differences between the two groups in regards to number of misoprostol doses, requirement for oxytocin for augmentation, and cesarean section indication	**Strengths:** Study looking specifically at amniotomy timing after vaginal misoprostol + minimized bias with randomized trial **Limitations:** -At this facility, an induction was considered failed with subsequent cesarean delivery after a patient received four doses of misoprostol (200mcg) without achieving active labor, which is not a universal practice. -The control group provided the opportunity for the senior resident to perform amniotomy as indicated **Conclusion:** The authors conclude that in specific cases, early amniotomy after vaginal misoprostol for induction of labor appears to be associated with higher successful vaginal delivery, and shorter induction to delivery compared to delayed or spontaneous amniotomy. **Implications:** Providers can consider early amniotomy after vaginal misoprostol to benefit a shorter labor duration without increased adverse events based on the results of this study. However, further research needs to be conducted to ensure results are generalizable.

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study nor do they identify research gaps.

Source: Battarbee, A. N., Vaz, S., & Stamilio, D. M. (2020). The association between delayed amniotomy and adverse outcomes in labor induction. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *247*, 85-89. https://doi.org/10.1016/j.ejogrb.2020.02.002

Purpose/Sample	**Design (Method/Instruments)**	**Results Continued**	**Strengths/Limitations**
Purpose: The purpose of this study was to determine if delayed amniotomy is associated with adverse delivery outcomes. **Sample/Setting:** This was a retrospective cohort study that included 1,125 women who underwent delayed amniotomy. Inclusion criteria was women with a viable, singleton, undergoing induction at a tertiary hospital. The study took place at the University of North Carolina at Chapel Hill between April 2014 to March 2017. **Johns Hopkins Evidence Appraisal Strength:** Level III **Quality:** Good	-Retrospective cohort study of women undergoing labor induction -Exclusion criteria was if oxytocin was not used for labor induction, SROM less than or equal to eight hours after oxytocin initiation, or if there was not documentation regarding rupture of membranes -Delayed amniotomy was defined as rupture of membranes more than 8 hours after oxytocin initiation -Primary study outcome was cesarean delivery with secondary outcomes including postpartum hemorrhage, maternal infectious morbidity, 5 minute APGAR less than 7, and NICU admission **Results** -In unadjusted analyses, women with delayed amniotomy were more likely to be delivered by cesarean, compared to those without delayed amniotomy (27.4% versus 15.9%, p<0.001)	-Delayed amniotomy was associated with increasingly higher odds of cesarean delivery with increasing severity of maternal obesity based on BMI -No statistically significant differences in postpartum hemorrhage or infectious morbidity among women with delayed amniotomy compared to those without -Women with delayed amniotomy were more likely to deliver a neonate with 5 minute APGAR score <7, compared to those without delayed amniotomy (4.4 % versus 1.9 %, p = 0.001) -NICU admission was also more frequent among women with delayed amniotomy, compared to those without (16.2 % versus 12.3 %, p = 0.01) - There was no significant association between delayed amniotomy and the secondary maternal outcomes, postpartum hemorrhage and infectious morbidity	**Strengths:** Large sample size + evaluation of the impact of maternal BMI, parity, cervical ripening, and gestational age at delivery **Limitations:** Results may not be generalizable due to the study taking place at a single, tertiary facility + no documentation for reason of induction of labor or NICU admission + defining delayed amniotomy at 8 hours **Conclusion:** Delayed amniotomy, as defined as greater than eight hours after starting oxytocin for induction, was found to be associated with increased odds of cesarean delivery, low APGAR scores, and increased rate of NICU admission. **Implications:** In reviewing this retrospective cohort study, providers should consider avoiding delayed amniotomy given the association with increased cesarean delivery. Further research should be conducted on delaying amniotomy in labor induction.

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study nor do they identify research gaps.

Source: Tan, P. C., Soe, M. Z., Sulaiman, S., & Omar, S. Z. (2013). Immediate compared with delayed oxytocin after amniotomy labor induction in parous women: A randomized controlled trial. *Obstetrics & Gynecology*, *121*(2), 253-259. https://doi.org/10.1097/aog.0b013e31827e7fd9

Purpose/Sample	Design (Method/Instruments)	Results	Strengths/Limitations
Purpose: The purpose of this study is to compare immediate with delayed, as defined as four hours, oxytocin infusion after amniotomy on vaginal delivery within 12 hours and patient satisfaction with the birth process. **Sample/Setting:** -Inclusion criteria: multiparous, age 16 years or greater, singleton, cephalic presentation, gestation 37 weeks or greater, Bishop's score 6 or greater, cervical dilation of 2 centimeters or greater, intact membranes, reassuring FHT -206 recruited and randomized -105 women assigned to immediate oxytocin infusion + 101 women assigned to delayed oxytocin infusion -Occurring at the University of Malaya Medical Centre in Kuala Lumpur, Malaysia **Johns Hopkins Evidence Appraisal Evidence Level** **Strength:** Quantitative Level I (RCT) **Quality:** High	-Randomization via a computerized random number generator -Primary outcomes included vaginal delivery rate within 12 hours of induction as well as maternal satisfaction score -Secondary outcomes included amniotomy to delivery interval, mode of delivery, pain medication and epidural rate in labor, uterine hyperactivity, intrapartum and postpartum fever, delivery blood loss, maternal antibiotic use, amniotomy- to-hospital discharge interval, and various neonatal outcomes (special care nursery admission, umbilical cord blood pH and base excess, APGAR score, phototherapy for jaundice, and intensive care admission). -Administration of oxytocin or placebo was administered to both groups immediately following amniotomy -Vaginal assessment took place at four hours for both groups **Results:** -There was no significant difference in the participants' basic characteristics, indication for labor induction, or presence of meconium at amniotomy	-Vaginal delivery rate within 12 hours of amniotomy in the immediate oxytocin group was 91 out of 96 (98.4%) as compared with 91 out of 94 (96.8%) in the delayed oxytocin group (p=0.72) -Maternal satisfaction averaged 3 (3-4) in the immediate oxytocin group compared to 3 (3-5) in the delayed group (p=0.36) -Cesarean delivery, fever, postpartum hemorrhage, uterine hyperactivity, and adverse neonatal outcome rates were similar between the groups -The immediate oxytocin group had a shorter amniotomy to delivery interval of 5.3 +/- 3.1 compared with 6.9 +/- 2.9 hours (P< 0.001) and lower epidural analgesia rate of 2.9% compared with 9.9% (p= 0.046) -Fetal heart rate abnormalities were higher in the immediate group 28.6% compared with 16.8% (p=0.048) however the authors note the abnormalities were predominately early decelerations	**Strengths:** Randomization + double-blind study + generalizable findings to similar population **Limitations:** Small sample size **Conclusion:** This study concluded no difference in negative outcomes in comparing both groups. There was a decreased amniotomy to delivery time interval in the immediate oxytocin group. **Implications:** Due to the shorter amniotomy to delivery interval in the immediate oxytocin group, further research should be conducted to determine if the results are generalizable.

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study.

Source: Titulaer, L. M.L., Sander de Wolf, G., Bakkum, E. A., & Moll, E. (2019). Delayed versus immediate oxytocin infusion after amniotomy for induction of labour: A randomised controlled pilot trial. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *240*, 357-363. https://doi.org/10.1016/j.ejogrb.2019.07.036

Purpose/Sample	**Design (Method/Instruments)**	**Results**	**Strengths/Limitations**
Purpose: The purpose of this pilot trial was to get a preliminary understanding of the amniotomy-to-delivery interval, patient experience, assess the risks of waiting for spontaneous contractions after amniotomy, and explore the feasibility for a larger RCT **Sample/Setting:** -Inclusion criteria: Term gestation (37+), singleton, viable fetus, cephalic presentation, Bishop score greater than 5, intact membranes, presenting for IOL, 18+ years old, sufficient in Dutch or English language -33 women were analyzed in the immediate oxytocin infusion group + 31 women were analyzed in the delayed oxytocin infusion group -Occurring at the OLVG Hospital in Amsterdam, Netherlands -The study took place between November 2017 and April 2018 **Johns Hopkins Evidence Appraisal Evidence Level** **Strength:** Quantitative Level I (RCT) **Quality:** Good	-Amniotomy was performed in both groups as planned with the IOL or after cervical ripening -In the delayed oxytocin group, oxytocin was administered, if indicated, 12 hours after amniotomy -In the immediate oxytocin group, oxytocin was administered within 30 minutes of amniotomy -Primary outcomes included amniotomy to delivery interval and patient reported experience -Secondary outcomes included delivery within 24 hours, amniotomy to labor interval, meconium stained fluid, pain relief measures, maternal fever, uterine tachysystole, total oxytocin augmentation time, total oxytocin dose, highest oxytocin dose, mode of delivery, postpartum hemorrhage rate, APGAR <7 at 5 minutes, and neonatal infection **Results:** -The median amniotomy to delivery interval for the delayed oxytocin group was 15 hours compared to 6 hours in the immediate amniotomy group (95% CI 0.24-0.70) -Overall there was no difference	between the group in patient reported childbirth perception (p=0.43) -Amniotomy to established labor was 5 hours in the delayed group compared to 3 hours in the immediate group (95% CI, 0.23-0.74) -Significantly more parous women in the delayed oxytocin group used pain relief compared to parous women in the immediate oxytocin group (95% CI, 1.05-8.19) -Oxytocin was not used in 22.6% of all women in the delayed oxytocin group -The proportion of women delivered within 24 hours was not significantly different between groups -The frequency of intrapartum fever and neonatal infection was equal between both groups -There was no significant difference between the groups with regard to mode of delivery or hemorrhage rate	**Strengths:** Randomization + delay of oxytocin administration after amniotomy to evaluate the optimal interval between amniotomy alone and oxytocin infusion **Limitations:** Small sample size + established labor is a subjective measure making the interpretation of amniotomy to established labor outcome pragmatic + participants were not blinded to the allocated treatment **Conclusion:** The results of this pilot trial found that the amniotomy to delivery interval was prolonged by nine hours in the delayed amniotomy group. Multiparous women utilized more pain relief measures when oxytocin was delayed and they had a less positive perception of their delivery. **Implications:** Further research should be conducted regarding delaying oxytocin infusion after amniotomy

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study.

Source: Battarbee, A. N., Glover, A. V., & Stamilio, D. M. (2020). Association between early amniotomy in labor induction and severe maternal and neonatal morbidity. *Australian and New Zealand Journal of Obstetrics and Gynecology*, *60*(1), 108-114. https://doi.org/10.1111/ajo.13031

Purpose/Sample	**Design (Method/Instruments)**	**Results**	**Strengths/Limitations**
Purpose: The purpose of this study was to investigate whether artificial rupture of membranes at less than four centimeters dilation is associated with cesarean delivery, severe maternal and neonatal morbidity, and length of labor induction **Sample/Setting:** -Inclusion criteria: Term gestation (37+), singleton, viable fetus, and less than 4 centimeters dilated -Secondary analysis of a cohort study of all deliveries at 19 United States hospitals from 2002 to 2008 -Data was collected from 228,668 deliveries with 15,525 meeting inclusion criteria **Johns Hopkins Evidence Appraisal Evidence Level** **Strength:** III **Quality:** High	-Women were compared by early amniotomy at less than 4 centimeters dilation or did not early amniotomy as defined as artificial or spontaneous rupture of membranes at greater than or equal to 4 centimeters -Primary outcome was cesarean delivery -Secondary outcomes included severe maternal and neonatal morbidity as well as labor duration **Results:** -10,421 (67%) had early amniotomy -Women who underwent early amniotomy were more likely to be non-Hispanic white, obese, and multiparous (P <0.001) -Median time interval from induction onset to rupture of membranes was approximately four hours shorter for women who had early AROM compared to those who did not (P<0.001) -Cesarean delivery occurred in 7.8% of the early amniotomy group compared to 7.3% (aOR 1.30 95% CI 1.12-1.50)	-Increasing odds of cesarean delivery was noted in the early amniotomy group as maternal BMI increased -No difference noted in cesarean rates in women with non-obese BMI -Women who underwent early AROM were more likely to deliver sooner than women who had delayed AROM	**Strengths:** Use of a large, multicenter cohort (improves generalizability) + **Limitations:** limited to data collected from the original study + study time period limits generalizability to all populations **Conclusion:** Early amniotomy, defined as AROM at less than four centimeters, is associated with a shorter duration of labor induction without an associated increase in the odds of severe neonatal morbidity. Early AROM appears to be associated with increased caesarean delivery among obese women. Early AROM was also associated with decreased odds of severe maternal morbidity among multiparous women who have mechanical cervical ripening. **Implications:** Early amniotomy when utilized in labor induction may be advantageous, specifically in non-obese BMI women. Further studies need to be conducted to determine early amniotomy's risks versus benefits in obesity.

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study.

Source: Gagnon-Gervais, K., Bujold, E., Iglesias, M., Duperron, L., Masse, A., Mayrand, M., Sansregret, A., Fraser, W., & Audibert, F. (2012). Early versus late amniotomy for labour induction: A randomized controlled trial. *The Journal of Maternal-Fetal & Neonatal Medicine*, *25*(11), 2326-2329. https://doi.org/10.3109/14767058.2012.695819

Purpose/Sample	Design (Method/Instruments)	Results	Strengths/Limitations
Purpose: The purpose of this study was to evaluate the impact of early versus late amniotomy on delivery mode in women undergoing induction of labor. **Sample/Setting:** -Inclusion criteria: 18 years of age or greater, singleton fetus, cephalic presentation, intact membranes, reassuring FHT, admitted for IOL, Bishop score of 6 or greater -143 women with randomization of 71 women in the early amniotomy group and 72 in the late amniotomy group -This RCT took placed from October 2006 to May 2010 in two academic centers in Montreal, Canada **Johns Hopkins Evidence Appraisal Evidence Level** **Strength:** Quantitative Level I (RCT) **Quality:** Good	-Web-based randomization -Early amniotomy group had amniotomy and oxytocin administration within one hour of randomization -Late amniotomy group had the oxytocin infusion started and amniotomy delayed for four hours -Primary outcome measured was the rate of cesarean delivery -Secondary outcomes included mean duration of labor, mean amniotomy to delivery interval, and rate of intrapartum fever **Results:** -Cesarean rates were similar in both groups among nulliparous (EA 17.6% versus LA 16.6%, p=0.91) and multiparous (EA 2.7% versus LA 0% p=1.0) -Duration of labor (oxytocin to delivery) was shorter in the early amniotomy	group in nulliparous women (12.1 +/-6.7 versus 15.4 +/- 5.6 p=0.03) -Among nulliparous women, intrapartum fever was less frequent in the early amniotomy group compared to the late amniotomy group (6% versus 25% p=0.03)	**Strengths:** Randomization + stratification by parity + strict definitions of early and late amniotomy **Limitations:** Trial was stopped early due to difficulty with recruitment + low cesarean rate due to low risk population included in the study **Conclusion:** This was an underpowered study; however, the data collected shows no difference in rates of cesarean section and a decreased duration of labor in nulliparous women who underwent early amnitomy **Implications:** The authors of this study suggest that nulliparous women may benefit from early amniotomy with regard to labor duration and the risk of intrapartum fever.

Author Recommendations: The authors do not discuss specific recommendations based on the results from this study.

Table 2 - Study Demographics

Study	Year	Total number of Participants	Country of Origin
Macones et al.	2012	585	United States
Bala et al.	2017	150	India
Bostancı et al.	2017	200	Turkey
Pasko et al.	2018	285	United States
Battarbee et al.	2016	546	United States
Makarem et al.	2013	320	Egypt
Battarbee et al.	2020(b)	2,081	United States
Tan et al.	2013	206	Malaysia
Titulaer et al.	2019	64	Netherlands
Battarbee et al.	2020(a)	15,525	United States
Gagnon-Gervais et al.	2012	143	Canada

Table 3 - Induction Agents, Amniotomy, and Labor Duration

Source	Agent	Amniotomy Timing	Labor Duration
Bala et al. (2017)	Oxytocin Rate of 3 mU/min with similar incremental increase every 30-40 minutes. The maximum concentration allowed was 42 mU/minute which could be escalated up to 72 mU/min	Early amniotomy: IOL with amniotomy and oxytocin administration 30-60 minutes after amniotomy Delayed amniotomy: IOL with oxytocin and amniotomy 4-8 hours later	Shorter labor duration in the early amniotomy group compared to the delayed amniotomy group (7.35 +/- 4.21 vs. 11.66 +/- 5.56)
Bostancı et al. (2017)	Cervidil Utilized 10mg inserts and placed for 24 hours or removed if a patient experienced 3+ contractions within 10 minutes, lasting 45+ seconds, or moderate or better quality resulting in cervical change	Early amniotomy: amniotomy at 3 cm dilation Standard amniotomy: spontaneous rupture of membranes	A shorter median time from induction to delivery in those who underwent early amniotomy compared to standard amniotomy (13.72 +/- 7.35 vs. 22.73 +/- 8.37)
Battarbee et al. (2016)	Foley Balloon All participants had the foley balloon inflated with 80cc and taped with tension for a maximum of 12 hours	Early amniotomy: amniotomy less than one hour after foley removal Late amniotomy: amniotomy greater than one hour after foley removal	A shorter median time from catheter removal to vaginal delivery in the early amniotomy group compared to the late amniotomy group (10.6 vs. 13.8)
Makarem et al. (2013)	Misoprostol (vaginal) Each group received 50mcg of misoprostol every six hours until three or more uterine contractions of 40 seconds duration or longer averaged over 10 minutes was achieved OR a maximum of four doses	Early amniotomy group: performed at 3cm dilation Late amniotomy: avoided amniotomy	Shorter labor duration for the early amniotomy group compared to the late amniotomy group (9.72 +/- 4.61 vs 13.61 +/- 5.61, p=0.002)

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