

Incidence of subtypes of the suprapatellar fold in fetus and their clinical relevance in early periods of life: a preliminary study*

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Aim: To determine whether the morphology and incidence of subtypes of the fetal suprapatellar fold are different from those of adults.

Materials and methods: Suprapatellar folds of 30 fetal knees (6 male and 9 female fetuses, ages varying between 20 and 34 weeks of gestation) were classified according to their morphological features.

Results: In 33.3% of the knees, the suprapatellar fold was forming an apparent barrier between the suprapatellar bursa and the main articular cavity. Vertical parts of the mediopatellar fold in 3 fetuses and lateral fold in 4 fetuses were coursing as the continuation of the suprapatellar folds. The suprapatellar fold, as an almost complete membrane, was more frequent in fetuses compared with those of adults reported previously.

Conclusion: Our findings support the fact that the suprapatellar folds of the knee joint in early periods of life are different than those of adults. We consider that the resorption of the mesenchymal tissue, particularly on the lateral part, continues until adulthood and causes alterations in the formation of intraarticular folds. The results of this preliminary study suggest that knee pain caused by impingement of the complete suprapatellar fold and intermittent painful swelling of the knee by a valvular mechanism may be encountered more frequently in early periods of life than in adulthood.

Key words: Suprapatellar fold, fetus, knee joint

Fetusda suprapatellar plika alt tiplerinin insidansı ve bunların yaşamın erken dönemindeki klinik önemi: bir ön çalışma

Amaç: Bu çalışmanın amacı fetusta suprapatellar plikanın alt tiplerinin yapı ve sıklığının erişkindekine göre farklı olup olmadığını belirlemektir.

Yöntem ve gereç: Gestasyonel yaşları 20-34 hafta arasında değişen 6 erkek, 9 kız fetus'a ait 30 dizde suprapatellar plikalar, morfolojik özelliklerine göre sınıflandırıldı.

Bulgular: Dizlerin % 33,3'ünde suprapatellar plika, suprapatellar bursa ile gerçek eklem boşluğu arasında önemli düzeyde bariyer oluşturuyordu. Olguların 3'ünde mediopatellar plikanın vertikal bölümü, olguların 4'ünde ise lateral plikanın vertikal bölümü, suprapatellar plika ile devamlılık gösteriyordu. Komplet ve komplete yakın membran tipindeki suprapatellar plikaların oranı, daha önce erişkin için bildirilenlere göre daha fazlaydı.

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Sonuç: Bulgularımız diz eklemine yaşamın erken dönemlerindeki suprapatellar plikaların erişkindekinden farklı olduğunu desteklemektedir. Mezenşimal doku rezorpsiyonunun, özellikle dizin lateral kısmında, erişkin döneme kadar devam ettiği ve bunun eklem içi plikaların şeklinde değişikliklere yol açtığı düşünüldü. Bu ön çalışmada elde edilen bulgular, yaşamın erken dönemlerinde komplet suprapatellar plikanın sıkışmasından kaynaklanan diz ağrısı ve valvular mekanizma ile diz eklemine oluşabilen intermitten ağrılı şişliklere, erişkindekinden daha sık rastlanabileceğini düşündürdü.

Anahtar sözcükler: Suprapatellar plika, fetus, diz eklemi

Introduction

The first sign of a developing articular cavity of the knee appears as multiple small cavitations at the beginning of week 8 of gestation. These cavitations unite to form a single cavity until week 10.5 (1,2). The suprapatellar bursa (SB) that initially develops separately from the main joint cavity, proximal to the patella between the quadriceps femoris muscle and femur, later becomes connected with the joint cavity due to the regression of the mesenchymal tissue. The mesenchymal remnants between the bursa and the main joint cavity form the suprapatellar fold (SF) (3).

Clinical significance of the SF particularly in arthroscopy has been emphasized by clinicians (4,5). In the present study, we planned to determine the variations of the SF in the fetal knee. In addition, we aimed to establish both the subtypes and the frequencies of variations of SF, which would lead to certain clinical problems in the early period of life.

Materials and methods

This study was carried out on 30 fetal knees (6 male and 9 female fetuses, 20-34 weeks of gestation). The fetuses were provided from spontaneous abortion materials coming to the pathology laboratory for autopsy.

Knees were dissected with a surgical microscope (Leica M-651) as follows: after the removal of the skin over the knee, a U-shaped incision was performed connecting the medial aspect of the medial epicondyle of the femur, upper part of the tibial tuberosity, and the lateral aspect of the lateral epicondyle. Then the patellar ligament and infrapatellar fold were dissected and the patella was pulled upwards. On the upper part of the patella, the SF was examined and photographed.

SF was classified under 3 main groups and 11 subtypes as below (Table, Figures 1a-e):

- A- Subtypes for the cases having an apparent connection between SB and the main articular cavity;
 - Absent
 - SF extending up to medial 1/3 of the area between the bursa and the main articular cavity
 - SF extending up to medial 1/3 and 1/2 of the area
 - SF extending up to 1/2 and 2/3 of the area
 - SF extending up to more than medial 2/3 of the area
 - Laterally located SF alone
- B- Subtypes for the cases that SF is a prominent barrier
 - Complete membrane
 - Fenestrated membrane (in which the SF having one or more small hole(s) but not having an apparent orifice)
- C- Subtypes for additional features
 - Laterally located pillar fold accompanying a medially located SF
 - Lateral patellar fold originating as a part of SF
 - Mediopatellar fold originating as a part of SF

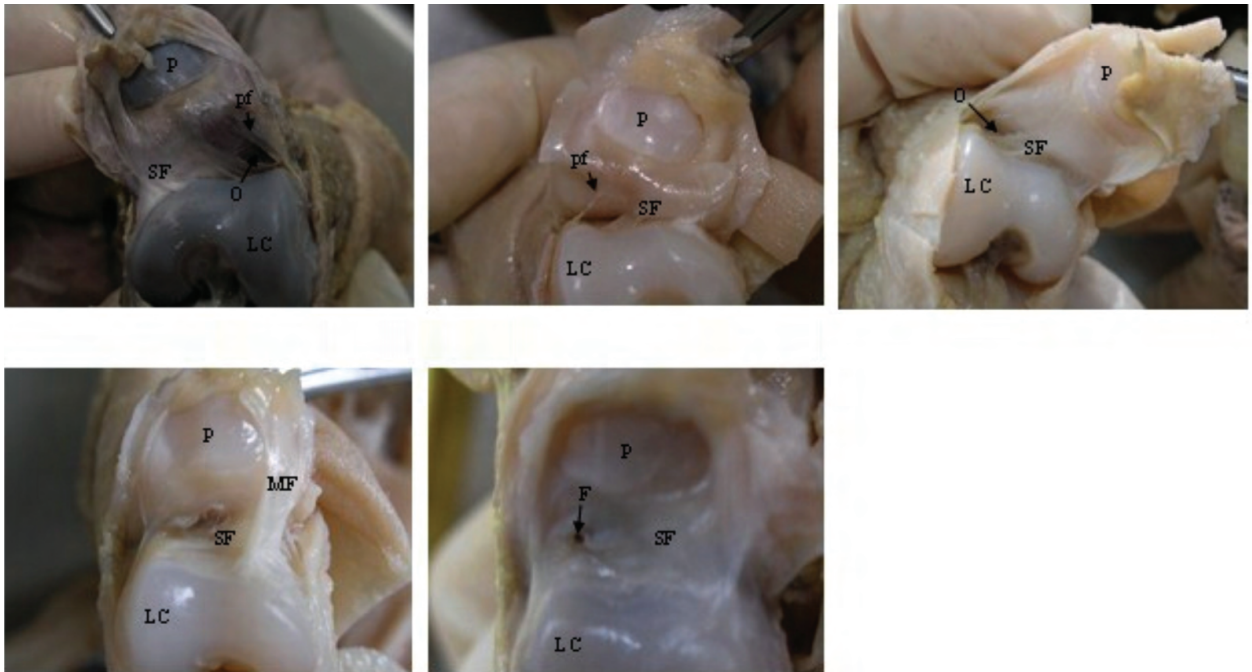
Results

The frequencies of each subgroup of the SF are given in the Table.

In all cases, SF originated from the interior surface of the quadriceps femoris tendon anteriorly with various widths, running upwards and then extending

Table. Frequency of suprapatellar fold subtypes.

	SF	Right	Left	Total	%
	Absent	0	0	0	0
Subtypes for the cases having an apparent connection between SB and the main articular cavity	SF extending up to medial 1/3 of the area between the bursa and the main articular cavity	1	2	3	10
	SF extending up to medial 1/3 and 1/2 of the area	2	0	2	6.7
	SF extending up to 1/2 and 2/3 of the area	2	5	7	23.3
	SF extending up to more than medial 2/3 of the area	5	3	8	26.7
	Laterally located SF alone	0	0	0	0
Subtypes for the cases in which the SF is a prominent barrier	Complete membrane	3	2	5	16.7
	Fenestrated membrane	3	2	5	16.7
	Laterally located pillar fold accompanying a medially located SF	5	5	10	33.3
Subtypes for additional features	Lateral patellar fold originating as a part of SF	3	1	4	13.3
	Mediopatellar fold originating as a part of SF	2	1	3	10



Figures 1. (a-e) Suprapatellar fold; accompanying a laterally located large pillar fold in the left knee (a) and a narrow pillar fold in the right knee (b), bounding the suprapatellar bursa on the medial 2/3 of the right knee (c), forming a complete membrane with a transparent lateral part, continuing with the mediopatellar fold in the right knee (d) and forming a fenestrated membrane in the right knee (e). (O: opening of the suprapatellar bursa, P: patella, LC: lateral condyle of femur, pf: pillar fold, F: fenestra on the suprapatellar fold)

downward and backward to end just above the condyles. In 66.7% of the cases, SF had an aperture that was always located on the lateral side. In these cases, the free margin of SF formed a C-shaped arch with its open part facing laterally.

Total frequency of the cases that the SF is a prominent barrier was determined as 33.3%. In cases with fenestrated SF, the hole was always on the lateral side, whereas in complete membranes the lateral part was always thinner than the medial. Additional synovial folds in various locations on the membrane were also observed, particularly in large SFs.

Vertical parts of the mediopatellar fold in 3 cases and lateral patellar fold in 4 cases were coursing as the continuation of the SF.

Discussion

The main articular cavity of the knee joint continues superior to the patella as the SB. The SB, which initially develops separately from the main articular cavity, later becomes connected to it through an orifice, due to the resorption of the mesenchymal tissue. The resorptional remnants, which restrict the orifice in various levels, form the SF (3).

SF is also named as the medial suprapatellar plica, plica synovialis suprapatellaris, and suprapatellar septum. Its incidence has been reported as 89%-94% in the adult population (4,6,7). Gülman et al. (1994) investigated morphological variants of the SF on 50 neonatal cadavers and reported the incidence as 90% (8). Ogata and Uthoff (1990) studied serial or non-serial sections from the knees of 112 embryos and fetuses and observed the SF in 33% of the fetus knee joints (1). This lower percentage may be due to the methods to detect the fold rather than the age effect. We did not encounter any study on the frequency of subtypes of the SF in fetuses.

The shape and size of the SF has quite a few variations. Accordingly, classification of the fold has great variability (4,6-8). Gülman et al. (1994) classified the SF in 4 main groups as septum completum, septum perforatum (with 6 subtypes), septum residuale (with 4 subtypes), and septum extinctum (8). Dandy (1990) described 2 main groups for SF in adults as narrow and broad forms (7). The narrow form has been divided into 5 subgroups, changing from absent to

2/3 of the width of the SB. The broad form has been also divided into 5 subgroups, changing from 2/3 of the width of the SB to complete. In the current study, Dandy's classification was modified and simplified.

The cases with an apparent orifice on SF have clinical importance because the loose bodies can pass through the orifice, hide within the SB, and cannot be observed during arthroscopy (9). The location of this orifice in our series was always on the lateral side. It is compatible with the explanation of Ogata and Uthoff, who claim that there is less mesenchymal tissue on the superolateral side than on the medial (1). Dandy reported the incidence of cases with an apparent orifice as 75% in adults (including all subtypes of the narrow form of SF and the subtype that the SF is more than 2/3 of the width of the SB) (7). In the present study, those cases were observed in 66.7% of the knees. Gülman et al. reported both septum residuale and septum extinctum in 33% newborn cadavers (8). This small ratio appears to be associated with the diversity of classifications: the cases having small apertures less than 1/3 of the total area were also included in some subtypes of septum perforatum in the Gülman's classification (8). In the current study, similar to Dandy's classification, those cases were evaluated separately from the fenestrated subgroup as the subtype of SF occupying more than 2/3 of the area, because of its clinical relevance (as being a passage for loose bodies).

The suprapatellar fold is rarely symptomatic. However, Kim et al. reported an arch type SF with pathologic features (as fibrotic, nonelastic, avascular in nature, whitish, and thickened). They also demonstrated impingement of SF between the quadriceps femoris tendon and the femoral condyle during knee flexion (5). It appears that the risk of plica syndrome increases in cases with the broad subtypes of the SF.

It has been asserted that complete or almost complete SF may cause intermittent painful swelling of the knee by a 1-way valvular mechanism (5). Dai et al. declared the frequency of cases in which the SF forms a prominent barrier between the SB and the main articular cavity (diaphragmatic type) as 17% in adults (6). Dandy reported the complete membrane as 4.2% and the broad forms (including more than 2/3, complete, perforated, arch, pillar subtypes) as

31.6% in adults (7). These rates were much higher in our study: the rate for complete type was 17% and the rate for the cases that SF is a prominent barrier (including more than 2/3, complete, and fenestrated subtypes) was 60.3%.

Based on their study involving a series of newborn cadavers, Gülman et al. reported the rate for the cases with complete type as 26% and for the cases with a prominent barrier (complete and perforated subtypes) as 67% (8). Those rates are quite similar to ours. Neto and Leite also studied 26 newborn cadavers by both double-contrast Arthro-TC and dissection and evaluated the SF only in terms of the presence of any communication between the main articular cavity and suprapatellar bursa (10). They reported that 15% of the people are born with imperforated SF, which is also similar to our results. The difference between the fetus/newborn and adult results raises doubts about the continuation of the degenerative process of this fold within and after the intrauterine period. Our opinion is that the effects of the developing peripheral structures (e.g., bones, muscles, and the joint itself), enlarging articular cavity, as well as the usage of the quadriceps femoris muscle on the membrane may have roles in this process during development.

Additionally, the relation of SF with the lateral fold and mediopatellar fold was also investigated in this series. Mediopatellar fold in 3 cases and lateral fold in 4 cases were coursing as the continuation of

the SF. Some authors stated that suprapatellar and mediopatellar folds are continuous with each other, while some others have defined them as completely separate folds (11). There are no data about the incidence of the cases in which the suprapatellar fold is continuous with the mediopatellar fold. All the articular folds are formed by the union of the small cavitations and intraarticular mesenchymal regression in fetal term. Therefore, coincidental structural relation of the mediopatellar and/or lateral folds with SF, as the common mesenchymal remnants, appears usual.

Consequently, the higher frequencies of complete and almost complete membranous form of SF in fetuses than those of adults suggested that the mesenchymal tissue resorption, which begins in the intrauterine period, continues during the childhood and adolescence particularly on the lateral side of the knee. The results of this preliminary study, which included a limited number of fetuses, showed that the morphology of SF in fetuses is different compared to adults. However, new investigations are needed to display possible differences between adults and pediatric age group in the morphology of SF. If the complete membranous form of SF is found frequently in the pediatric age group, pediatric orthopedic surgeons should be more provident with respect to the knee pain caused by impingement of the complete SF and intermittent painful swelling of the knee by a valvular mechanism.

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