



Musculoskeletal normal variations of the lower limb - the main cause of inappropriate referrals to the pediatric orthopedic surgical clinic; a clinical and questionnaire-based survey

**A dissertation for the degree of PhD
RESUME**

Supervisor Professor
Răducu Nicolae Nemeș
MD, PHD. Department of Surgery

PhD Student
Safwan. M. Bourgleh
MBBS, MSc

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1. INTRODUCTION

Musculoskeletal symptoms are world widely one of the leading causes of visits to primary care doctors and such visits are on the increase, being the most frequent reason for visits to the outpatient departments all over the world [1-4].

Normal variants of the musculoskeletal system of the lower limb form an important part of the secondary care referrals; many children who are referred to orthopedic clinics are normal and have no specific disease or deformity. They are referred with a variation of normality such as flexible flat foot, in toeing, bow legs [5]. Maloney et al. reported that “half of all new referrals to their pediatric orthopedic clinic were children with normal variants of lower limb development” [6-7].

Working as an orthopedic surgeon for 12 years and 5 before years as a resident I could also noticed, as in the literature that the musculoskeletal normal variations of the lower limb represent more than 30% from inappropriate referrals to the outpatient services of the pediatric orthopedic clinics, unnecessarily loading the activity of the service, being resource consuming even dangerous for children due to the unnecessary investigations needed for diagnosis. Considering it as a public health problem I decided to choose as the subject of my PhD thesis the musculoskeletal normal variations of the lower limb as anatomo-clinical entity, the way it is perceived by the doctors belonging to the primary care system (pediatricians, family physicians and general practitioners) and to detect the main causes of their inappropriate referral to the orthopedic surgeons.

2. THE CURRENT STATE OF KNOWLEDGE

This chapter is designate to make a review of the classic and most recent literature data regarding the common musculoskeletal normal variations of the lower limb (in-toeing gait, bow legs and flexible flat foot), serving as a theoretical basis for personal research.

3. PERSONAL CONTRIBUTION

3.1. WORK HYPOTHESIS, GENERAL OBJECTIVES AND RESEARCH METHODOLOGY

Working as an orthopedic surgeon for 12 years and 5 before years as a resident I could noticed, according to the literature, that the musculoskeletal normal variations of the lower limb represent more than 30% from inappropriate referrals to the outpatient services of pediatric orthopedic clinics, unnecessarily loading the activity of these services, being resource consuming and even dangerous for children due to the unnecessary investigations needed for diagnosis. Starting from this finding I approached this topic trying to clarify both the aspects regarding MSKNV of lower limb as an anatomico-clinical entity and the way those are perceived by the doctors belonging to the primary care system (pediatricians, family physicians and general practitioners), in order to detect the main causes of their inappropriate referral to the orthopedic surgeons.

The main objectives of thesis were:

- To establish the prevalence of MSK normal variations of lower limb among the total number of cases with MSK pathology, which were referred to a private orthopedic clinic in Jeddah, Saudi Arabia in a determined period of time (2011-2016) and to study their clinic and therapeutic aspects, that must be known to avoid inappropriate referrals that overload the activity of ambulatory pediatric orthopedic services.
- To study the physicians' reasons for referral to orthopedic surgery, to explore associations between these reasons and patient, physicians, and health care characteristics.
- To study and identify the knowledge deficits and misconceptions which will help the teaching physicians, or national societies in directing efforts to change behavior and ultimately improve patient care and outcomes.
- To find out the reasons of inappropriate referrals to the pediatric orthopedic surgeon.
- To assess the factors that might affect the doctor knowledge, such as current position, place of training or previous experience, in an attempt to identify areas that could be improved in under/post graduate training programs of pediatrics and family medicine, to help for the care of children.
- To study the objective findings in pediatric orthopedic clinic, and to match these findings with the physicians' perception regarding pediatric orthopedic complaints and their referral decision.

For realizing the proposed objectives mentioned above, we performed two distinct studies:

1. A retrospective clinical study, performed upon 764 MSK normal variations of the lower limb, selected from 2,321 patients who visited a private orthopedic clinic in Jeddah, Saudi Arabia (4,753 visits), during a six years period (2011- 2016), designed to evaluate the prevalence of MSKNV of lower limb among the patients referred to orthopedic clinic, and to study their main epidemiologic, clinic and therapeutic characteristics in such a way that we can establish a correct general behavior towards them, which will prevent the overloading of the

specialized clinics, but at the same time ensure the correct diagnosis in a timely manner of the cases that may evolve or are already pathological and require specialized treatment. Inclusion criteria were: age less than 12 years and musculoskeletal evaluation requested by the family, the patient or referral from another physician

2. A questionnaire based survey (study), addressed to the physicians belonging to the primary health care (pediatricians, family physicians and general practitioners), designed to collect data regarding factors which lead to inappropriate referrals of the MSK normal variation of the lower limb to the pediatric orthopedic specialist, in an attempt to identify areas that could be improved in clinical practice. This investigation involved factors depending on the doctors (misconception and knowledge deficits about MSK normal variations due to the lack of training both during the university studies and after graduation, poor previous experience, etc.), the patients and their families and on the health system.

The study was performed on a number of 189 physicians who provide primary health care (pediatricians, family doctors and general practitioners), with different professional degree (consultants, specialists or residents).

An original questionnaire consisting of 14 questions divided into 2 sections was used; first section was designed to investigate the professional background of the participants (specialty, professional degree, university graduates, courses or postgraduate training courses, etc.) while the second section was designed to assess the level of knowledge regarding the main form MSK normal variations of the lower limb (in-toeing gait, bow legs and flexible flat foot).

Knowledge questions were scored in the way that right answers were given a score of “1”, whereas wrong or don’t know answers were given a score of “0”. Total score and its percentage were computed, an adequate level of knowledge means a rate of correct answers of over 70% to all 13 questions, each question representing 7.7%; and then we came up with 3 categories of results:

- inadequate knowledge level <50%
- medium level: 50-70%
- adequate level: 70-100%

3.2. RESULTS AND DISCUSSIONS

3.2.1. DISCUSSION OF THE MAIN RESULTS OF CLINICAL STUDY

According to the literature, our study revealed that almost one third (764) of all patients (2,321) referred to the ambulatory department of Jeddah Pediatric Orthopedic Clinic in a six years period, were MSKNV, with a prevalence rate of 32.9%.

Both sexes are affected equally, even if some studies including ours reported (63.4% girls vs 36.6% boys, with a sex ratio of 0.69) a prevalence of girls [65]. There are also some differences regarding the association between sex and MSKNV types; in most literature there is insignificance gender distribution in knee variations [7] which is almost the same in our results (23.5% boys and 24.3% girls). It is reported that occurrence of flat feet is more frequent in boys

than girls [80]. Other studies reported higher percentage prevalence among females than in males [81,82] which is in agreement with the result of the current study. The incidence of severe flat foot is higher in females too. One explanation for the higher incidence of flat foot in females could be the greater laxity of their joints.

Including patients aged between birth and 12 years, our study revealed that the average age of the patients with MSKNV at the first visit was of 4.2 ± 3.6 years, about two third of them belonging to the patients younger than 4 years; we also noticed that the average age of the patients with MSKNV was different depending on the MSKNV type. The mean age of presentation for in toeing was 3.8 years which is consistent with previous studies, showing that the maximum of incidence presentation is between mainly 3 to 4 years of age. In cases of normal variations of the knee, usually from birth to roughly 18 months of age, there is a normal "Varus" stage of development in which bowed legs persist. From 24 months onward, children normally will enter a stage of increasing valgus at the knees and this generally will persist until adolescence [10]. In our study the mean age of this condition was 2.3 years.

The diagnosis was established by a thorough clinical examination of the patients, carried out according to the classical methodology including natural history, physical examination and laboratory tests. Some important findings were revealed to us by the clinical study. First of all, except for the traumas, the age of the first visit is not similar to the onset age of the MSK disorders or disease, even though they are present at birth in the most of cases. The mean age of the first visit was 4.2 ± 3.6 years for the children with MSKNV and 5.7 ± 3.8 years for the rest of cases in the entire study group. The following explanation of this delay between the real onset and the establishing of diagnosis could be: either these MSKNV do not become clinically evident before the age of the walk or even the child's entry into the school communities (kindergarten or even school), or the parents do not pay attention to the first signs, minor at first, but which become obvious only after their impairment to some extent. Three main groups of symptoms, isolated or associated making up the clinical picture of the MSKNV paid attention to the parents and determined the physicians to refer patients to the pediatric orthopedic surgeon: pain due to trauma or without trauma, abnormal gait and deformities of the MSK system.

X-ray examination was the most common imaging test, performed in 42.9% (934) of cases that can be considered within the reasonable limits, especially taking into account that 475 cases were trauma, where X-ray examination is mandatory. But, comparing the weight of the X-ray examination between the entire studied group (2,321 cases) and those performed in the MSKNV group (764 cases), we noticed that X-ray test was requested by the pediatric orthopedic specialist in 63.7% of the patients with MSKNV (52% of the total radiological examinations requested), which is actually an over investigation which must be addressed, beside cost issues inappropriate imaging, unnecessarily exposes patients to excessive radiation, inconvenience, and actual harms that come from the cascade of diagnostic and therapeutic interventions that often follow identification of a lesion that proves only to be an incidental [83]. At the first sight such over investigation seems to be at least weird as the first visit in the ambulatory department was performed by the well trained pediatric orthopedic specialists. The only explanation that could stand is the existence of a large amount of cases where the limit between normal MSK variation and those turned to pathological were very close, and the X-ray was considered necessary for having a much more certain diagnosis and for the establishing of the most proper therapeutic plan.

The lesion structure of the studied group, based on the final diagnosis of each patient, show that the MSKNV (764 cases) represented 32.9% of the total clinical visits performed in

the ambulatory of the Jeddah Pediatric Orthopedic Clinic between 2011 and 2016, in toeing gait being the most frequent type, followed in order by flexible flat foot and knee varus or valgus. Regarding the pathologic aspects of the MSK system, trauma was the most frequent entity, followed in order by cerebral palsy, developmental hip dysplasia, scoliosis, club foot and oteocondritis; we also registered an important number of pathological circumstances (413 cases), labeled by us as "other than previous" in which are included postural deformities, congenital deformities, developmental deformities and lesions, etc., and another group of 118 patients within the normal limits, without any pathological findings, in 90 cases with no complain since beginning except an orthopedic checking was strongly requested by the parents, either because they could not be convinced by the pediatrician that their child has not any musculoskeletal problems, or because of the other reasons like the presence of orthopedic problems in their family history, the remaining 28 cases of this group came with pathological suspicion but the examination showed normal examination.

Most cases of MSKNV (737=96.5%) were considered within the limits of normal variations of the lower limb musculoskeletal system, while only 27 (3.5%) cases turned out to be pathological ones. There were no significant differences neither in the distribution of the main clinical forms of MSKNV (in toeing gait was the most frequent type, followed in order by flexible flat foot and knee varus or valgus), nor in the distribution of the main types of MSKNV turned to pathological.

Only 5.8 % of the knee variations were pathological, which is in agreement of other study [84]. The most common form of pathologic bow legs is Blount's disease, also known as tibia vara, which must be differentiated from physiologic genu varum [38, 40, 42]. Variables such as walking age, race, weight, and gender have been suggested as risk factors for Blount's disease, they have not been useful in differentiating between Blount's pathology and physiologic genu varum [85, 86]. 2.5 % of in toeing were pathological and needs surgical correction. Our findings were in line with a previous study [87, 88]. 4.12 % of flat foot did not resolved and not improved during follow-up, required surgical intervention, findings were in agreement with a previous study [89, 80].

Total visits number performed for MSKNV were 1,083; 17 % had 2 visits and 7.7% were seen more than 3 times, while 75.3 % showed once only. Most cases do not require any follow-up as it is benign normal variations (85.7%). In 10.7% of the cases the follow-up was not required but the patient came! High number of follow-up in our study could be due to the fact that the treating clinician did not reassure and educate the families of these children well, or may be a regular review required as it is the practice in some clinics. Regular review is detrimental as it serves to reinforce that the child with a normal variant has an abnormality [7].

Regarding the appropriateness of the referral, we have to mention that there are a lot of things that can be taking into account about the appropriateness of the referrals. Starting from the classic definition that considers an appropriate referral to the pediatric orthopedic surgery as meaning the musculoskeletal medical condition which cannot be managed by the general practitioner, the family physician, the pediatrician or even the general orthopedic surgeon, we can see that, according to this definition, a lot of medical consultation can be framed as inappropriate, since most of the cases, even that needing treatment like trauma (ligament injury or some kind of fracture) or oteocondritis, could be easily managed without referral to the pediatric orthopedic surgeon. But taking into account the moral and medico-legal responsibility in case of an unfavorable evolution of the patients, my opinion is that the referrals of the traumatic lesion of the bones, joints or ligaments, even minor, to the pediatric orthopedic

specialist have not to be considered as inappropriate in no way, but on the contrary a gesture of medical responsibility.

On the other hand, there are a large number of wrong referrals, like patient with rheumatoid arthritis or patient with congenital deformity which must be referred to another specialty, like chest wall deformity, all these wrong referrals considered as inappropriate. Even in these cases, both these patients have to be referred to an appropriate specialist, not to the orthopedist, so that, actually not the referral is wrong but the addressee, which is another discussion regarding to the training level of the primary health system staff.

But here, referring strictly to the structure of our studied group of patients (2,321 cases) we registered 882 inappropriate referrals with an inappropriate referrals rate of 38 %.(Graphic 4.11) The other important thing we have noticed was that the most inappropriate referrals were MSKNV (764 = 86.62) and that was the reason for the next part of our research in which, using a questionnaire based survey method, we tried to find out the main causes of the inappropriate referrals and to show the way to improve this.

3.2.2. DISCUSSION OF THE RESULTS OF THE QUESTIONNAIRE BASED SURVEY

It is well known that the inappropriate referrals lead to a large consumption of time and pediatric orthopedic resources, which results in delay of referral of more appropriate patients. Starting from this statement, confirmed by the data of our clinical study, which revealed that during a six year period (2011-2016) a number of 882 (38%) inappropriate referrals were registered in Jeddah Pediatric Orthopedic Clinic, we tried to find out the main causes behind these inappropriate referrals by a questionnaire-based survey focused on the NMSKV, which provided 82.6% (764) of the inappropriate referrals.

The GPs' and family physicians' and even pediatricians' gatekeeper role is challenging, and the increasing referral rates suggest a poorer gate that keeps functioning by them [91, 92], but the complete reasons for the increasing referral rates are complex and not fully understood [93].

In our study we tried to find out the main causes that could be compromising the gatekeeper role for GPs and family physicians, and generally speaking we can tell that the inadequate knowledge regarding three common orthopedic pediatric problems is the main cause of the high inappropriate referrals, that can be more or less influenced by several nonmedical factors, the express request of the parents and the fear from forensic consequences being the most common.

The inadequate knowledge regarding the three common pediatric orthopedic problems regardless of the specialty or professional degree turned out to be the main cause of the high inappropriate referral as the results of our study showed. In the survey, we found a positive association between physicians' referral rates and referring due to inadequate MSK knowledge, or medical uncertainty. The results revealed a presumably reduced tolerance for medical uncertainty among high referrers.

Risk and uncertainty are a part of life, and medical uncertainty is inherent in clinical practice. Physicians, and people in general, have varying degrees of acceptance and tolerance for uncertainty, which contributes to variability in clinical practice [94]. and may result in inequity in the delivery of care. Medical education and practice emphasize medical knowledge and, to a lesser extent, how to deal with the limits or lack of knowledge [95]. MDs, perhaps

especially young doctors, are learning to be afraid of uncertainty [96]. Physicians obviously want to diagnose and treat based on evidence, but many have insufficient coping strategies when faced with medical uncertainty. Indeed, the problem is not the uncertainty, but how the physicians deal with it [97].

The physicians probably assumed that a negative result would decrease the patients' worry or resolve their symptoms. There are several consequences of the inadequate handling of uncertainty. The increased biotechnical testing [98], and inclination to refer [99-100], cause increased health care costs. It may also lead to over-diagnosis and over-treatment [101], with possible side effects and unnecessary anxiety for the patients.

In fact Sharmila Jandial found out that doctors' self-rated confidence in pediatric musculoskeletal (pMSK) was the lowest compared with other bodily systems, most respondents were confident "in most aspects" or "very confident" for cardiovascular, respiratory, and abdominal systems, while in pediatric musculoskeletal the majority had "no" or "some" confidence (21% and 53%, respectively) [102].

Inadequate knowledge regarding common pediatric orthopedic problems was reported by the majority of the participants (77.53% on average, 79.89% according to the specialties and 75.17% according to the professional degree), that means that only 12.47% of the respondents had a reasonable level of the knowledge regarding the NMSKV of the lower limb. Only the consultants exceeded the threshold of 50 percentage right answers, being able to be enclosed in the low to medium and/or adequate level of knowledge, while the rest of the respondents had a much more low level of the knowledge: 33.3% for family physicians, 20% for specialists, 12.68% for residents and 7.7% for general practitioners.

Another criteria included among the factors that could have played a role in the acquisition of the knowledge regarding the common pediatric orthopedic problems were the place of the undergraduate medical school, the percentage of musculoskeletal or orthopedics in training program of Pediatrics & Family medicine educational activity, the presence of any elective training in orthopedics or attending of orthopedics conferences or courses. From this point of view, we noticed that the physicians who graduated at medical schools in Jeddah were more knowledgeable regarding common pediatric orthopedic disorders than those who graduated at medical schools in Makkah and Taif (16.7% versus 6.8%), while the other factors, such as the percentage of musculoskeletal or orthopedics in training program educational activity, attending any orthopedics conference/course and having elective training in orthopedics, were not significantly associated with the knowledge' level. Differences between knowledge in physicians graduating from different near cities in Saudi Arabia must be investigated deeply, trying to provide adequate similar knowledge to the faculties of medicine.

Regarding the curricula of the MSK training in the residency program of pediatric and family medicine in Saudi Arabia, the residency program is controlled by the Saudi Commission for Health Specialties. In pediatric residency program, there is no mandatory rotation in orthopedic, but some residents can attend orthopedic as elective, this elective rotation period ranging between 1–2 months during the five years of training, while in family medicine there is mandatory orthopedic rotation for one month only during the five years of program.

Finally, we can say that the high rate of inadequate knowledge in general, regardless of specialty or professional degree, reflects the huge gap in the under/post graduate MSK knowledge, which needs intensive care to deal with it during medical college learning and post graduate continuous medical education, this conclusion being supported by increasing consultant's knowledge.

Although the low level of knowledge turned out to be without any doubt the main cause of the inappropriate referrals, we also found other two factors which can more or less influence or even determine the appropriateness or inappropriateness of the referrals' decision. This are the parents' request and the fear of forensic consequences, both of them being conditions that sometimes put the doctors under a such high pressure that makes them decide an inappropriate referral, either to get rid of the annoying requests of the parents, or as a means of protection from future medico-legal issues.

Inappropriate orthopedic referral following parents' request was mentioned by 74.4% of physicians (75.7% according to the specialty and in 73.1% according to the professional degree), this fact being expected as it is difficult to imagine that a such high number of physicians with low level of knowledge could have been able to withstand the distrust and pressure of the parents and to convince them of the uselessness of this

The referral decision is important to each patient and to the health care system, and it is a composite trade-off among different concerns, such as patient needs, expected medical benefit, costs, and patient preference [2,3]. The referral decision should be based on medical arguments, but is also influenced by several non-medical factors. [4, 5]. Two non-medical factors in our study turned out to have a significant influence in making the referral decision beside the knowledge' level of the participants: the parents' express request and the fear of forensic consequences.

Inappropriate orthopedic referral following parents' request was mentioned by 74.4% of physicians (75.7% according to the specialty and in 73.1% according to the professional degree), this fact being expected as it is difficult to imagine that a so high number of physicians with low level of knowledge could have been able to withstand the distrust and pressure of the parents and to convince them of the uselessness of this inappropriate referrals and even on the consequences resulting from possible future unnecessary and excessive investigations. Yet we have to note that the lowest rate of inappropriate referrals due to parents' request was registered among the pediatricians, that could be explained by the fact that these can deal with parents and convince them about the useless of orthopedic referral for their child case, as pediatricians always dealing with families most likely have more communication skills in this regard than family physicians and general practitioners. Surprisingly, our research showed that the physicians who reported a percentage of more than 10% of musculoskeletal or orthopedic cases in training program educational activity were more likely to inappropriately refer orthopedic cases compared to those who reported lower percentage and also the physicians who attended any orthopedic conference/course tended to inappropriately refer orthopedic cases as opposed to those who did not attend such conferences/courses, this differences being borderline insignificant however ($p=0.052$). These controversial results regarding the physicians who had more than 10% training or those who attended conference or courses that had more inappropriate referrals than the others, could be partially explained by the fact that that the statistical significance of this results was borderline ($p=0.045$ & 0.052), but surely other factors should be involved, the fear of forensic consequences and the low level of knowledge regarding MSK problems being the most important, but the quality of these conferences and courses could be taking into account. On the other hand, this evaluation has important implications for the program directors regarding the effectiveness of MSK curriculum in training programs and the postgraduate conferences quality, who can then initiate measures to improve resident education. Such efforts during residency training have the potential of improving patient outcomes. Needless to say, we advise for further studies regarding this issue.

The fear of forensic consequences was the second main non-medical cause of the inappropriate referral decision, but the rate of inappropriate referrals due to the fear of medical consequences was significantly lower than that due to parents' pressure, both according to specialties (64.2% vs. 75.7%) and to professional degree (57.9% vs. 62.4%). Physicians who had adequate knowledge regarding common pediatric orthopedic disorders were less likely to inappropriately refer orthopedic cases to protect from medico-legal issues compared to those who had inadequate knowledge (33.3% versus 67.1%), that confirm the fact that the higher the knowledge level, the less inappropriate referrals will be registered.

As expected, the lowest rate of the inappropriate referrals (35.5%) to protect from medico-legal issues belonged to consultants who are supposed to have much more knowledge about NMSKV and subsequently much more self-confidence. According to the specialties, the lower rate of inappropriate referrals belonged to pediatricians (57.8%), while the highest rate was registered in the general practitioners' group (80.8%).

It was surprisingly to notice that the rate of inappropriate referrals was very close for family physicians, specialists and residents (63.2%, 65.1% and 63.4% respectively), but with mention made above related to the fact that, not having decisional right, actually the rate of inappropriate referrals of the residents belongs to their supervisors, consultants and specialists.

On the other hand, another surprisingly fact we noticed was that physicians who reported a percentage of more than 10% of musculoskeletal or orthopedics cases in training program educational activity were more likely to inappropriately refer orthopedic cases to protect from medico-legal issues compared to those who reported a lower percentage (71.4% versus 53.7%). We could not find out a complete and valid explanation, but a partially one at least could be the fact that the physicians having inadequate level of knowledge are much more aware of the fact that the limits between normal variants of MSK and those converted to pathologic are not very clear, and, being aware of the forensic consequences, they prefer to refer them to the specialist, for adequate assessment and treatment.

Elizabeth Matzkin reported that a cognitive examination of musculoskeletal medicine was distributed among 334 participants consisting of medical students, residents, and staff physicians. The results showed that 79% of the participants failed the basic musculoskeletal cognitive examination [103].

Our study had likewise a higher finding of 77.53% of the participants with inadequate knowledge while 22.47% only had adequate knowledge based on the questionnaire results, which suggests that training in musculoskeletal medicine is inadequate in both medical school and non-orthopedic residency training programs.

According to Pinney and Regan there is a marked discrepancy between necessary skills and knowledge needed to treat patients with musculoskeletal conditions, as determined by a survey of primary care physicians, and the amount of time devoted to teaching these skills in Canadian medical schools! One hundred and forty-one practitioners in family medicine stated that, on the average, 27.4% of their practice involved musculoskeletal disorders, yet <3% of all curricular hours in the typical Canadian medical school are devoted to musculoskeletal education [104]. In addition, it clearly noticed that in case when there is ability for pediatrician and family physician to consult an orthopedic colleague easily and unofficially, this will decrease inappropriate referral, as colleagues strengthen each other's resolve and self-confidence, in conclusion; when there are more regular staff meetings between pediatrician, family physicians and orthopedic surgeon, this will lead to a lesser referral rate .

Physicians need strategies for dealing with patients' requests for medically inappropriate tests and treatments [105]. Furthermore, according to a systematic review, it is probable that in

order to increase self-management in patients with nonspecific pain conditions, cognitive reassurance (providing explanations and education) improves their outcomes immediately after the consultation and at follow-up [106].

Consequently, physicians should practice these communication skills to reduce inappropriate referrals.

The good statement of medical benefit included mentioning that medical beneficial referrals should contribute considerably to a better treatment outcome and/or a shortened course of the disease. We believe this statement covers the most important purpose of referring patients to secondary care.

In this study, we found that 75.7% of the participants will inappropriately refer when the parents introduce the issue of referral, and 62.4% due to fear from malpractice claims in the future. Needless to say, that physicians were expected to yield no medical benefit. Roland et al. reported that in 20% of the referred cases the general practitioner was under the pressure of the family [107]. In this case, inappropriate referral may not reflect the lack of physicians' training and experience, as there are many physicians that refer patients when they feel that the child's family is not satisfied with their decision.

Referring on demand simply to satisfy the patient is not a good practice. It is important to elicit the patients' ideas, concerns, and expectations, and to involve the patient in the decision-making process [108]. Nevertheless, physicians have an ethical duty to avoid doing harm, e.g. the side-effect of investigations, and they are not obliged to provide unnecessary or inappropriate care. They must also balance the needs of the individuals with those of the society, such as the need to control health care costs [109]. Wammes et al. found that 'more than half (of the GPs) indicated that it takes a lot of time and effort to convince a patient that additional investigation is not beneficial, and that this fact further increased the number of referrals [92].

Limitation to the questionnaire-based survey. In spite of trying to avoid many obvious limitations, honestly, we can admit the following limitations:

- it was not a comprehensive thoroughly questionnaire, since we were concentrating on making it as short as possible, this leads to evaluate the non-medical reasons of inappropriate referral with 2 questions only.
- our work can be considered as a selection bias, because it was performed on an inhomogeneous study group which could be better if it included a number of pediatricians, GPs, GPs, consultants, specialists and residents, and then the rate of correct or no answers, as well as the opportunity to send them to specialist would have been really significant.
- the residents were included in the study, which, according to the health care system, don't have the right to refer the cases; we included them to evaluate their knowledge and attitude to refer.

4. CONCLUSIONS

1. Normal musculoskeletal variations of the lower limb represent the most common cause of inappropriate referrals to pediatric orthopedic clinics (32.9% in our study), being high cost and time consuming and leading to a futile overloading of the secondary health system.
2. Both sexes are affected equally, even if some studies, including ours, reported a prevalence of girls (63.4% girls vs 36.6% boys, with a sex ratio of 0.69)
3. Except for the trauma, the patients' age at the first visit (4.2 years on average) is not similar to the onset' age, even though they are present at birth in the most cases, two explanations being possible: either they do not become clinically evident before the age of walking, or the parents do not pay attention to the first signs that become evident only after they are aggravated to some extent
4. Pain due to trauma or not, abnormal gait and deformities of the MSK system, isolated or associated were the main clinical signs that determine parents to visit a doctor belonging to primary health system, who most often refer the patients to the pediatric orthopedic specialists
5. The high rate of X-Ray examinations requested by the specialists in NMSKV group (63.7%) could be explained by the existence of a large amount of cases where the limits between normal variation and those turned to pathologic were very close.
6. In toeing gait being the most frequent type, followed in order by flexible flat foot and knee varus or valgus
7. Most cases of NMSKV assessed within normal limits (737=96.45%) didn't require any treatment and follow-up visits
8. The treatment of pathological cases (27=3.55%) was a complex one, using both conservative and/or surgical methods, with a therapeutic plan established according to the type and severity of the lesion, age and general status of the patient's and parents' agreement and preferences.
9. The main cause of the inappropriate referrals was the low rate of knowledge about the NMSKV, reported by majority of the participants (77.53% on average, 79.89% according to the specialties and 75.17% according to the professional degree)
10. Other additional factors as: the place of undergraduate medical school, the percentage of musculoskeletal or orthopedics in training program of Pediatrics & Family medicine educational activity, the presence of any elective training in orthopedics or attending of orthopedics conferences or courses had influenced the knowledge level to some extent.
11. Uncertainty due to a low level of knowledge was the main cause of the weakness towards the express request of the parents registered in 74.4% of the physicians (75.7% according to the specialty and in 73.1% according to the professional degree) and also the main cause of the inappropriate referrals made in order to protect themselves, for fear of medico-legal consequences (64.2% according to specialty and 57.9% according to professional degree)
12. The only way to avoid the inappropriate referrals of the NMSKV of lower limb is to improve the knowledge level by revising and improving the effectiveness of MSK curriculum in the training program of the students and residents and also by including all primary care physicians in a regular program of courses and conferences, all these goals coming both from the Ministry of Health and Universities of Medicine.
13. In the same time we believe that in order to decrease the number of inappropriate referrals, it will be of great benefit if the targeted physicians participate a special conferences regarding suitable communicating skills with the parents, as well as comprehensive forensic

medicine conferences to strengthen the weak points in this field, from the physicians' perspective.