

ON A COMPUTATIONAL APPROACH FOR DIAGNOSIS OF LABOR OUTCOME

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Abstract. This paper presents a computational approach for diagnosis of labor outcome on a basis of correlation analysis for sample of false and true pelvis *distanti*. The sample was obtained by obstetrical measurements in the maternity hospital. The results of this study are sufficient to allow conclusions about the existence of conjugated links between external and internal dimensions of the pregnant's pelvis. The obstetrical literature holds that these relations are still unclear or ambiguous. It was concluded that the reasons of such a statement are due to relationship between sizes in the true pelvis. An obstetrician would make the prognosis of labor outcome by computer software, which has been developed on a basis of these quantitative relations and a fetus head *distanti*.

Key words: obstetrics, labor outcome, *distanti* of true and false pelvis, significance of conjugated links, software, prognosis

Introduction

For the last decade the obstetrics used modern methods and delivery by cesarean section is in common use but the fatal outcome of delivery is left at the level of 8.5 %. The hemorrhages in the various parts of new-born child's brain are high in the list of fatal outcome pattern (23.5 %) with the labor traumata (5.5 %) and can be related to clinical discrepancy between a head of fetus and lying-in woman pelvis [1].

A clinical stenosed pelvis based on the diagnosis both contracted pelvis and large-scale fetus proportion is often a main cause to delivery by cesarean section [2].

Up to now, pelviroentgenography is in the most common used method for generative passage measurements. This is a technique whereby the dimensions of pelvis plates (cross-sections) are measured [3]. But this examination is very complicated and not easily accessible in common obstetrical practice because it necessitates the special X-ray equipment. On the other hand, both pregnant and fetus receive a large radiation load due to X-rays. Therefore, pelviroentgenography is used only by strict indications. The other modern examination method – ultrasonic examination – allows determining only the *distanti* of fetus and his mass value. These reasons make it impossible to diagnose the labor outcome.

The diagnosis of labor outcome on a basis of the remaining methods of pelvimetry has trustworthiness equal or smaller than 50 %.

For the obstetrician the basic challenge is to diagnose the time history of labor and its outcome. Every time during an obstetric aid a doctor must answer the question: is the labor

outcome favorable to the pregnant and fetus? Alternatively, the obstetrician timely induces the delivery by cesarean section as a result of clinical discrepancy.

Statement and the method of the investigation

During the pregnancy the anthropometry (stature and weight of a pregnant) is done and measurements of external *distantii* of false pelvis (*d. spinarum*, *d. cristarum*, *d. trochanterica*, *d. externa*) are carried out. From the literature it follows that these proportions give no unique ways to answer the question: what are the *distantii* of the true pelvis, which determine the geometry of maternal passage [2, 4]?

Thus, we can formulate two problems.

Problem A. To assess the internal *distantii* of pelvis, if the *distantii* of false pelvis and anthropometric dimensions are known. The quantitative relations must be established between these dimensions.

Problem B. If problem A has been solved, we must make a prognosis for labor outcome with the favorable possibility or cesarean section must be done (the ultrasonic dimensions of fetus head are known).

Let us consider problem A. The generative passage of true pelvis is defined as a «curved tube» with a variable cross-section. Four obstetrical plates or cross-sections (*introitus* plate, *latus* or broad part plate, narrow part plate and true pelvis outlet) must approximate it. Longitudinal and transversal dimensions define these plates [2-4] (Fig. 1). To determine the relationship between the anthropometric data, the *distantii* of true pelvis and the dimensions of true pelvis the correlation analysis [5] was used for the sample of sizes of 96 women delivered by cesarean section, which has been obtained from medicosanitary hospital № 9 in Perm. The sample contains the X-ray measured pelvis *distantii* and the *distantii* of false pelvis. On the basis of this sample we calculated a correlation ratios for each pair of the parameters. The following conclusions were obtained, as a result of testing a simple statistic hypothesis: the calculated correlation ratio is different from zero.

The probability that all dimensions form connected graph is 95 %. If the probability of connected graph is 99 % the number of conjugated links decreases. If this probability is 99.9 % any link between every dimension and the transversal dimension of the narrow part vanishes.

Thus, there exist the significant conjugated links between external and internal *distantii* of pelvis. Note that it is not possible to determine the dimensions of true pelvis only by dimensions of false pelvis. The part of dimensions of true pelvis is only deduced from the internal dimensions of the pelvis. For example, straight *distantia* of narrow part plate must be determined from the value of transversal *distantia* of *introitus* plate (Fig. 1).

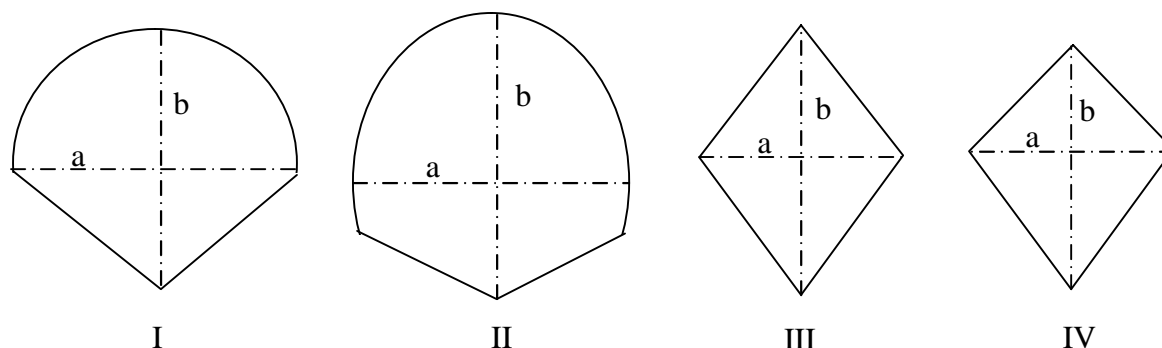


Fig. 1. The reduced geometry of generative passage: I – *introitus* plate; II – *latus* (broad) part plate; III – narrow part plate; IV – true pelvis outlet; a – transversal dimension; b – longitudinal dimension.

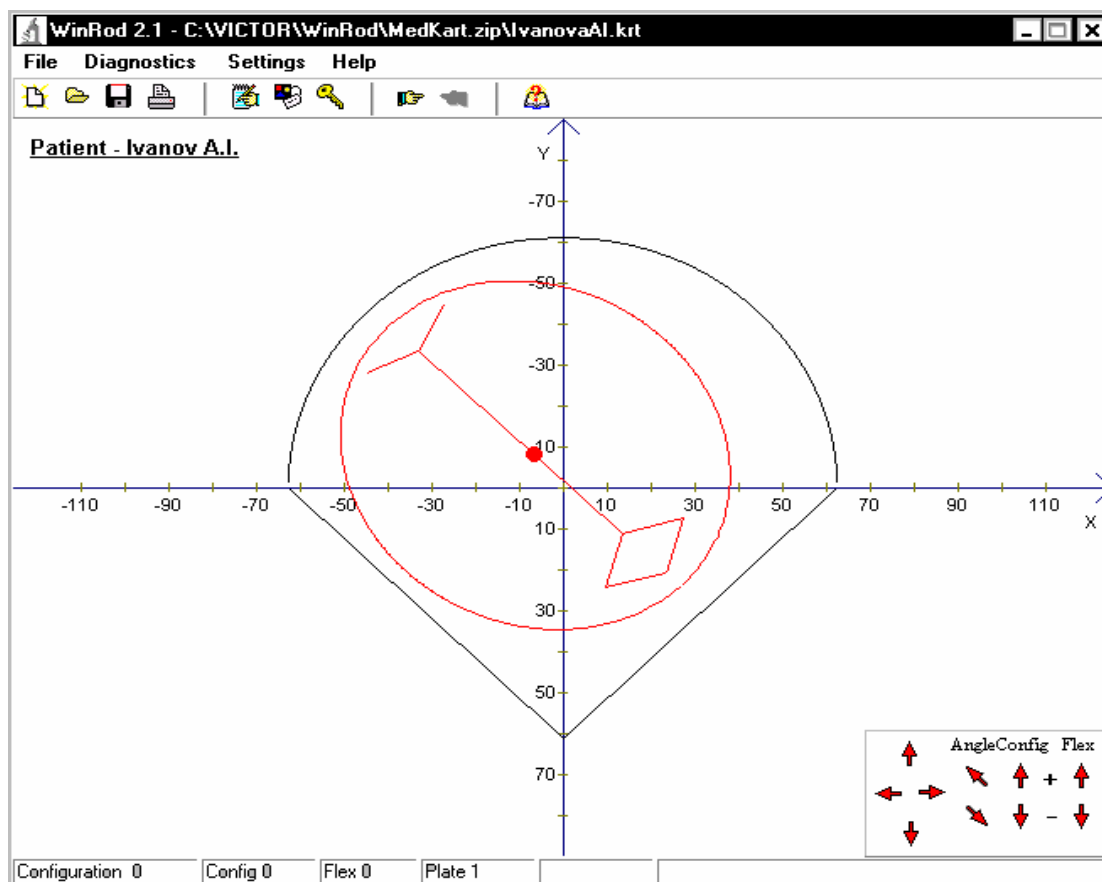


Fig. 2. The second stage: the fetus head passing through the generative passage (*latus* part plate).

It is evident that the high accuracy is necessary for prognosis of labor outcome, but we accumulate the errors when calculating the internal dimensions by the other internal ones. Therefore, the quantitative relations were derived from the mean-root-square method in the polynomial approximation form taking into account the couple, triple, etc. interplay of parameters.

The implementation of labor outcome prognosis by software

The dimensions of true pelvis are determined by the quantitative relations with the dimensions of false pelvis and anthropometry. On the basis of these data a forecast of fetus head passing through the generative passage is given (Problem B). The space of generative passage is simulated with four sequential obstetrical plates [3], as shown in Fig. 1. The dimensions of true pelvis according to its pelvis type (normal pelvis, flat pelvis, beaked pelvis, etc.) determine the parts of the simple figure dimensions representing the every plate. The head of fetus numerically projects on the sequentially positioned plates. The elliptical cross-section is applied to the corresponding plate. If an ellipse is inserted into the corresponding plate, then the head of fetus can be looked upon with a high probability as being passed through this plate.

The rotation, flexion and configuration of the fetus head can be assigned by a computer code. Thus, if we see the apparent impassing of the fetus head through a plate, it is possible to change the positions of ellipse axes. The decreasing of ellipse axis corresponds to the process of a change of configuration of the fetus head, i.e. it corresponds to the compression of the fetus head under the pelvis muscles contraction and reactions at the

In-patient Chart

Original data

Surname: Ivanov Date: 05.10.00

First name: Anna Time: 11:08:23

Patronymic: Ivanovna Birthyear: 1980

Starting measurement (completes by an obstetrician)

Distantii of false pelvis

Type of pelvis: Type1

Distantii of fetus head

Straight, mm: 90

Transversal, mm: 80

Circle, mm: 267

Flexion, deg: 5

Number of labors: 1

Stature, cm: 170

D.spinarum, mm: 38

D.cristarum, mm: 30

D.trochanterica, mm: 45

D.externa, mm: 40

Evaluational distantii of true pelvis

	Straight, mm	Transversal, mm	Area, mm ²	Configuration
I plate	122	120	7093	0
II plate	118	118	7250	0
III plate	100	122	6100	2
IV plate	114	122	6954	1

Computer analysis results

Configuration, mm: 2 Flexion, deg: 5

Tentative diagnosis: Norm

Obstetrician: Petrov Y.A.

OK Analysis Help Cancel

Fig. 3. The example of in-patient chart.

generative passage walls. The flexion allows to relate the maximum dimension of ellipse projection and the reference position of the fetus head into the pelvis *introitus*.

After the end of passing the fetus head through the all plates the in-patient chart is filled with obtained rate of compression. In-patient chart may be written in an archive (database) and it is possible to display or to print the chart according to patient's surname.

The software was developed for IBM-compatible computers. The usage of the software by an obstetrician requires the minimal skills.

Conclusions

The validation of the obtained relations and the method of prognosis are now making in maternity hospital. The authors hope that the proposed method would permit an obstetrician easy to make a prognosis for labor outcome.

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МЕТОДИКА КОМПЬЮТЕРНОГО ПРОГНОЗА РОДОВ

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В работе предлагается методика прогноза исхода родов. Прогноз осуществляется с помощью установленных методами корреляционного анализа статистически значимых количественных связей между наружными размерами большого таза, ростом женщины и внутренними размерами малого таза. Установлено, что известная в литературе «неясность и неоднозначность» таких связей обусловлена зависимостью части внутренних размеров таза только от последних. Количественные соотношения были получены методом наименьших квадратов в виде полиномов, учитывающих двойные, тройные и т.д. взаимодействия параметров. По полученным на основе статистической обработки размерам малого таза и известным размерам головки ребенка проводится прогноз прохождения плода через родовой канал. Объем канала моделируется четырьмя последовательными классическими сечениями (плоскостями). Разработано программное обеспечение, использующее как эти зависимости, так и размеры головки плода и позволяющее врачу-акушеру прогнозировать исход родов. Программным способом задается ротация, сгибание и конфигурация головки. После проведения головки через все сечения автоматически заполняется медицинская карта прогноза родов с полученной степенью сжатия головки (конфигурации). Медицинская карта может быть записана в архив (базу данных) и востребована по фамилии пациентки на экран или печать. Использование программы врачом или оператором требует минимальных навыков работы на компьютере.

Ключевые слова: акушерство, исход родов, размеры большого таза, внутренние размеры таза, статистически значимые связи, программное обеспечение

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