A new factor involved during childbirth labor: the importance of having a good dental occlusion

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It is widely recognized that the physiology of childbirth labor largely depends on the interaction between three factors: a) the force generated by uterine contractions; b) the structure and characteristics of the birth canal and c) the fetus. Harmony between these three variables determines the initiation of maternal dynamic phenomena and the establishment of an optimal maternal-fetal balance in which both warrant for a correct delivery timing. The present study considered the above known factors and assessed if any other factor, still not recognized, could also play a role, and eventually modify the timing of delivery during the expulsive period. In particular, we focused our attention on the role played by the temporomandibular joint and dental occlusion on maternal body balance and on the stability of muscular reflected forces. The importance of assessing the temporomandibular function and the dental occlusion lies in the fact that any alteration in chewing or in temporomandibular joint (TMJ) mobility and occlusion brings to relevant modifications on the vertebral column and pelvic girdle. Our hypothesis is based on the evidence that those women who have any kind of alteration in their dental occlusion, can have an altered capability of pushing during the expulsive period, as the force applied on the pelvic floor is not expressed. Moreover, recent studies have highlighted a relationship between temporomandibular dysfunctions and sleep apnea syndrome and between sleep apnea syndromes and pregnancy. These relationships are explored in this study.

The duration of the first stage of childbirth labor is defined as the time between the beginning of the active phase and the complete cervical dilation, while duration of the second stage of labor is defined as the time between the complete cervical dilation and fetal expulsion (1). The second stage is divided into two phases: the passive second stage, during which the head of the fetus descends passively down the maternal pelvis; and the active second stage, which corresponds with the phase of expulsive efforts. The World Health Organization (WHO), current national clinical practice guidelines in the United States and in Canada state that the diagnosis of a prolonged second stage of labor should be considered, in nulliparous women, when the second stage exceeds 2-3 hours, while in multiparous women the second stage would be prolonged when it exceeds 1-2 hours, where the upper limit is modified by the use for regional anesthesia (SOGC Clinical Practice Guidelines, 1998; ACOG Practice Bulletin No. 49, 2003; WHO, 2005).

Safety and effectiveness of management of

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the second stage of labor represent a fundamental clinical challenge for laboring women and obstetric practitioners. Indeed, several systematic reviews found evidence of a strong association between a prolonged active second stage and operative vaginal delivery, an increased incidence of indication for emergency cesarean section, and a higher risk of maternal complications − such as postpartum hemorrhage, chorioamnionitis, puerperal sepsis, severe obstetric lacerations (third- or fourth-degree), anal sphincter tear (2), obstetric trauma, due to a pelvic floor damage, such as postpartum urinary incontinence (3) and postoperative pyrexia, unintentional hysterotomy extensions in case of cesarean section (4).

Prolonged labor has been reported as an important risk factor even for neonatal outcomes. Although larger studies do not confirm a direct correlation between birth depression, neonatal trauma (brachial plexus palsy, facial palsy, fractures, intracranial hemorrhage) and admission to the neonatal intensive care unit, there are reports of severe metabolic acidosis, neurological damage, meconium-stained amniotic fluid, longer neonatal stay in the hospital and perinatal death (5).

The causes of a prolonged labor are nowadays still scarcely known. Weak contractions, fetal malposition, disproportion between maternal pelvis and fetal head use of epidural anesthesia (6), maternal ethnicity, maternal body mass index (7), gestational age birth weight (8), maternal age fear of childbirth parity (9), a scarce support provided by midwifes during labor and prostaglandin use are reported to influence the duration of labor. No evidence of a possible association between physical activity and duration of labor has been found (10, 18)

The present study is based on the hypothesis that women who have any kind of alteration in their dental occlusion may have a reduced capability of pushing during the expulsive period, since the force applied on the pelvic floor during labor is not properly expressed.

Malocclusion is an abnormal alignment of the teeth of the maxilla and the mandible that prevents the teeth from meeting properly. The term was coined by Edward Angle, the father of modern orthodontics, as a derivative of occlusion, which refers to the manner in which opposing teeth meet. Malocclusions can be divided mainly into three types, depending on the sagittal relations of teeth and jaws, by Angle's classification method, based on the relative position of the maxillary first molar (19-27).

Posture is the position of the body with respect to the surrounding space. A specific posture is determined and maintained by coordination of the various muscles that move the limbs, by proprioception, and by the sense of balance, in relation with the force of gravity (28-36).

The origins and consequences of the biomechanical correlation between the cranio-mandibular complex and the cervical column have been intensely studied in last ten years, in the effort to find evidence that a dental malocclusion could cause a temporomandibular dysfunction and then a cervical spine diversion .Occlusion and mandibular movements have been investigated with open and closed eyes, in standing and sitting position, and the conclusion is that the registration proprioceptive position and the visual system can influence mandibular movements .Many research found experimental evidence of the relation between the mandibular position and head posture and with the whole body posture as well. Many studies in literature reported evidence of the dependence between mandibular movements and possible head and neck movements, led a clinical study on 130 volunteers, demonstrating the correlation between a cranio-mandibular defect, the mobility of the cervical tract and the weakness of neck and shoulders muscles. Urbanowicz documented that an increase of the vertical dimension of the mandibular posture could create a sub occipital compression and a deregulation of the postural balance of the neck and head (37-43). Ries detected an asymmetric activation of the temporalis, masseter and sternocleidomastoid muscles in patients affected by temporomandibular disorders (TMD) (44-50). A precise diagnosis is fundamental to address the actual causes. In a correct therapeutic plan, the examination should include an accurate anamnesis, especially concerning the stomatognathic system; an exam of the oral cavity; a measurement of the inferior limbs; the evaluation

of a descendant postural defect; and an overall muscular assessment. In addition to these exams, it is necessary to perform a postural analysis on a stabilometric platform, by using reflective passive markers on the body and an optoelectronic unit with infrared cameras, to analyze the postural defect, the malocclusion and the correct mandibular position, in order to guarantee the best therapeutic approach.

Various studies have already investigated the effect of a dental support device on the isometric strength of different muscles (51-55) and a number of these demonstrated an improved physical performance even in athletes. Patients with a proper dental occlusion showed greater endurance in isometric muscle performance than those who present a malocclusion. Another variable that could influence delivery and labor could be the occurrence of Obstructive Sleep Apnea (OSA) during pregnancy, as sleep disorders are linked to bruxism which is linked to occlusion, TMJ dysfunction and facial pain. A recent study defined "gestational OSA" as the respiratory sleep disorder that occurs during pregnancy, thus distinguishing it from the chronic form, already present in women before pregnancy.

A better understanding of risk factors for abnormal labor progression may impact the timely diagnosis of dystocia, active management of labor and, at the end, the method of delivery. Our aim was to investigate whether subjects with a good temporomandibular closure could have a shorter expulsive period.

Table I. *Analysis on the 190 eutocic deliveries.*

Presenting part	
left occipitoanterior (LOA)	106 (56%)
right occipitoanterior (ROA)	80(42%)
right occipitoposterior (ROP)	4(2%)
Blood Loss	
<500mL	171(90%)
500-1000mL	15(8%)
>1000mL	4(2%)
N of pregnancies	
nulliparous	87(46%)
second pregnancy	60(31%)
third	32(17%)
fourth	8(4.2%)
fifth or sixth	2(1%)

MATERIALS AND METHODS

Design of the study

Each woman underwent two different examinations: the first one at term, performed at the Pregnancy Outpatients Consultation Room of the Obstetrics and Gynecology Department of the Hospital "Vittore Buzzi" in Milan (Italy), the second examination was performed during delivery at the Hospital's Obstetrics Ward. The Hospital Ethics Committee approved the experimental protocol and all subjects who took part in the study provided written informed consent.

A total of 246 pregnant unselected healthy singleton pregnant women, at term, attending the Pregnancy Outpatients Consultation, volunteered to enter the study at the Obstetrics and Gynecology Department, at "Vittore Buzzi" Hospital, Milan (Italy) between December 2003 and July 2004. They were all Caucasian with an average of 31.6 years of age.

Of this group, 56 were excluded from our study for the following reasons: 29 (26 nulliparous and 3 multiparous) underwent a caesarean section and 27 (20 nulliparous and 7 multiparous) needed vacuum extraction for fetal distress.

The remaining 190 women who had eutocic (physiological) deliveries were included in this study: 115 were nulliparous, 68 on their second, 6 on their third and 1 on her fourth pregnancy. Details of this population are presented in Table I.

Of the total population considered at the beginning of the study, 80% of women had jobs outside of the house (74.1% employees, 5.2% freelancers), while 20% worked at home (housewives). Fifty-five percent of the total population never practiced regular sport activity.

Regarding the obstetric history, 45.8% of women were nulliparous, 31.6% were at their second pregnancy, 16.8% at their third, 4.2% at their fourth and 1% at their fifth or sixth. Of the initial group, 60.5% of women never had a eutocic delivery before, 36% one, 3% two and 1% three while 96.8% never had a cesarean section.

Measurement

Each subject underwent two phases of examination, antepartum and during delivery, respectively. During

the prepartum examination, healthy pregnant women attending the Term Consultation were asked about their weight, height, job, practiced sport activities, past medical history (particularly about skeletal pathologies, postural defects and temporomandibular joint disorders), as well as their past obstetric history. A dentist also assessed their stomatognathic system, their occlusal parameters, their temporomandibular joint mobility and their maximal mouth opening. Measurements of each woman's occlusal parameters and TMJ mobility were made in mm by a dentist and a chiropractor, two times each, in randomized order.

During delivery, we collected data on modality and procedure of their deliveries, timing of labor, expulsive period duration, eventual analgesia and/ or induction with prostaglandin or oxytocin, newborn weight, sex, blood pH and Apgar score. Statistical analyses were established by correlation and multiple regressions as appropriate.

Statistical Analysis

The correlation between the duration of the expulsive phase (dependent variable) and other parameters (independent variables) was analysed by Statistical Package for the Social Sciences (SPSS 25.0, SPSS Inc., Chicago, USA"). To assess the degree of linear correlation and multiple regressions a P- value less or equal to 0.05 was accepted as significant.

RESULTS

During the first phase of data collection, we observed in our global sample of 246 women that the mean measure of the maximal mouth opening was 46.1 mm with a standard deviation of 1.5 mm (range 30-60 mm). The capability of mouth opening had a Gaussian distribution (Fig. 1), with a mean of 46 mm and a data interval included between the 5° percentile (35.5 mm) and the 95° percentile (56.6 mm).

During delivery, at the second phase of data collection, 190 women had a mean duration of the dilation phase of 210 min (range 5-780 min) and a mean duration of the expulsive phase of 43 min (range 3-185 min). The results of our analysis on the 190 eutocic deliveries are presented in Table I.

The position of the presenting part was in 56% of cases left occipitoanterior (LOA), in 42% right occipitoanterior (ROA) and in 2% right occipitoposterior (ROP). The blood loss was less than 500 mL in 90% of cases between 500 and 1000 mL in 8% and more than 1000 mL in the remaining 2%.

A significant correlation (R^2=26.8%) was found between cervix dilation time and the following parameters, taken as independent variables: number of vaginal deliveries (p=0.008), pre-gravidic weight (p=0.007), third trimester weight (p=0.024), analgesia (p=0.001), prostaglandin treatment (p=0.018) and oxytocin treatment (p=0.028). The regression analysis of these significant variables confirmed their significant correlation with the duration of labor (R^2=28.8), number of vaginal deliveries (p=0.006), pre-gravidic weight (p=0.008), third trimester weight (p=0.031), analgesia (p=0.001), prostaglandin treatment (p=0.010) and oxytocin treatment (p=0.010).

The expulsive period had a significant correlation (R^2=25.5%) with the following variables: maternal height (p=0.009), number of vaginal deliveries (p=0.000), maximal mouth opening (p=0.011), oxytocin treatment (p=0.013), neonatal weight (p=0.018). The regression analysis between the duration of the expulsive period and each of the previous independent variables confirmed a significant relation (R^2=23.2%), except for maternal height (p=0.154), as follows: number of vaginal deliveries (p=0.001), maximal mouth opening (p=0.004), oxytocin treatment (p=0.001), new born weight (p=0.013). Excluding maternal height, the regression analysis confirms the significant relation (R^2=22.1%) to the number of vaginal deliveries (p=0.001), maximal mouth opening (p=0.008), oxytocin treatment (p=0.001) and newborn weight (p=0.014).

The significant negative correlation between duration of the expulsive period (dependent variable) and maximal mouth opening (independent variable), with an angular coefficient of -1.37 (R^2=3.7%) is shown in Fig. 2.

To strengthen the above results, we repeated the analysis on the nulliparous group only, a sample of 115 subjects (60% of the entire initial sample). The duration of the cervix dilatation showed a significant correlation (R^2=23%) with the following parameters, taken as independent variables: analgesia (p=0.023) and oxytocin treatment (p=0.008). The regression

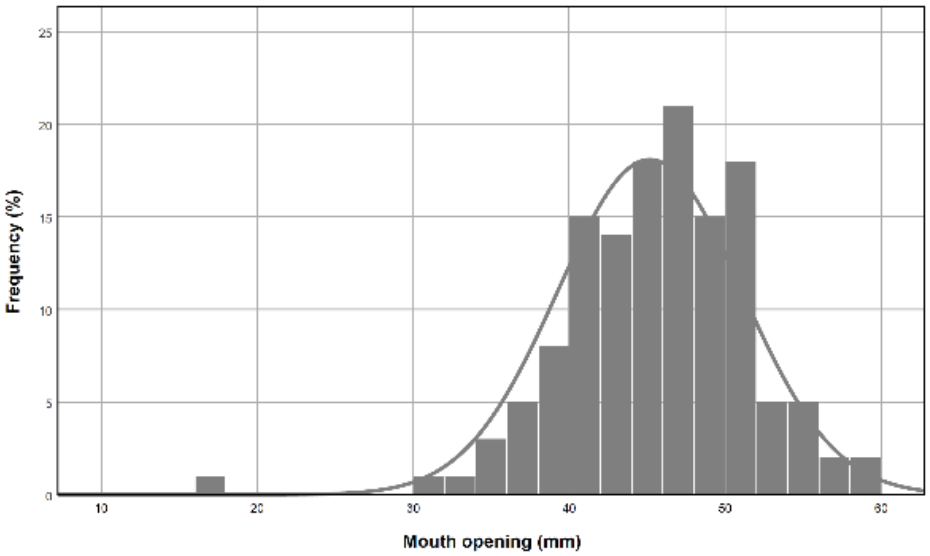

Fig. 1. *Distribution of mouth opening in sample population. Underlying gray line represents normal distribution.*

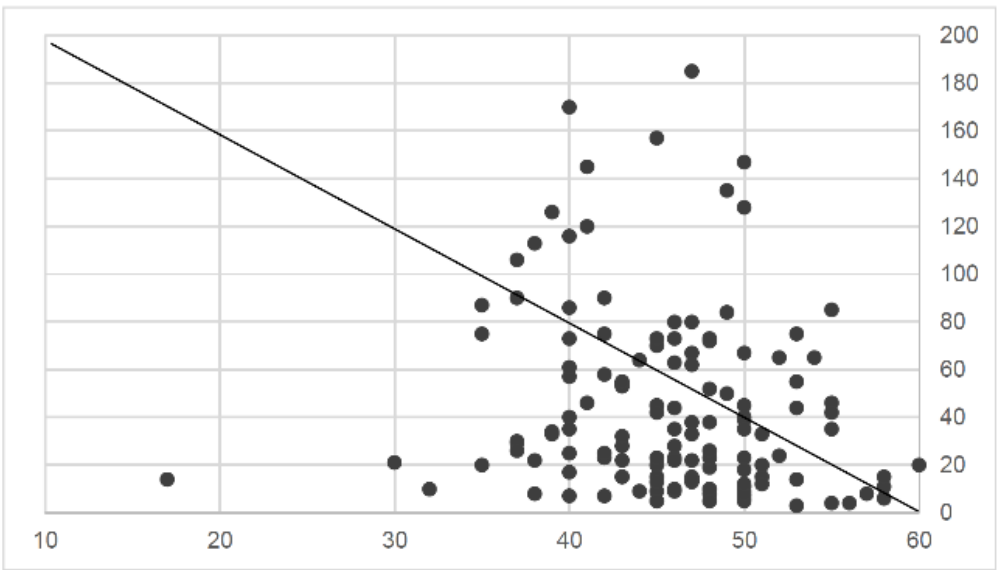

Fig.2. *Scatter plot representing mouth opening on the x-axis in mm, expulsive period time in minutes on the y-axis and regression line.*

analysis confirmed the level of significance (R2=24%) between cervical dilatation time and each of the previous significant independent variables: analgesia (p=0.001) and oxytocin treatment (p=0.000). As shown in Fig. 3, the duration of the expulsive period had an asymmetric distribution, with a median of 45 min, a 5° percentile of 10 minutes and a 95° percentile of 120 min.

The expulsive period is significantly correlated (R^2=16.3%) to maternal height (p=0.007), maximal mouth opening (p=0.003) and oxytocin treatment (p=0.006), taken as independent variables. The multiple regression analysis confirmed the relation between the duration of the expulsive period (dependent variable) and maximal mouth opening (independent variable). Fig. 4 shows this significant

correlation, with a P-value of 0.004 and a R2=6.2%, with a negative angular coefficient of 1.6.

The correlation between maximal mouth opening and duration of the expulsive period showed a relative risk of 2.8-2.9. for a mouth opening of < 40 mm. It means that if a nulliparous woman has a small mouth diameter, she has a high relative risk to have a longer expulsive period during labor, with all the possible complications that can follow a long expulsive period.

DISCUSSION

The strong connection existing between the different skeletal components of the body and the continuous nervous control on muscles, by means of the elaboration of information taken from periodontal, articular and muscular proprioceptors and of sensory stimuli, determines continuous variations in head, mandibular and hyoid bone posture, but also in vertebral column and pelvic structure. It has been demonstrated how a malocclusion could be responsible for an imbalanced muscular reaction: when the tooth has a premature contact, the homolateral elevator muscles release, allowing the contraction of the antagonist ones. If the nociceptive stimuli persist, the muscles divert the mandible in a more favorable occlusal intercuspation, modifying the overall posture. In case of pre-contact, strong descending repercussions affect the neck muscles, such as the homolateral upper trapezius muscle and contralateral sternocleidomastoid muscle. The head undergoes a

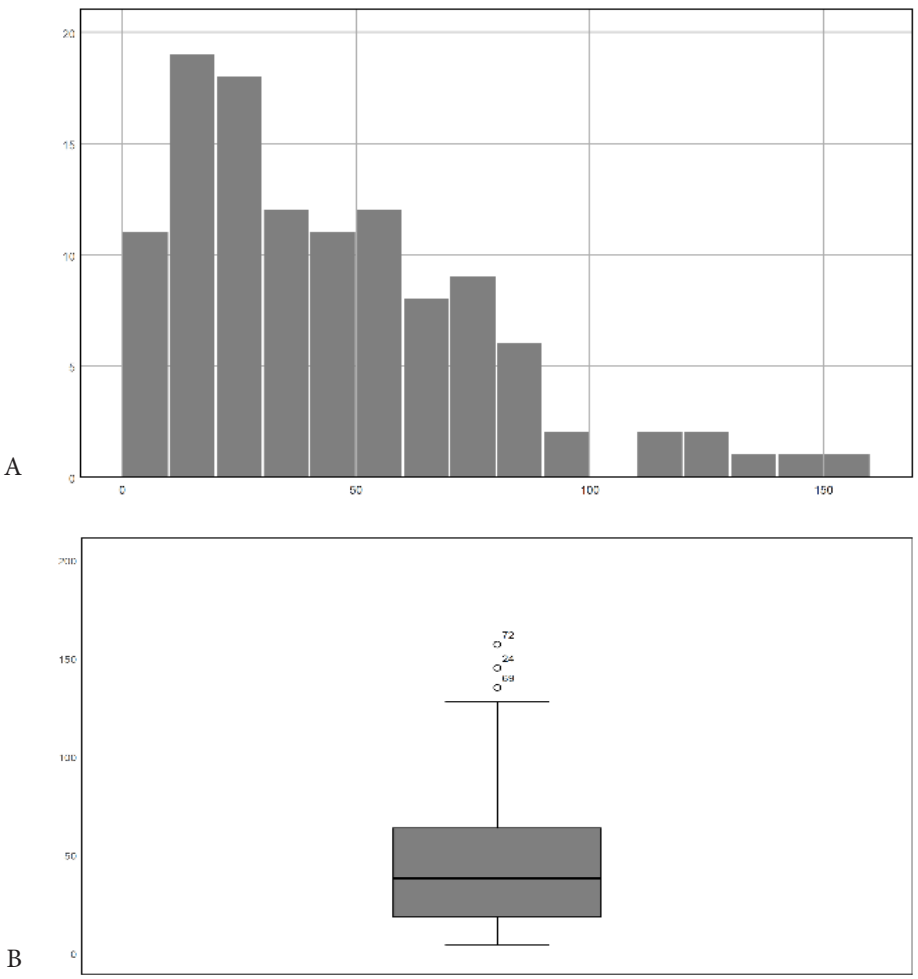

Fig. 3. a. *Boxplot representing expulsive period time, box represents interquartile range, black line median and confidence interval.* ***b****. Patients #69 #24 and #72 resulted outliers.*

flexion towards the mandibular deviation that results in shoulder asymmetry. The cervical column flattens, and this results in thoracic and lumbar compensatory curves. These modifications trigger compensatory muscle imbalances: the iliopsoas muscles cause a pelvic slope and, in worse cases, an asymmetry of the inferior limbs.

Accordingly, a good temporomandibular occlusion plays an important role in guaranteeing body balance. The harmony between all the components of the stomatognathic system, such as bones, TMJ, masticatory muscles and teeth, influences the overall posture, and the mandibular position is important in balancing the craniosacral function (56-63).

The main result of our study is that the expulsive period is strongly influenced by a general musculoskeletal balance: our findings can be of important relevance, suggesting that the dynamic of delivery is the result of maternal posture balance and can be modified by any alteration of the physiologic equilibrium determined by a series of factors, including the temporomandibular joint. It is reasonable to think that a good temporomandibular closure, reflected by women's mouth opening, can influence the delivery timing.

In our study we also found a statistically significant correlation between dilation time and epidural anaesthesia, maternal body mass index, neonatal birth weight, parity and prostaglandin use.

Concerning expulsive period, we found a statistically significant correlation between expulsion time and the factors mentioned above and mouth opening.

While we confirm literature data concerning the effect on delivery time of epidural anaesthesia maternal body mass index, neonatal birth weight parity and prostaglandin use, we add a direct significant negative correlation

between duration of the expulsive period (dependent variable) and maximal mouth opening (independent variable): as the maximal mouth opening increases, the expulsion time (64-70).

In our study, we enrolled only Caucasian pregnant mothers who delivered at term, with an average age of 31.6 years, so that we couldn't focus our analysis on how maternal ethnicity, gestational age and

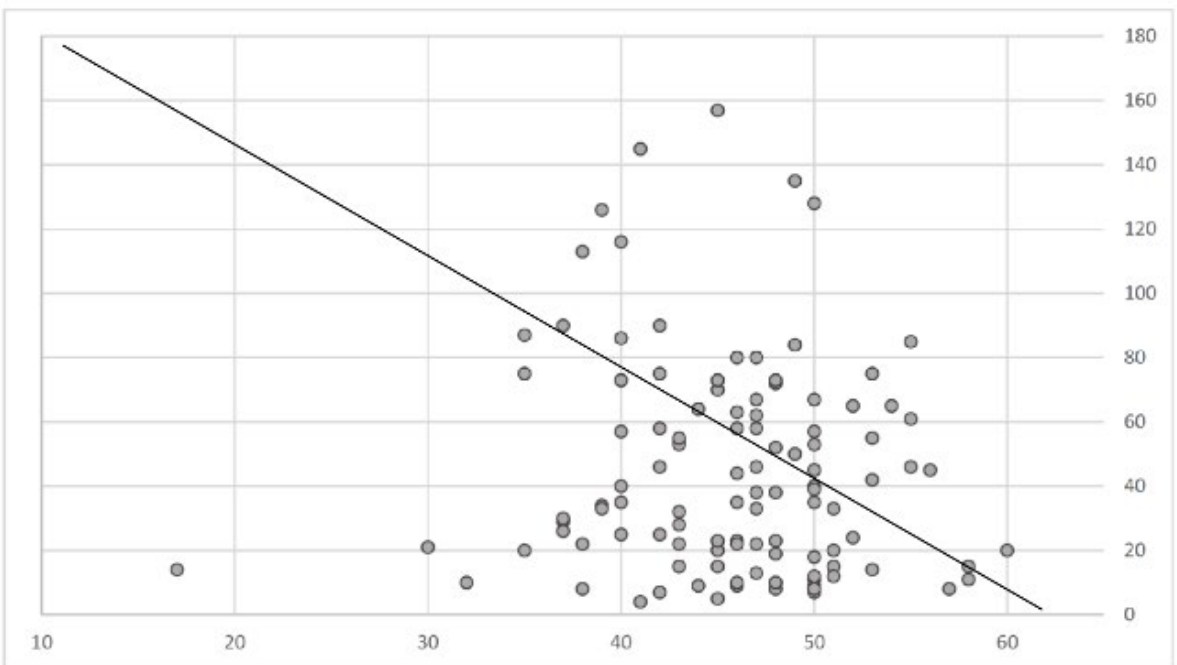

Fig. 4. *Scatter plot representing mouth opening on the x-axis in mm, expulsive period time in minutes on the y-axis and regression line.*

maternal age influence labor.

Moreover, we did not evaluate maternal fear of childbirth, which is a possible factor influencing delivery time, considering that maternal opening mouth diameter is an anatomical factor, independent from any maternal psychological expectation, fear or support from midwifes.

Analyzing only the nulliparous subgroup, only oxytocin and epidural analgesia treatment show a significant influence on the first stage of labor, and this surely opens new perspectives for future research.

Instead, concerning the expulsive time, the second stage of labor, beside the known factors as oxytocin use, parity, and neonatal weight, we added a new factor, less commonly considered, as the mouth opening diameter. This factor was evident for all pregnant women and especially for the nulliparous. In this subgroup indeed, the only significantly influencing factors on expulsive duration were maternal height, mouth opening and oxytocin use.

Since maternal height may be related to mouth opening, we have detected that between factors significantly involved in a prolonged second stage of labor, temporomandibular malocclusion plays a fundamental role. In support to our hypothesis, a pilot study indicated that the duration of the second stage of labor was significantly shorter among patients who wore a dental support device, in comparison to the non-device group .

The maximal mouth opening reflects the correct mandibular closure and the absence of a temporomandibular joint disorder. All these findings support the hypothesis that, working on this so far ignored variable so as to improve or correct any potential malocclusion, will enable to modify the delivery timing, making the expulsive period faster and less painful.

A better understanding of risk factors for abnormal labor progression may impact the timely diagnosis of dystocia, active management of labor and, at the end, the method of delivery.

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