**Original paper**

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# Sonographic assessment of the prevalence and evolution of fluid collections as a complication of kidney transplantation

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**Abstract**

**Aim of the study:** The aim of this study is to assess the prevalence and evolution of perirenal fluid collections in a group of 488 patients who have undergone kidney transplantation. **Material and methods:** Sonographic documentation of 488 deceased-donor kidney recipients was evaluated for the prevalence of perirenal fluid collections and their evolution in time, depending on selected demographic features of the patients, time of detection, initial dimensions and precise position of the collection relative to the kidney and the location of the transplanted organ in the right or left iliac fossa. The collected data were used for statistical analysis to determine the strength of the potential relationships. **Results:** In 146 out of 488 subjects perirenal fluid collections were found. In 1/3 of the patients more than one fluid collection was diagnosed. Over 40% of fluid collections were detected within 10 days from the date of the first scan and 24.11% were detected within 10–20 days from the date of the first scan. The majority of fluid collections were located near the lower pole of the kidney. Perihilar collections were the least common. Collections encapsulating the kidney and subcutaneous collections were the largest in size on average. A statistically significant difference between the size of collections located on the surface and the size of those located near the upper pole of the transplanted kidney was demonstrated. However, no correlation was proven to exist between the persistence of the fluid collection and its position relative to the transplanted kidney and its initial size. **Conclusions:** The correct evaluation of a fluid collection's dynamics of development and nature requires periodic follow-up of the recipient, preferably in a single clinical center. Ultrasonography is an inexpensive, non-invasive and repeatable method for the determination of the presence of fluid collections. However, the decision whether treatment is necessary requires the sonographic image to be compared with the laboratory signs of inflammation and biochemical analysis of the contents of fluid collections.

## Introduction

The current data of the Poltransplant register indicate that approximately 1000 deceased-donor kidney transplantations are performed in Poland every year[1]. These procedures have a significant risk of postoperative complications, including the formation of perirenal fluid collections. According to the literature on the subject the prevalence of fluid collections in kidney recipients is estimated to be approximately 20–50%, which makes them the most common transplantation-related complication[2,3].

Furthermore, a significant proportion of fluid collections are considered to form as a result of imperfect surgical techniques, both in terms of the dissection of perihilar structures of the transplanted kidney and damage to the lymphatic pathways accompanying the iliac vessels of the recipient[4–6].

The clinical significance of perirenal fluid collections is associated partly with their nature as well as with their location, original size and growth dynamics. This is because large, expansive collections can exert mechanical pressure on the key structures around the transplanted organ, causing significant impairment of its vasculature or function[3,4,7].

Considering these facts it should be noted that a kidney transplant patient requires comprehensive and long-term diagnostic imaging follow-up in order to detect and monitor potentially dangerous complications. Therefore, a method which is non-invasive, relatively inexpensive and safe for the transplanted organ is necessary. As a method meeting all these criteria, ultrasonography has become a method of choice for the postoperative assessment of a graft. It is also worth emphasizing the fact that the superficial location of the transplant in one of the iliac fossae allows for easy visualization of the kidney and vascular anastomoses in the essential projections in the majority of cases (due to the lack of deflections from intestinal gas), which is invaluable particularly in the early post-transplant period[3,4,7].

The standard sonographic examination of a transplanted kidney involves morphological evaluation of the kidney and perirenal structures, including fluid collections in B-mode imaging and detailed analysis of renal vasculature using color and spectral Doppler imaging. The analysis takes into account the peak systolic flow in the main vessels of the anastomosis as well as intrarenal pulsation index (PI) and resistance index (RI)[7].

Considering the typical time of occurrence following transplantation and the nature of their contents, fluid collections have been divided into early ones which include haematomas, seromas and urine leaks and late collections which include lymphoceles and abscesses[4,7,8].

The ultrasound image of a fluid collection depends on its nature and location. The fluid surrounding an extraperitoneal graft is well-delimited and has a fairly regular shape, while in the case of a kidney transplanted intraperitoneally unstructured, free fluid is usually found[4].

In the immediate postoperative period perirenal haematomas and serous leaks can assume the form of a narrow rim encapsulating the kidney. An acute haematoma is usually characterised by high echogenicity (Fig. 1), which becomes significantly lower with time and evolution of the haematoma. Haemorrhage-related collections are characterised by a tendency to form internal compartments (Fig. 2). The sonographic image of a urine leak is equally non-specific. A weakly to well-delimited hypoechoic or anechoic area may be visualised near the kidney, and, more commonly, the distal segment of the ureter or urinary bladder. This location of a urinoma is associated with the significantly higher susceptibility of the distal part of the ureter to ischaemic necrosis and the resultant perforation and with imperfect ureterovesical anastomoses. Urine collections can contain deposits visible as internal deflections and septation is less com-

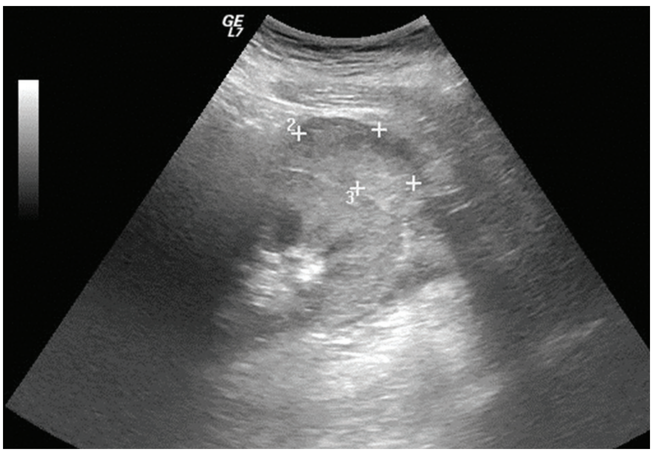


**Fig. 1.** *Perirenal, partly hyperechoic fluid collection with smooth contours. Ultrasound image of a possible haematoma*

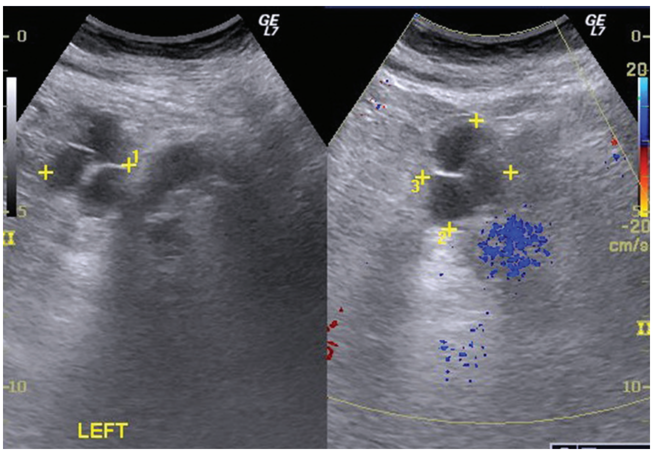


**Fig. 2.** *Fluid collection with polycyclic contours with internal compartments – an image of possible late evolution of a perirenal haematoma*

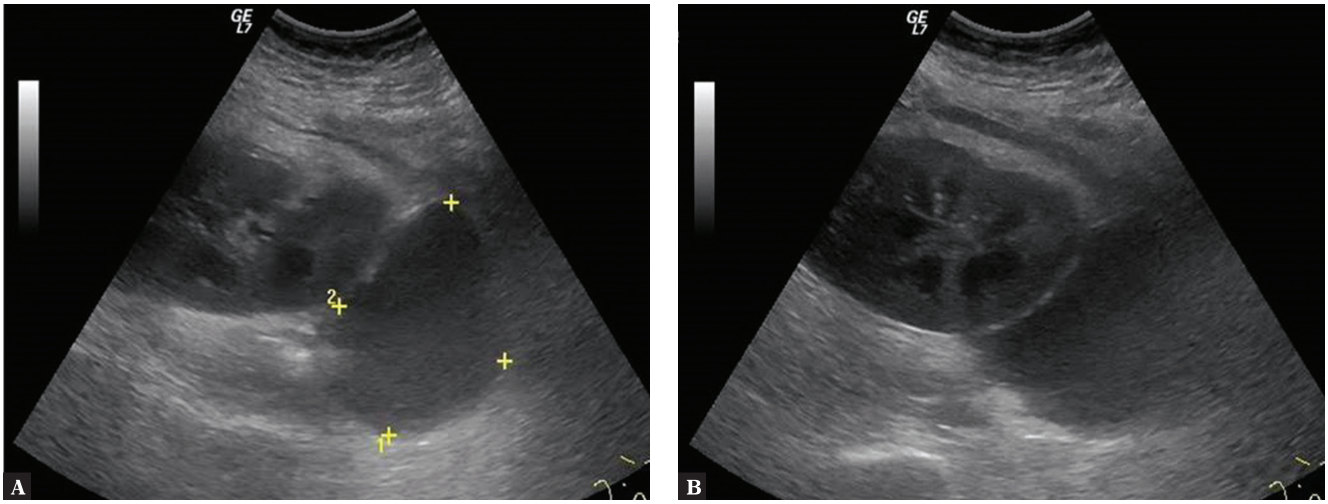


**Fig. 3.** *Perirenal, regular fluid collection, most probably a lymphocele*

mon in them than in haematomas[3,4,7,8]. Lymphocele is the most common type of fluid collection (22%) complicating the post-transplantation period. It usually occurs in the form of a small, round pocket, which may be associated with the pelvicalyceal system dilation. As in the case of urine leaks the lymphocele image can be characterized by echo reduction or absence (Fig. 3, Fig. 4)[5,7,8].

Careful, systematic ultrasound follow-up primarily aims to identify those fluid collections which may threaten or are already threatening the normal function of the graft. Research shows that it is mainly fluid collections which exceed 50–100 ml, grow rapidly, are symptomatic and are associated with acute graft rejection episodes that should be the cause for clinical concern and need intervention[2].

The treatment strategy also depends on the type of a fluid collection. In the majority of cases a draining catheter is recommended, while simple needle aspiration procedures are associated with a high rate of recurrence[8,9]. In the case of a lymphocele after the fluid has been drained an obliterating agent may be additionally applied (ethanol, povidone, doxycycline or fibrin glue), which increases the efficacy of the procedure. In rare cases requiring surgical treatment classic or laparoscopic marsupialization of the fluid pocket into the peritoneal cavity is applied[2,4,7,8,10]. Abscess evacuation should be combined with an antibiotic therapy[8,9]. The treatment of perirenal haematomas requires a somewhat different approach. In the case of uninfected fluid collections drainage is not recommended since the catheter can become blocked with blood clots[7,10]. However, some authors argue for the efficacy of percutaneous drainage with large lumen catheters, i.e. 12–14 Fr. Haematomas which do not spontaneously resolve with time should be evacuated with surgical methods[8,9]. In contrast, the majority of cases of postoperative urine leak require primary surgical repair; minimally invasive radiological procedures such as percutaneous temporary nephrostomy or double J catheter can represent additional bridging methods or methods supporting the healing process[2,7,9].

## Material and methods

The available documentation (descriptive and imaging records) of ultrasound scans of 488 consecutive patients who had undergone deceased-donor kidney transplantation between January 2001 and May 2017 were included in a retrospective analysis. Ultrasound scans were routinely conducted in the immediate postoperative period (up to 3 days from the procedure), before the patient's discharge (usually between day 10 and 14 after the operation) and subsequently at approximately 6–12 month intervals as well as in every case of developing clinical signs of graft function deterioration. Doppler linear 6–12 MHz and convex 3.5–5 MHz transducers were used for the scans depending on the conditions of the examination.

This study is an attempt to perform a statistical evaluation of the prevalence of perirenal fluid collections and their evolution in time depending on selected demographic features of the patients, time of detection, initial size and precise position of the fluid pocket relative to

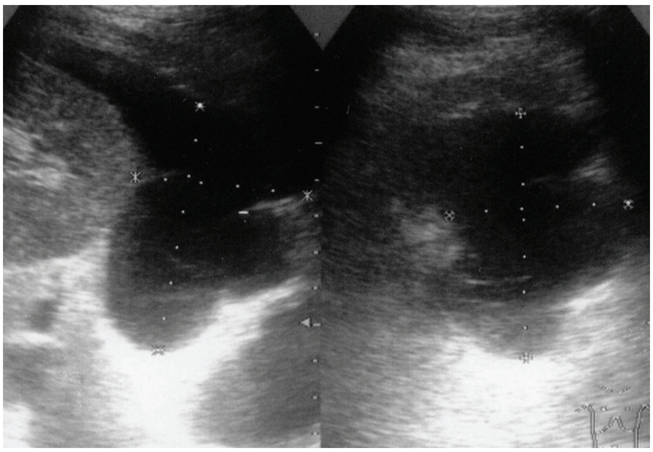

**Fig. 4.** *Extensive, irregular fluid collection partially encapsulating the kidney, most probably a lymphocele*

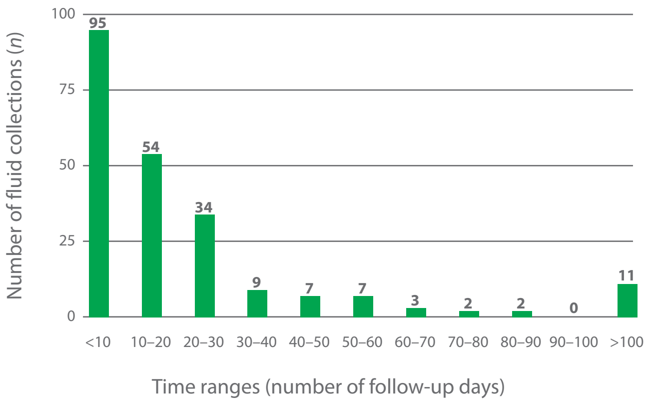


**Fig. 5.** *Percentage distribution of the detected fluid collections depending on the time elapsed*

the kidney and the location of the transplanted organ in the right or left iliac fossa. The collected data were used for statistical analysis to determine the strength of potential relationships.

The STATISTICA, version 12 (StatSoft, Inc., 2014) software was used to conduct the statistical analysis. Patients with data deviating to an extreme extent from the statistical distribution of data from other patients, regardless of the cause, were excluded from the assessment of fluid collection evolution. Statistical significance level of $p < 0.05$ was assumed.

Categorical data were analyzed using the Pearson chi-square test. The normality of quantitative data distribution was verified using the Shapiro-Wilk test. The homogeneity of variance was evaluated using the Brown–Forsythe test. The comparison of two groups of quantitative data was made using the Student's t-test (for normal distribution and homogeneous variances). For cases which did not meet these conditions the Mann–Whitney U test was applied. The correlation of quantitative data with a different distribution than normal was evaluated using the Spearman's rank correlation coefficient.

| | All transplant recipients | Patients with a diagnosed perirenal fluid collection |
|---|---|---|
| **Number** | 488 | 146 |
| **Women** | 167 (34,22%) | 49 (33,56%) |
| **Men** | 321 (65,78%) | 97 (66,44%) |
| **Age [years]** | | |
| $x_{mean}$ | 45,01 | 45,84 |
| **SD** | 13,71 | 13,41 |
| **Min.** | 14 | 14 |
| **Max.** | 73 | 73 |

$x_{śr}$ – mean value; SD – standard deviation in the sample; Min. – the lowest value in the sample; Max. – the highest value in the sample

**Tab. 1.** *Comparison of all kidney recipients and patients with diagnosed perirenal fluid collections*

The relationships between more than two groups of quantitative data were evaluated using the non-parametric Kruskal–Wallis ANOVA test (after non-normality of the data distribution was determined). In certain cases post hoc tests (for multiple comparisons) were applied.

## Results

The study included 488 individuals with a mean age of 45 years (±13.69). Half of the subjects were below 47 years of age, 25% were up to 34 years old, and 75% were up to 56 years old. The youngest person was 14 and the oldest one was 73 years old (Tab. 1). Among 488 patients who had undergone allogeneic kidney transplantation perirenal fluid collections were diagnosed in 146 individuals. In 43 patients (29.45%) the presence of more than one fluid collection was found. In total, 224 perirenal fluid collections were identified. In the sample of 146 patients fluid collections were most commonly diagnosed in the age range of 40–50 years (nearly 1/3 of the patients – 30.82%). However, there was no evidence to conclude that there was a statistically significant relationship between age and the fluid collection diagnosis. Despite the fact that fluid collections seemed to be more common in the male population ($n = 97$; 66.44%), no statistically significant relationship between gender and the presence of a fluid collection was found either.

The ultrasound follow-up period lasted between 1 (single assessment) and 5536 days. Despite that, in more than half of the cases the number of days did not exceed 62 (Mdn = 62.5). Patients with a diagnosed fluid collection were most commonly followed up for 20 to 30 days from the date of the first scan (13.70%). Nearly half of the identified fluid collections appeared up to 10 days from the first scan ($n = 95$; 42.41%). One fourth of all fluid collections were detected between day 10 and 20 ($n = 54$; 24.11%) (Fig. 5).

Out of 146 transplanted kidneys with the associated fluid collections 67 (45.89%) were transplanted to the right and 79 (54.11%) were transplanted to the left iliac fossa. The choice of the target location for the transplant did not correlate significantly with the gender or age of the patient.

In terms of the position of the fluid collection relative to the transplanted organ it was concluded that the majority of fluid collections were found near the lower pole of the kidney ($n = 72$; 32.14%), and the lowest number of fluid collections were found near the renal hilum ($n = 10$; 4.46%) (Fig. 6).

The present authors have also compared the sizes of the fluid collections in relation to their position relative to the kidney. The largest dimension of the fluid pocket upon its detection in ultrasound was used for calculations. Fluid collections encapsulating the kidney seemed to grow larger than fluid pockets located elsewhere (mean = 57 mm, median [Mdn] = 48 mm). It was

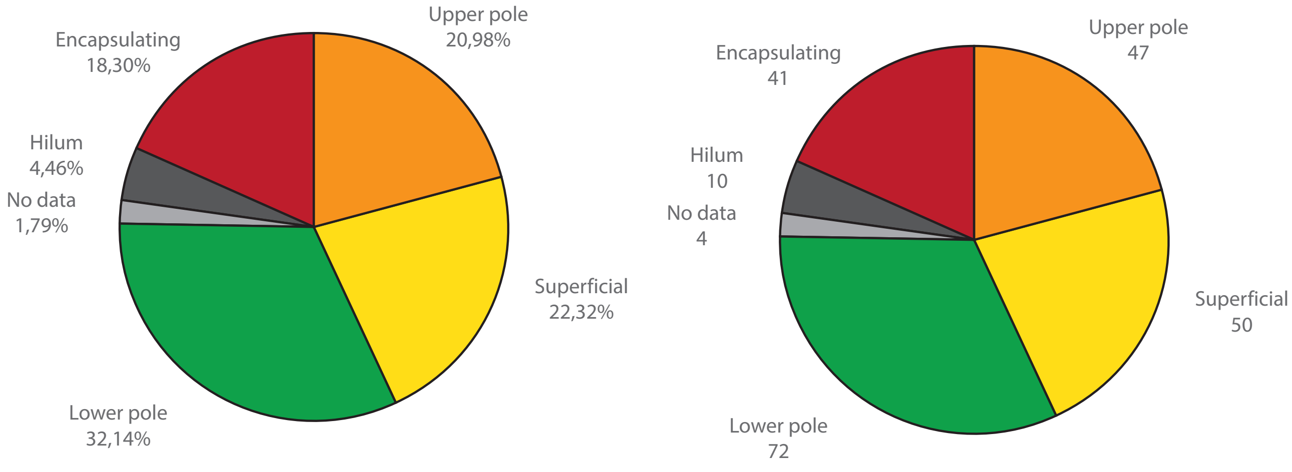


**Fig. 6.** *Prevalence of fluid collections depending on their position relative to the transplanted organ*

demonstrated in the tested sample that there is a relationship between the original size of the collection and its position relative to the kidney ($p$ = 0.03). A multiple comparisons test demonstrated a statistically significant difference between the size of collections located on the surface and the size of those located near the upper pole of the transplanted kidney ($p$ = 0.02). Larger collections (Mdn = 49 mm) were located subcutaneously (Fig. 7).

An attempt has also been made to determine whether there is a relationship between the duration of the presence of a fluid pocket (the period from the date of detection to the date when the fluid collection was reported for the last time) and its position relative to the transplanted kidney (Fig. 8) and its initial size (Tab. 2, Tab. 3). However, based on statistical analysis no correlations of this type have been demonstrated.

## Discussion

In a long-term evaluation of 488 patients who underwent allogeneic kidney transplantation fluid collections have been found in nearly 30% of subjects. These results correlate well with reports in medical literature according to which perirenal fluid collections should be expected in 20–50% of cases[2].

Based on the research material collected in the study it has been demonstrated that fluid collections formed most commonly within 20 days of the date of the first scan (66.52%) with the largest number of fluid pockets developing before day 10 of follow-up (42.41%). This means that the majority of cases involved a fluid collection as an acute complication of the organ transplantation procedure or a sign of acute graft rejection. Ac-

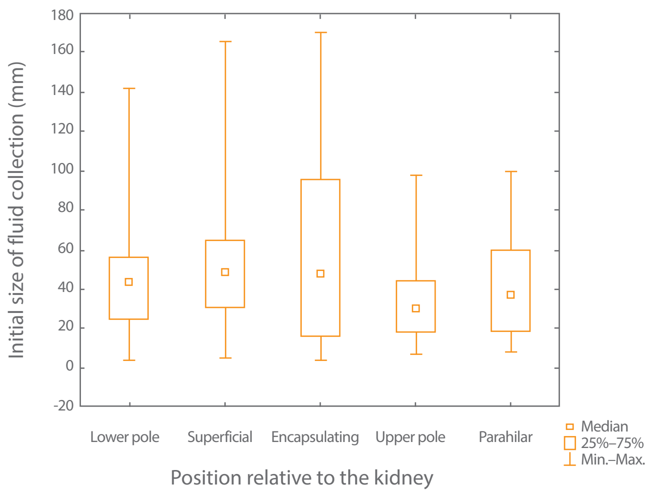


**Fig. 7.** *Fluid collection size distribution depending on their position relative to the transplanted organ*

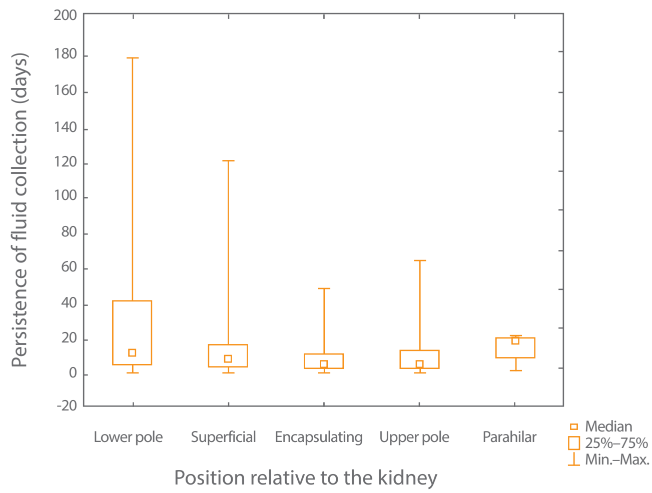


**Fig. 8.** *Analysis of correlation between the persistence of a fluid collection and its position relative to the kidney, following the determination of non-normality of distribution for both these characteristics*

| Shapiro–Wilk normality test | n | W | p |
|---|---|---|---|
| Initial size of the fluid collection | 99 | 0.92 | <0.001 |
| Persistence of the fluid collection | 105 | 0.58 | <0.001 |
| The initial size of the fluid collection should be understood as its largest dimension upon detection (mm). The persistence of the fluid collection should be understood as the time range (the number of days) from detection to the last scan in which a given fluid collection was observed. | | | |

**Tab. 2.** *Verification of the normality of the studied characteristics' distribution: of the initial size and persistence of a fluid collection*

| Spearman's rank correlation coefficient | n | r | $t_{n-2}$ | p |
|---|---|---|---|---|
| Initial size of a fluid collection and its position relative to the kidney | 99 | 0.16 | 1.568 | 0.120 |
| The calculations took into account cases in which the numerical values of both studied characteristics were known. It was decided that the cases for which the fluid collection's persistence was 0 days or was a distinct outlier were rejected. | | | | |

**Tab. 3.** *Analysis of the correlation between the persistence of a fluid collection and its size following the determination of non-normality of distribution of the studied characteristics*

cording to the literature the immediate postoperative period is usually complicated by small encapsulating haematomas and plasma effusion[4,7,9]. Statistical data from numerous scientific reports regarding lymphocele occurrence indicate that this type of fluid collection usually occurs within the first year after the transplantation, with a peak between week 4 and 8. Lymphocele accounts for approximately 10–22% of all diagnosed fluid collections, 0.04–14.6% of which require intervention[2,4–6]. Our observations revealed that between day 20 and 40 from the first scan (the peak of lymphocele occurrence) 19.20% of fluid collections were diagnosed. However, one should bear in mind that the present authors did not have access to the results of biochemical analysis of the diagnosed fluid collections' contents; therefore, it is not possible to determine their clinical nature. It seems, therefore, that an important step in clinical investigation would be to conduct a prospective study to ascertain the nature of fluid collections, which would allow for the determination of the causes of their development as well as the methods of their prevention and elimination of the predisposing factors. Moreover, according to the medical literature some of the types of fluid collections can be the sign of pathologies which threaten the graft function and the patient's health[2,5].

It is also worth adding that the length of follow-up for half of the patients did not exceed 62 days (Mdn = 62.5) – due to their remote place of residence some patients underwent ultrasound evaluation in our center only up to the time of discharge from hospital. This situation could have affected the percentage distribution obtained in this study. This indicates the huge significance of following transplant patients up in the transplant center; otherwise, the evaluation of the dynamics and nature of the fluid collection and the decision whether to drain the fluid pocket can be inadequate or even impossible.

The authors of the present study have not managed to demonstrate the existence of any statistically significant correlations between the prevalence of perirenal fluid collections and demographic characteristics of the recipients or the location of the graft in the right or left iliac fossa and between the persistence of the fluid pockets and their initial dimensions and position relative to the kidney. However, a statistically significant relationship between the largest initial dimension of the fluid pocket and its position relative to the kidney has been demonstrated. It is not surprising that the loose texture of the subcutaneous tissue creates the most favorable conditions for the development of large fluid collections. Similar fluid collections spreading around the renal capsule and considered to be encapsulating the organ tended to grow larger; however, it should be emphasized that unidimensional assessment of the fluid collection's size may not fully correspond with the actual volume of the fluid collection. This is because fluid collections encapsulating the kidney, unlike other, more rounded types of fluid pockets, tend to assume a shape similar to a thin crescent. Interestingly enough, however, fluid collections are least common in the parahilar area and their mean size is relatively small. Therefore, a fluid collection rarely causes compression of the vessels or ureter of the graft, producing severe clinical signs. As mentioned above, only a small proportion of fluid pockets require draining and possibly sclerotisation.

## Conclusions

Perirenal fluid collections are a common finding in patients who have undergone allogeneic kidney transplantation. The majority of fluid collections do not give any distinct clinical signs and thus do not require treatment. Despite growing large subcutaneous fluid pockets and those encapsulating the kidney tend to be spontaneously absorbed. In contrast, fluid collections which can compress key structures of the graft are a rare finding and they are often small in size. The correct evaluation of a fluid collection's dynamics of development and nature requires periodic follow-up of the recipient, preferably in a single clinical center. Sonography is an inexpensive, non-invasive, non-damaging, repeatable method of assessment of fluid collections, particularly in such a superficial and easily accessible location as the iliac fossa. This method, however, is insufficient to evaluate the clinical nature of this abnormality. The decision whether a fluid collection requires treatment must also take into account the observation of laboratory signs of inflammation and the biochemical analysis of the collection's contents.

### Conflict of interest

*The authors do not report any financial or personal affiliations to persons or organisations that could negatively affect the content of or claim to have rights to this publication.*

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