META-ANALYSIS

Meta-analysis of the predictive value of ultrasonic measurement of cervical internal orifice width and cervical length for premature delivery

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Abstract

Objective: To systematically assess the predictive value of ultrasonic measurement of cervical internal orifice width and cervical length for premature delivery.

Method: The systematic review and meta-analysis comprised literature search on Cochrane Library, PubMed, Embase, Web of Science, China National Knowledge Infrastructure and other databases for clinical studies published between January 1, 2000, and December 31, 2020, on the predictive value of ultrasonic measurement of cervical internal orifice width and cervical length for premature birth. Two researchers screened the literature, extracted data, and analysed the risk of bias independently. Meta-analysis was performed using RevMan 5.3.

Results: Of the 1,382 studies initially identified, 10(0.7%) were analysed. There were 242 patients in the study group and 931 in the control group. Compared to the control group, the cervical length of the study group was smaller ($p<0.0001$), the width of the internal cervical orifice of the study group was larger ($p<0.00001$), and the cervical Bishop score of the study group was higher ($p<0.00001$). Preterm delivery patients with cervical length <10mm were significantly more than those with cervical length 10mm of more ($p=0.0008$). Preterm delivery patients with cervical internal orifice width <5mm were significantly less than those with cervical internal orifice width greater than or equal to 5mm ($p<0.00001$).

Conclusion: Ultrasonic measurement of cervical length and width of internal cervical orifice had significant clinical value for predicting premature delivery.

Keywords: Ultrasound, Internal cervical orifice, Cervical length, Premature delivery, Meta-analysis.

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Introduction

Preterm birth is an important issue in obstetrics and gynaecology (Ob/Gyn) and paediatrics.[1] There are many factors affecting preterm birth, most of which come from social pressure or changes in the surrounding environment of pregnant women. The increased rate of preterm birth causes a great impact on the health of mothers and newborns. In general, mothers who give birth between 28 and 37 weeks of gestation are considered to have preterm delivery.[2] Preterm infants usually suffer from varying degrees of intellectual disability or nervous system diseases,[3,4] which puts great burden on family and society. Therefore, accurate prediction of preterm birth in clinical practice is beneficial to the formulation of interventional measures to improve pregnancy outcomes and reduce the rate of preterm births.[5,6]

The cervix plays an important role in pregnancy, and studies have confirmed that cervical length is inversely linked to the risk of miscarriage.[7] Ultrasound measurement of cervical length is currently the most commonly used method for clinical screening of preterm birth, and is recognised as an effective indicator for predicting spontaneous preterm birth.[8]

At present, clinical prediction of preterm birth is mainly based on clinical symptoms, medical history, Bishop score, biochemical examination, and ultrasound examination of cervical length.[9] The first three tests are all subjective, and there are many influencing factors regarding biochemical tests.[10] However, many studies have found that ultrasound measurement of cervical length is an effective way to identify the risk of preterm birth.[11] Although there are several reports measuring the predictive value of cervical length by ultrasound for preterm delivery, the findings appear to be contradictory.[12,13]

Since these controversial findings may be the result of variations in many factors, a meta-analysis is essential to provide more robust conclusions on this challenging issue.[14] The current systematic review and meta-analysis was planned to fill the gap in literature regarding the predictive value of cervical length and internal cervical mouth width detected by ultrasound for preterm delivery.

Materials and Methods

The systematic review and meta-analysis comprised a literature search on Cochrane Library, PubMed, Embase,

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Web of Science, China National Knowledge Infrastructure (CNKI) and other databases for clinical studies published between January 1, 2000, and December 31, 2020, on the predictive value of ultrasonic measurement of cervical internal orifice width and cervical length for premature birth. The references of relevant studies were checked for possible missing articles. The search terms included ultrasound, cervical opening width, cervical length and premature birth.

Those included were clinical trials or observational studies with subjects being preterm delivery patients in the Department of Ob/Gyn, used ultrasound to examine the width of cervical internal opening or cervical length, provided clear pathological diagnosis as the reference standard, data included cervical internal orifice width, cervical length, and Bishop score.[15,16] Duplicate publications, non-empirical studies, such as reviews and conference papers, those with incomplete data, and studies without access to full text or necessary data were excluded.

Two independent researchers screened the literature and extracted information. In case of a difference of opinion, a third researcher resolved the matter. Titles and abstracts were read, irrelevant literature was excluded, and the full text was further accessed to verify whether the literature met the inclusion criteria. Data extracted from each article included authors' names, publication time, study type, sample size, internal cervical orifice width, cervical length, Bishop score, and other results.

The risk of bias was assessed using the Newcastle-Ottawa Scale (NOS),[16] with a maximum score of 9 and a minimum score of 0. A higher total score represented better quality of the literature. In general, high-quality literature was scored 7-9 points, medium-quality literature 4-6 points and low-quality literature was scored 0-3 points.

Meta-analysis was done using RevMan 5.3,[17] and odds ratio (OR) was taken as the effect indicator for categorical variables. In the evaluation of effect size, the exact point estimate and 95% confidence interval (CI) were worked out to comprehensively reflect the reliability and accuracy of the effect size. The chi-square test, with alpha (α)=0.1 as the standard, was used to determine the presence of statistical heterogeneity among the results. At the same time, the I2 index was also combined to quantitatively describe the degree of heterogeneity.[18] If no statistical heterogeneity was found among the results, the fixed effect model was applied for meta-analysis. However, if statistical heterogeneity was discovered, the random-effects model was used for meta-analysis.

Results

Of the 1,382 studies initially identified, 10(0.7%) were analysed (Figure 1). There were 1,173 patients; 242(20.6%) in the study group SG comprising preterm delivery cases, and 931(79.4%) in the control group CG comprising non-preterm delivery cases.

NOS score of all the 10[19-28] studies was >6 points, indicating that the studies were of high quality (Table).

Twelve (91%) (p<0.00001) implied that the results of the 2 groups had a certain degree of heterogeneity. SG had shorter cervical length than CG (mean deviation (MD)=-12.01, 95% CI: -14.89--9.12), p<0.0001) (Figure 2).

There were 6(60%) studies[19-22,24,28] with 161(66.5%) SG patients and 584(62.7%) CG patients with I2 64% (p=0.02). SG had larger width of the internal cervical mouth than CG (MD=6.71, 95% CI: 5.51-7.92), p<0.00001) (Figure 3).

There were 3(30%) studies[20-22] with 46(19%) SG patients and 175(18.8%) CG patients. with I2 0% (p=0.71). SG had higher cervical Bishop score than CG (MD=3.61, 95% CI: 2.56-4.66), p<0.00001) (Figure 4).

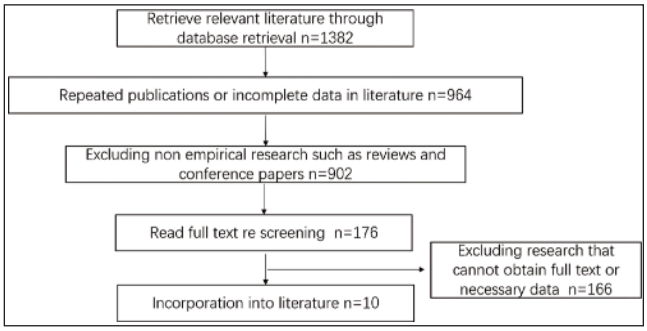

Figure-1: Study flowchart.

Table: Characteristics of the studies analysed.

Authors/year	Groups		NOS score	Research index
	Preterm delivery	Non-preterm delivery		
Liu 2016[19]	54	132	7	①②④
Han 2019[20]	15	38	8	①②③④⑤
Deng 2018[21]	6	80	8	①②③⑤
Xing 2015[22]	25	57	8	①②③④⑤
Homeira 2014[23]	16	179	7	①
Talat 2006[24]	18	232	7	①②
Ashley 2019[25]	28	74	9	①
Nesa 2013[26]	18	62	8	①④
Jasmina 2014[27]	19	32	7	①
Londero 2011[28]	43	45	7	①②

① Cervical length, ② Width of the cervical internal orifice, ③ Cervical Bishop score, ④ Relationship between cervical length and premature birth, ⑤ Relationship between the width of the internal cervical orifice and premature birth, NOS: Newcastle-Ottawa Scale.

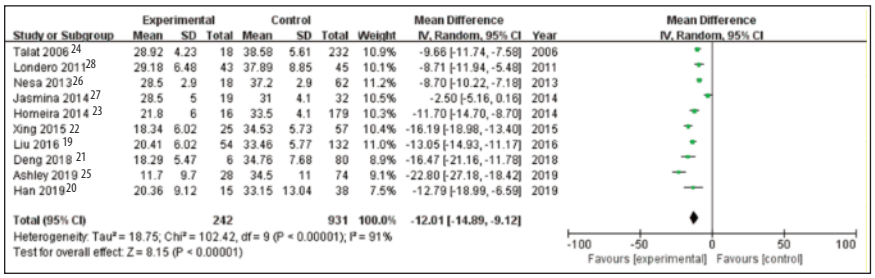

Figure-2: Meta-analysis results of cervical length in the two groups.

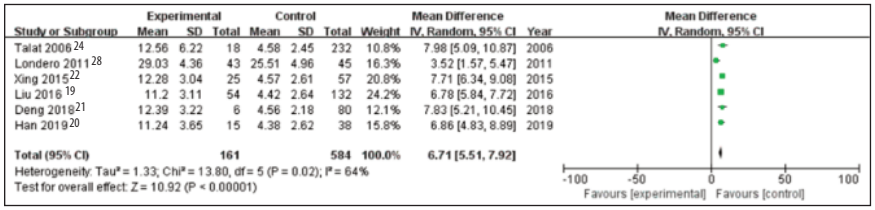

Figure-3: Meta-analysis results of internal cervical orifice width in the two groups.

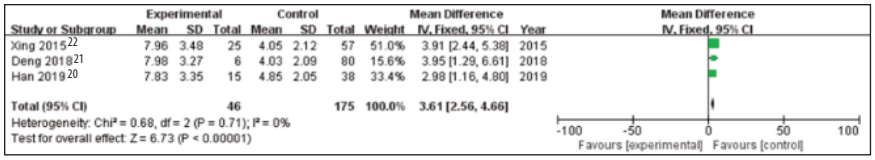

Figure-4: Meta-analysis results of cervical Bishop score in the two groups.

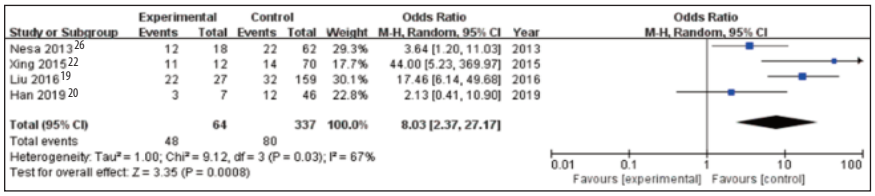

Figure-5: Meta-analysis results of cervical length and preterm birth in patients.

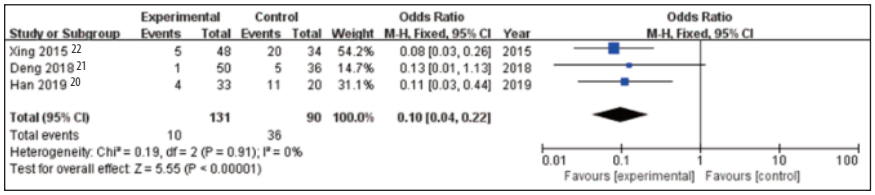

Figure-6: Meta-analysis results of the relationship between internal cervical orifice width and preterm birth in patients.

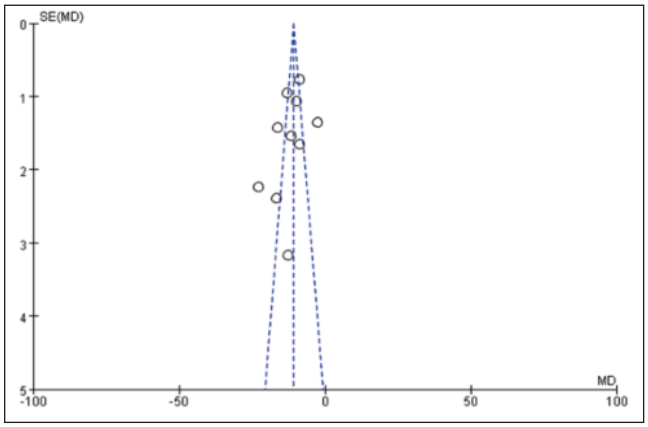

Figure-7: Funnel plot.

There were 4(40%) studies[19,20,22,26] having 64(26.4%) SG patients and 337(36.2%) CG patients with I2 (67%) (p=0.03). Preterm delivery patients with cervical length <10mm were significantly more than those with cervical length ≥10mm (OR=8.03, 95% CI: 2.37-27.17, p=0.0008) (Figure 5).

There were 3(30%) studies[20-22] having 131(54.1%) SG patients and 90(9.7%) CG patients with I2 0% (p=0.91). Preterm delivery patients with cervical internal orifice width <5mm were significantly less than those with cervical internal orifice width ≥5mm (OR=0.10, 95% CI: 0.04-0.22, p<0.00001) (Figure 6).

The funnel-shaped plot showed less publication bias in the studies analysed (Figure 7).

Discussion

With the change of social structure and industrialisation, pregnant women are facing more and more risks, and the probability of premature birth is increasing. According to statistics, the preterm birth rate in China has exceeded 10%, of which about one-fifth of preterm infants have risk of death.[29] With scientific advancements, the prediction methods of preterm birth are more and more advanced, which can effectively deal with the risk of preterm birth and give active treatment conducive to improving the survival rate and quality of life of preterm infants.

From the perspective of traditional medicine, obstetricians have always relied on various methods to assess the health status of the mother and foetus. Among them, vaginal examination, as a classic and direct method, has been widely used in the diagnosis of cervical condition.[30] Although vaginal examination can reflect the texture, length and opening of the cervix to a certain extent, providing a reference for the prediction of delivery, its accuracy is often affected by the personal experience and subjective judgment of the doctor, and there is a large variability.

Advancements in ultrasound technology have brought convenience to obstetric examination. Ultrasonography has gradually become an indispensable means in obstetric

examination because of its advantages of being a non-invasive, real-time tool with strong repeatability. Ultrasound examination plays an important role in antenatal examination, providing doctors with more accurate and comprehensive foetal and maternal information.

Ultrasound examination of Ob/Gyn mainly includes abdominal ultrasound, transperineal ultrasound and transvaginal ultrasound, each having its own characteristics and being suitable for different examination scenarios and needs. Transabdominal[31] is the most common ultrasound examination. It requires pregnant women to fully fill the bladder before the examination to form a good acoustic window so that the doctor may clearly observe the situation of the foetus and the uterus, and comprehensively assess the foetal size, foetal position, amniotic fluid volume, placental position and other key indicators. Transperineal ultrasound[32] is an emerging examination method. It makes direct contact with the perineum by means of the probe, and avoids the interference of abdominal fat, allowing the physician to observe the condition of the cervix and vagina more directly. Transperineal ultrasound has unique advantages of assessing cervical length and the degree of dilation of the internal cervical orifice, especially in predicting the risk of preterm delivery, which has been favoured by more and more obstetricians. Transvaginal ultrasound[33] is a more direct and accurate ultrasound examination. By inserting the probe directly into the vagina, key information, such as the length, texture, opening of the cervix, and the shape and size of the uterus, can be clearly displayed, thus providing doctors with a more accurate basis for diagnosis. However, the popularity of transvaginal ultrasound in clinical application is relatively low due to its relatively complex operation and the need for certain skills and experience.

In this study, ultrasonic measurement of cervical internal opening width and cervical length were used to explore the predictive value of preterm birth. The results revealed that relative to the non-preterm group, the cervical length of the preterm group presented shorter, the width of the internal cervical orifice in the preterm group presented larger, and the Bishop score in the preterm group presented higher. Lim et al. suggested that in women with a multiple pregnancy, second-trimester cervical length belonged to a promising predictor of preterm birth.[34] Crane et al. indicated that cervical length measured by transvaginal ultrasonography in high-risk women predicted spontaneous preterm birth at <35 weeks.[35]

In addition, the relationship between cervical length, internal cervical orifice width and preterm birth was analysed in the current study, and the results revealed that the incidence of preterm birth with cervical length <10mm was significantly higher than that with cervical length ≥10mm. The internal cervical width in the threatened premature labour group was significantly smaller than that in the non-threatened premature labour group, that is, the preterm birth patients with the width of cervical internal orifice <5mm were significantly less than those with the width of cervical internal orifice ≥5mm. Consistent with these findings, the indexes of cervical length and internal cervical mouth width of pregnant women in the preterm delivery group in a study were 20.36±9.12mm and 11.24±3.65mm, respectively, while those in the non-preterm delivery group were 33.15±13.04mm and 4.38±2.62mm, respectively.[20] Another study reported that there were 5 cases of premature delivery in the group with cervical internal orifice width ≥5mm, with an incidence rate of 5.81%, and 1 case of premature delivery in the group with cervical internal orifice width <5mm, with an incidence rate of 2%. A significant difference was discovered in the incidence of premature delivery between the groups.[21]

The current study had some limitations. Firstly, there were differences in ultrasound diagnostic methods used in the included studies, which may have led to bias in the results. Secondly, the sample size was inadequate, which may have affected the accuracy of the findings. Thirdly, the meta-analysis was not registered.

Conclusion

Ultrasonic measurement of cervical length as well as the width of internal cervical orifice had significant clinical value for predicting premature delivery, with high accuracy and repeatability, and was found worth promoting and using in future clinical work.

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Conflict of Interest: None.

Source of Funding: None.

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