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Doctoral Thesis

DEVELOPMENTAL DYSPLASIA OF THE HIP SCREENING INSTRUCTIONS AND TREATMENT

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FOREWORD

DDH represents a condition of the hip of the infants which has triggered a lot of interest and controversy in the medical world ever since the times of Hippocrates. Even today this condition still represents a real challenge for the orthopaedic surgeons although identified in early stages by clinical screening and imagery. The primary healthcare of new-borns evolved over time, becoming complex and allowing the early detection and treatment of DDH during the neo-natal period.

The data from the scientific literature is vast and confusing mainly because of the various definitions, various methods of diagnosis (clinic examination, X-ray, ultrasound imagery or MRI), the various age of the examined population (new born, 1 month old, 3 months old, 6 months old) and studies conducted on different types of population. Nowadays the diagnosis and treatment of DDH is made according to the clinical expertise of the examiner, not having the possibility of quantifying the condition and inclusion in a treatment algorithm.

Due to the plasticity of the two components of the hip-femoral joint, the DDH identified at birth can be cured "restitutio ad integrum" if detected and treated in early stages. DDH diagnosis is currently performed at 6 months of age based on X-rays of the pelvis. Today, the early diagnosis based on ultrasound imagery of the hip is not sufficiently documented with respect to the treatment plan and there is no precise algorithm of treatment in new-borns.

Currently, the concept of preventive medicine emerges internationally having clinical applications in all medical specialties. Health cannot be conceived as a gift but as a result of the daily concerns of each individual and of the society to which they belong. Having a prophylactic health care approach in our medical thinking and actions will not suffice, it is necessary to convince people of the value and returns of prevention. Some companies, based on the studies conducted over long periods of time, concluded that prevention, as opposed to treatment, brings financial, moral, social and psychological benefits to the patient.

Over time this pathology has aroused the interest of orthopaedists, paediatricians and neonatologists and the development of medicine has allowed a better knowledge of the conditions for the appearance of the condition, of the forms of early detection and optimal treatment.

Due to the development of imagery, which allowed the investigation of the hip-femoral joint, the information about this condition keeps on updating which is why the

medical community organizes frequently congresses and conferences for the guidance of the medical staff.

II. The hip joint

- Embryology of hip joint Over time the medical community has tried to correlate a specific pathology with the embryonic development of the foetus. The importance of embryological studies derives from the fact that they provide essential information for the development of health care strategies leading to better results. The factors acting in the prenatal period have numerous short term and long term health effects.

- Anatomy of hip joint It is a typical spheroid joint with great importance in statics and locomotion. It corresponds topographically to the gluteal region, limited in the upper part by the superior iliac crest, in the inferior part by the gluteal crease, laterally by the vertical lowered through the anterior superior iliac spine and it reaches medially the buttocks crease.

  The joint areas are the following:

  - The femoral head;
  - The acetabulum, having at its level the crescentic articular surface and the acetabular fossa.

  Because in the pathogenesis of DDH the femoral neck and anatomic shaft of the femur play an important role, the anatomical of the upper end of the femur is also presented.

- Biomechanics of the hip joint At the level of the hip-femoral joint the following movements can be performed:

  - Flexion extension;
  - Abduction – adduction;
  - Circular;
  - Internal –external rotation.

III. Hip dysplasia

- Definition: – The developmental dysplasia of the hip includes a large range of abnormalities of the hip joint, starting from the simple acetabulum dysplasia with hyper-laxity of ligaments to the full dislocation of the femur head out of the acetabulum and outside of the abnormally developed acetabular cup.

- Incidence – In Romania the incidence of hip dysplasia is unknown. Both the neonatologist and the GP perform a routine clinical screening, but the clinical examination is often inconclusive. Not knowing the incidence of DDH one cannot understand the magnitude of the problem. The only reference of DDH incidence in Romania in the scientific literature is 1‰ in North-western Transylvania but the year of the study is not stated.

- Aetiopathogeny – The development dysplasia of the hip (DDH) is a multifactorial disease whose aetiology is yet to be specified. Several etiological theories have been developed over time; some have been disproved while others fail to explain completely the DDH changes.

- Pathologic anatomy – The stimulus for the normal development of the acetabulum is the pressure of the femoral head on the articular cartilage and, vice versa, the development of the femoral head is conditioned by its inclusion in the acetabular cup. The moment the contact between the two elements is lost, the development becomes not only poor but there are also modifications to the adjacent structures: capsule, tendons and muscles. The severity of the condition varies depending on the time at which the luxation occurred (an old dislocation will show severe pathological changes, difficult to correct), on the type of dysplasia and associated malformations.

- Clinical picture – The clinical picture for the new-borns and infants is poor; it often happens that the diagnosis is based on the experience of the examining doctor as well as on the environmental factors during the clinical examination of the patient. Symptoms vary according to the age of the patient, type of injury (dislocated hip, luxated, sub-luxated), the time at which the dislocation happened and of the associated pathology. The foundation of the clinical examination of the new-born is the Ortolani manoeuvre and the Barlow test. These manoeuvres are also the basis of the clinical screening in detecting DDH.

- Paraclinical investigations

- X-ray of the pelvis – the x-ray symptoms vary according to the growth nucleus. For new-borns the x-ray presents little and imprecise elements because the bone tale-tale elements are not well distinguished. The minimum age, at which x-ray can provide the required elements in order to diagnose DDH, is 6 weeks;
- Ultrasound imagery –it has become more and more used in paraclinical investigation. The hip of new-borns and infants of max 6 months old (according to some authors) or of 3-4 months old (as per others) can be better investigated by using ultrasounds imagery rather than x-rays because of the existence of cartilage, both at the level of the acetabulum and of the femoral head;
- Arthrography;
- CT;
- MRI.

- Treatment The goal of the treatment is to recreate the normal articular connections until all adaptive modifications disappear. The early reduction of the hip dysplasia will lead to a shortened treatment with "restitutio ad integrum" based on the capacity of the acetabular cup to reshape itself in the first three month of life. Delayed treatment will cause a satisfactory connection between the acetabulum cup and the hip but the mobility will be reduced.

There are two objectives of the treatment of hip dysplasia:

1. The reduction of the femoral head in the acetabulum
2. Maintaining this reduction until all adaptive modifications between the acetabulum and femoral head disappear.

Due to the progressive potential of the pathology and of the articular and periarticular changes, treatment differs according to the age of the patient and type of dysplasia.

- Sequelae and prognosis DDH pathology has an unpredictable evolution and the orthopaedic surgical treatment may lead to major sequelae.

SPECIAL PART

1. Objectives of the study

The study is aimed at making a retrospective study on new-borns and infants and analysing the hip joint both clinically and with ultrasound imagery at the level of Galati County, wherever possible to take the ultrasounds imagery of the hip. Period of the study: 2009 – 2014. It will cover the following:

- The optimal method of early detection;
- The importance and frequency of risk factors;
- Creating a diagnostic algorithm;
- Clinical and para-clinical evaluation of patients detected with DDH;
- Evaluating the type of treatment applied;
- Clinical monitoring and imagery of patients with DDH during treatment;
- Evaluating the therapeutic efficacy of the treatment;
- Establishing an algorithm of early diagnosis, specific to the socio-economic conditions of our country;
- Establish a treatment algorithm for patients detected with DDH;
- Identifying the best way to inform patients and doctors about DDH;
- Creating DDH worksheets which should contain all the necessary elements for the identification of DDH, accessible to physicians, regardless of their specialty.

II. Materials and method

A retrospective study of the patients diagnosed and treated for DDH was created. During the period of January 2009 – December 2014 a total number of 673 patients addressed the ambulatory care within the Emergency Hospital for Children "Sf. Ioan" with the suspicion of DDH. All the patients were examined against the DDH worksheet.

The following patients were excluded: patients displaying neurological conditions (15), central motor impaired (23), displaying arthrogryposis (2), patients whose worksheet was incomplete (72) and whose age was over 6 months when having their 1st hip examination (52).

All infants with the age below 6 months were included in the study, infants who were having their 1st orthopaedic hip examination (509).

The DDH worksheet contains the patient and mother's identification data, the perinatal data about the foetus position or postnatal events, the pathological elements identified during the clinical examination as well as the result of the dynamic ultrasounds and type of administered treatment.

The clinical examination was conducted by me and the ultrasounds by the same doctor 7 days after the initial examination. For the study I used the Graf static ultrasounds method, I followed in sequence all the steps described in the original technique. For the ultrasounds I

used the Aloka Prosound α7 ultrasounds machine, having iDMS (intelligent Data Management System) software installed, with the possibility of adjusting the image in the cranio-caudal position and adjusting the penetration distance of the ultrasounds (useful for patients with macrosomia or for those with high level of body fat), Graf automatic measurement software of angles for the Graf classification method. The system is endowed with a 7.5 MHz linear probe, image freeze pedal and Mitsubishi thermal paper printer. I used the lateral hip examination tool as well as the ultrasounds probe fastening device.

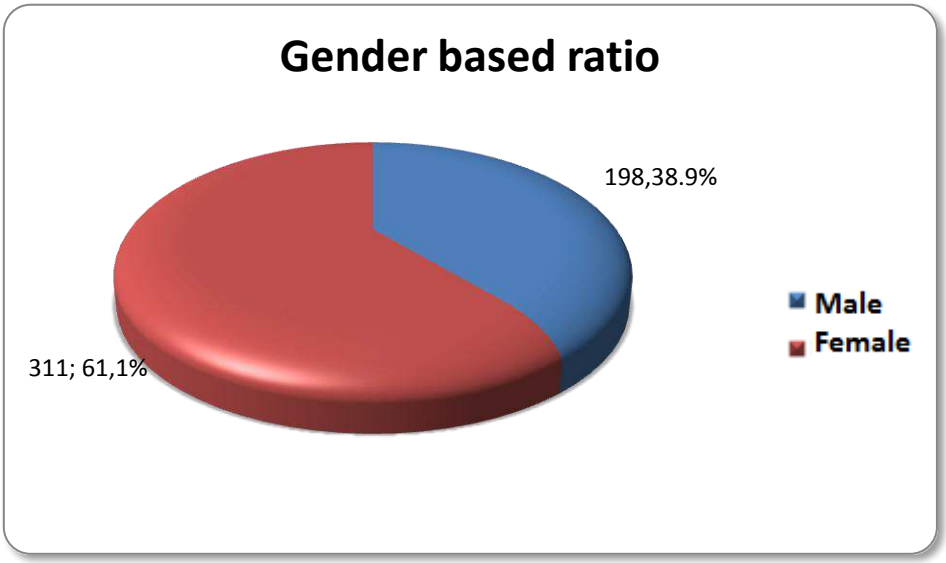
III. Results

The results were split in three categories:

- The influence of the perinatal factors in the occurrence of DDH;
- The influence of risk factors in the DDH diagnosis;
- The statistical analysis of the clinical and ultrasound elements.

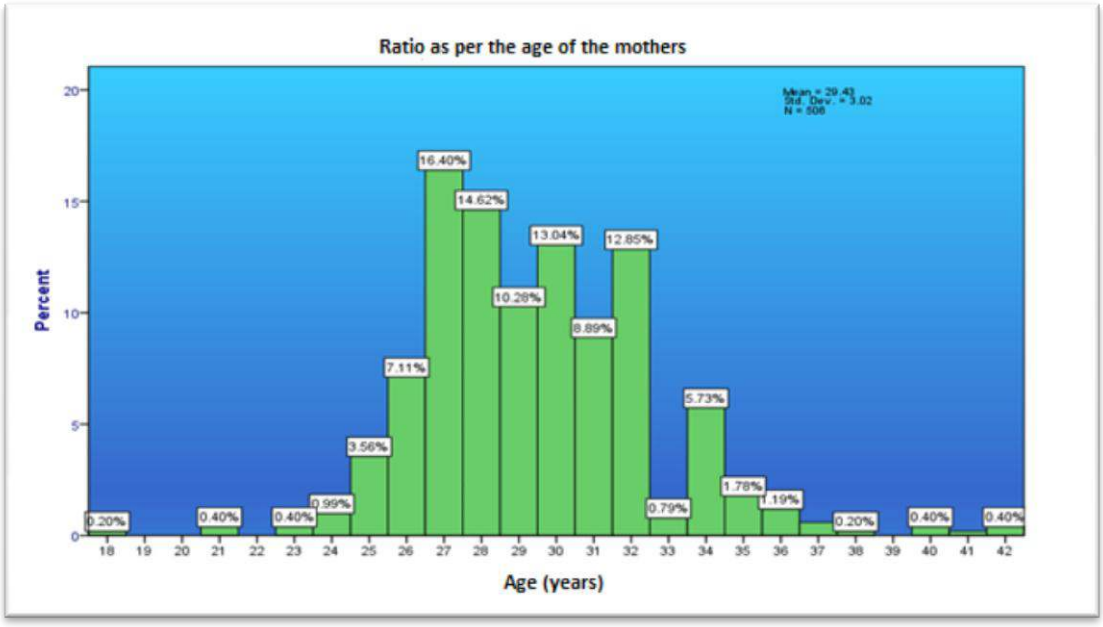
As far as the first batch of results, the study was oriented around finding a correlation between the occurrence of DDH and the perinatal elements. Consequently, I tried to show for the respective lot the presence of cause-effect elements between DDH and the following:

- Gender – It is well known that females are more prone to have this condition out of the examined batch one could see a difference in the rate between females and males with DDH



Pic. 49 – gender based ratio

- Origins – I think that the origins and the high percentage of patients coming from the urban area are the result of easy access to information, a better relationship with the GP and a better knowledge level of the parents.
- Age of the mother – The prevalent age group of mothers is in the range of 27-32.

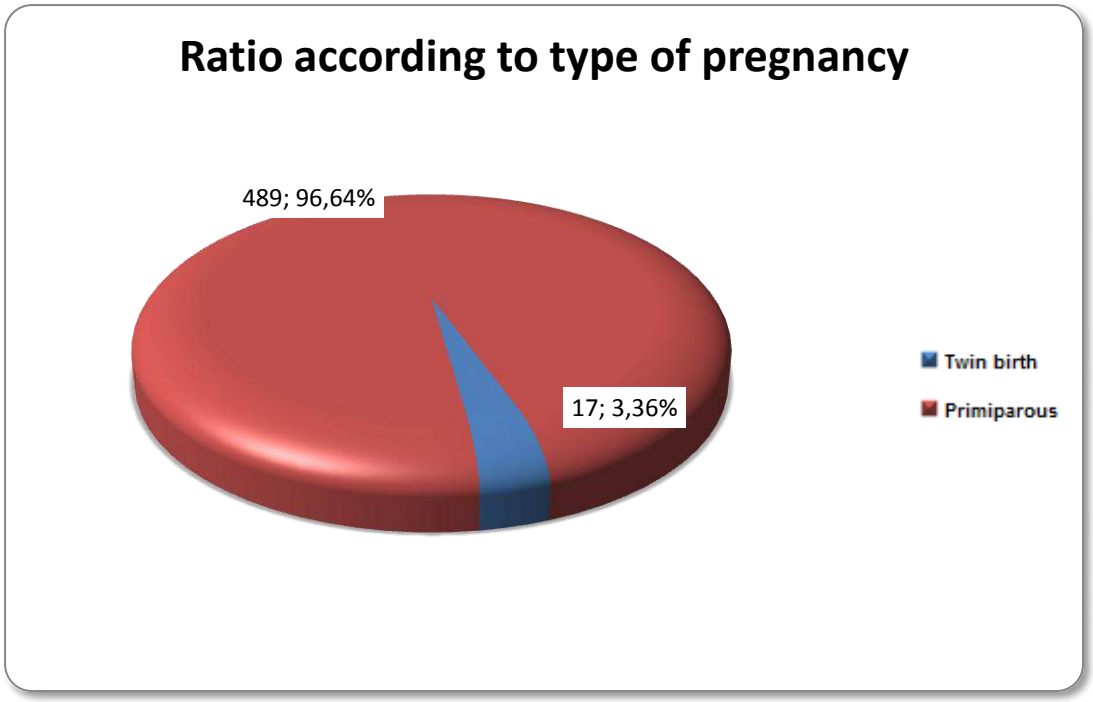


Pic. 53 – Ratio as per the age of the mothers

- Parity
- Number of births

The education level of the mother – although the education level of the mother cannot influence the DDH aetiology, it describes the image of the family environment of the DDH patient. A family with high education will not ignore the manifestation of a clinical sign and they will come to the specialist for a re-examination thus speeding up the diagnosis and treatment process.We can conclude based on the lot under study that the education level may become an important factor in the identification of DDH, and the natural evolution of the condition can be improved by the sheer vigilance of the caregivers. Given the above, one may say that DDH is "**the disease of ignorance**".

- Type of pregnancy – Multiple pregnancies can influence the pathogeny of DDH. The pathogenic mechanism is described by insufficient space in the uterus a factor which leads to abnormal mechanical pressure on the hip joint.

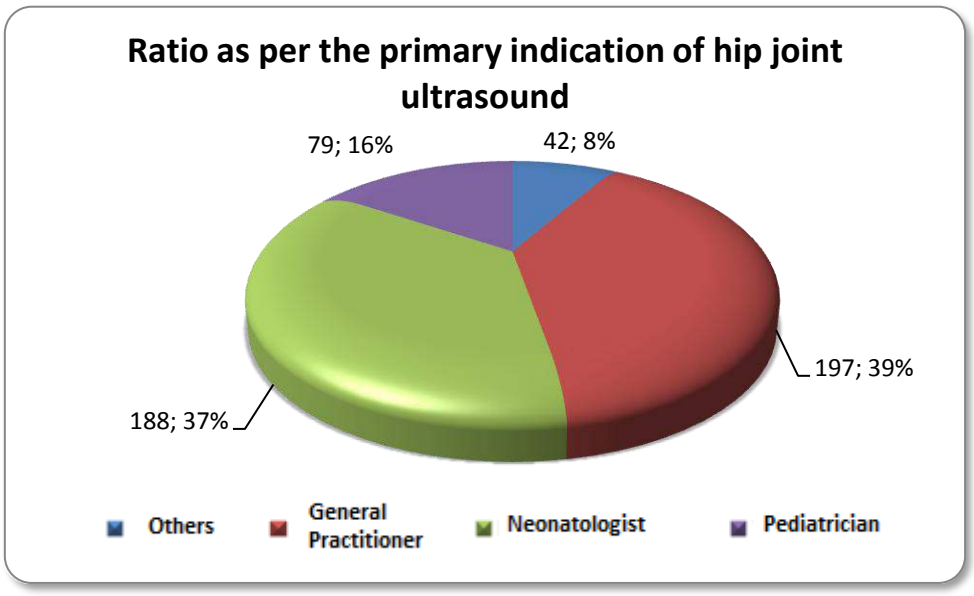


Pic. 59 – Ratio according to type of pregnancy

- Type of fertilisation
- Foetus presentation at 8 moths
- Foetus presentation at birth
- For 450 cases the presentation of the foetus at birth was "head first" (88,4 %), breech presentation for 54 cases (10,6 %) and shoulder presentation for 5 cases (1%);
- Administered medication
- Gestation age
- Weight at birth – Out the studied lot the weight at birth was around 3374.21 grams and an average of 3400 grams; most of the patients were in the range of 3000-4000 grams, 5.73% in the range of 4000-4500 grams and 1.78% in the range of 4500-5000.
- Size – Out of the studied lot the size at birth was around 50.4 cm with an average of 50 cm, having an even distribution in the range of 48-54 cm, with the minimum value of 46 cm for 0,2% cases and ma maximum value of 56 cm for 0,2% of the cases;
- The Apgar score – The Apgar score cannot influence the pathogeny and the natural evolution of the condition but it can imply the existence of congenital malformations.
- Type of birth

The primary indication of ultrasound – this type of analysis highlights that the neonatologist and the GP are the first specialists who analyse the orthopaedic status of the new-born. These specialties initiated in 78% of the cases the orthopaedic examination and

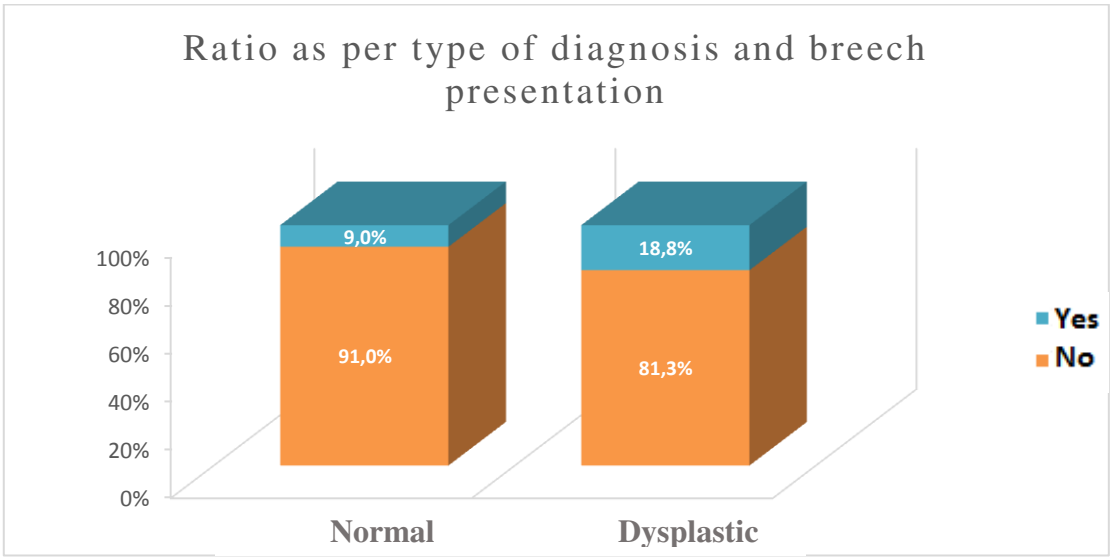
their identification enables the creation and the management of a DDH screening program. A large percentage is also represented by other sources of information of the parents (internet, magazines and social gatherings).



Pic. 71 – Ratio as per the primary indication of hip joint ultrasound

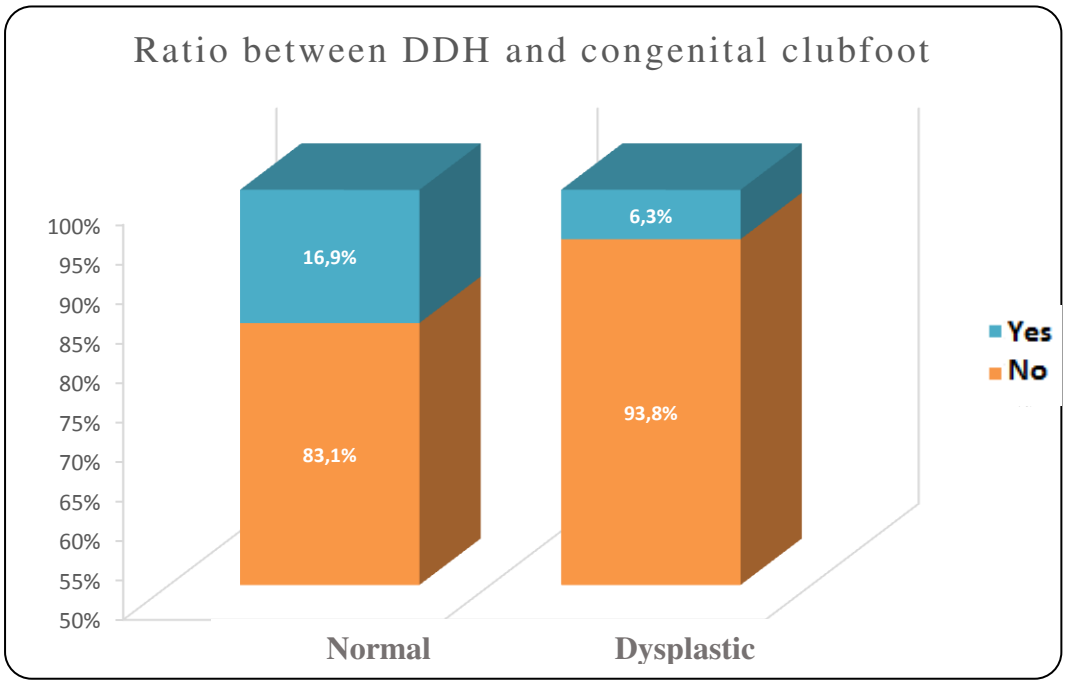
The second batch indicates the influence of the risk factors in the early detection of DDH:

- Family history
- Breech presentation – based on the statistical and literature data I think that the breech presentation must be considered a **major risk factor** in the occurrence of DDH.



Pic. 74 – Ratio as per type of diagnosis and breech presentation

- Oligohydramnios – In the studied lot there were no DDH patients displaying oligohydramnios.
- Hypertension of the mother
- Intrauterine foetus development delay – it does not favour DDH but the neurological changes, secondary to prematurity, lead to DDH.
- Primiparous or twin birth – out of the studied lot I did not highlight with statistical data a correlation between the dysplasia of the hip and primiparous or twin birth;
- Big weight at birth – the new-born with macrosomia is considered to be a risk factor of the occurrence of DDH
- Congenital Clubfoot – although the number of DDH patients presenting congenital clubfoot out of the studied lot was not big, the statistical association between the two pathologies is significant and in accordance with the information from the literature.



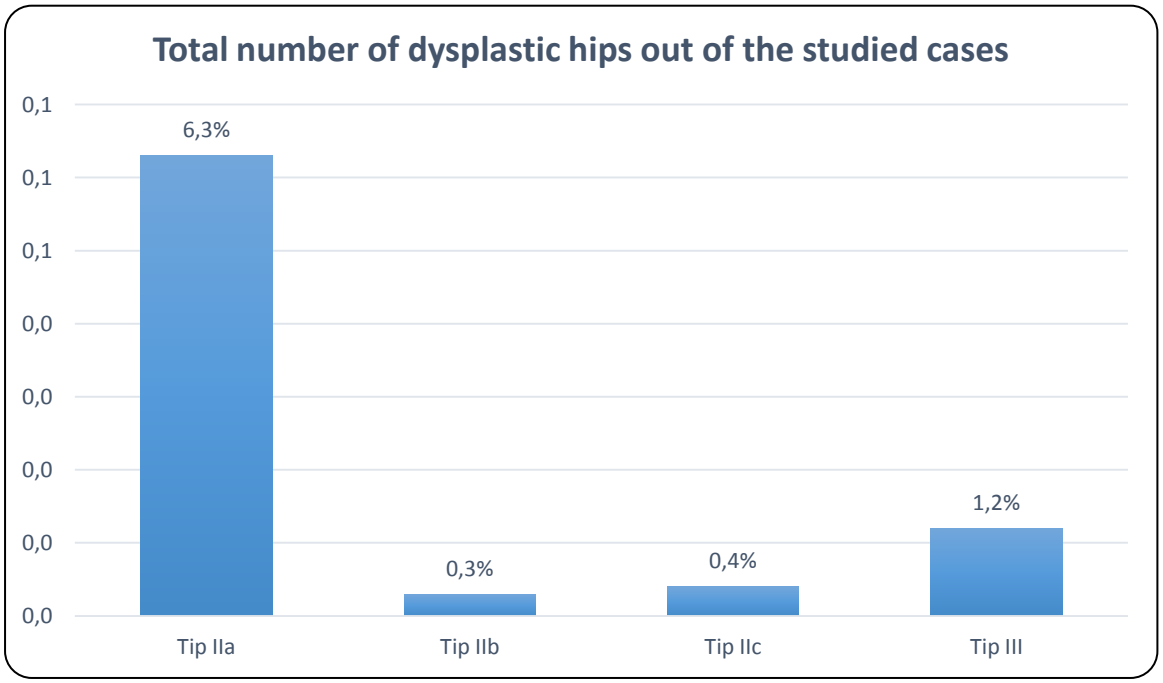
Pic. 81 Ratio between DDH and congenital clubfoot

- Torticollis
- Limitation of abduction
- Tonus disorders
- Feminine gender
- Geographical area and ethnicity

- Number of risk factors – for each patient I also counted the number of risk factors and I tried to highlight the correlation between this number and the risk of developing DDH.

The last section of the results I performed a statistical analysis the types of ultrasounds imagery and treatment administered to the patients.

- Age of the patient during the orthopaedic examination – The age at which the orthopaedic examination took place for children diagnosed with DDH is significantly lower than in healthy children.
- Magnitude of abduction during examination – the bigger the level of the damage, evaluated by ultrasounds, the smaller the average magnitude of abduction is.
- Ortolani and Barlow manoeuvre - the regular results showed that clinical screening is not effective in detecting DDH and it gives false-negative results.
- Asymmetric folds of the adductors
- Ultrasounds type



Pic. 91 Total number of dysplastic hips out of the studied cases

- Type of treatment - 65 hips was treated orthopedically by immobilization in a cast and abduction machine.
- X-ray examination – In the studied lot I used x-rays as the paraclinic examination method only for children over 6 months old.

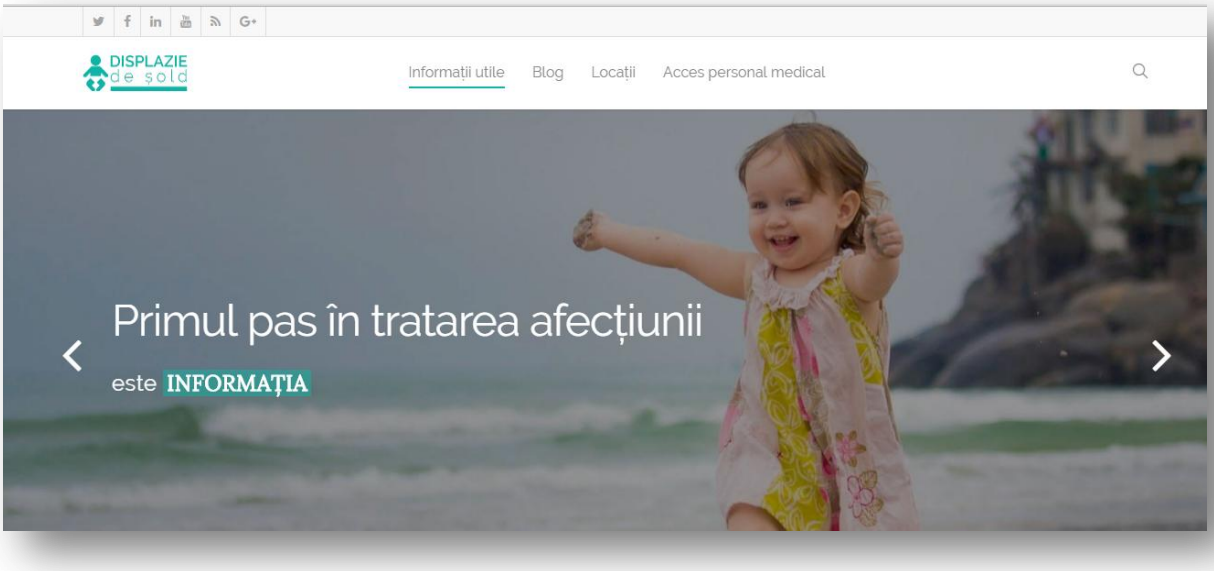
IV. Algorithm for early detection and treatment

Clinical screening for the detection of DDH is part of the routine clinical examination of new-borns performed by neonatologists in maternity. This is repeated every 2-3 weeks by the GP when the new-born is introduced in the health care system. But the effectiveness of the clinical screening was discredited over time because of the high percentage of false-negative results. Due to multiple clinical forms (dysplastic hip, subluxated, luxated, unstable), clinical screening is not only inefficient but also risky.

Introducing hip ultrasound imagery examination as a method of early detection initially increased the incidence of DDH by detecting and classifying the physiologically immature hip as dysplastic. This is why it was decided that the optimal age to perform ultrasound imagery examination should be 4-6 weeks.

V. Practical application

In the 21st century, technology has become part of our lives and we must accept this as a fact. In an attempt to assist parents and physicians interested in this pathology I purchased a web domain and I called it www.displaziedesold.ro . I chose this name because it reflects the information contained by the site.



Pic. 98 – Site Screen shot

The site addresses both the parents, by providing data about this pathology, describing it in plain language without medical terms, as well as the doctors, by granting them access to

the DDH worksheet, the algorithm for diagnosis and treatment as well as an information section about conferences and lectures on hip dysplasia.

VI. Clinical cases

In this chapter I exemplified with pictures the detection and three cases in various stages of evolution of the condition.

VII. Conclusions

- Mastering the correct technique of ultrasound examination in compliance with technical indications described by Graf, decreases the number of unusable ultrasounds and increases the quality of the examination, but failing to comply with the technique increases the number of incorrect examinations with ambiguous results, decreasing the confidence of the population in this method based on unjustified, unscientific facts.
- The clinical screening is insufficient in the early detection of DDH, only the dynamic clinic screening may increase the sensibility of this examination but it delays treatment and creates bottlenecks in the Ambulatory Care Service.
- I have grouped the risk factors, resulting from the study, on two categories: major risk factors (breech presentation, feminine gender, abduction limitation, congenital clubfeet) and minor (oligohydramnios, torticollis, big weight at birth, mother‘s HTN condition, ethnicity).
- The total number of risk factors does not influence the occurrence of DDH by comparison to each singular factor.
- The ultrasounds examination must be performed in the first two weeks for patients with major risk factors and at 4-6 weeks for the rest, thus optimizing treatment and shortening its period.
- The type of abduction device does not influence the treatment period, choosing one type of immobilisation based on the experience of each doctor, by the level of involvement of each family and level of tolerance of the patient.
- DDH is a condition which can be cured “restitutio ad integrum” constituting a pathology which can classify for the screening programs but ultrasound imagery of the hip represents the selection method for the early detection.

- The need to develop a national training program for the medical staff in the hip ultrasound technique which should lay the foundation of a future screening program.
- Creating a national database with the capitalisation of the results will allow a national evaluation of the incidence and the development of a screening strategy and treatment appropriate to the socio-economic realities of our country.

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