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Ultrasound contributions to the management of the severely isoimmunized fetus

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1 Introduction

Since the first intrauterine transfusion performed in our hospital in 1965, 322 pregnancies have been treated for anti-D isoimmunization with this technique. Intrauterine fetal transfusion since then has been performed under cineradiographic control with but little modification of the procedure described originally in Sir WILIAM LILEY's report in 1963.

In 1980, after a trial period, we routinely started to adopt sonography for transfusional-needle guidance into the fetal peritoneal cavity and for monitoring fetal conditions during therapy [5].

Since the first experience reported by HANSMANN and LANG in 1972 [11], the advantages of this procedure have been extensively described [1, 9], especially as regards its great simplicity and the significant reduction or total alimination of X-rays exposure. A few papers have also reported the possible role of sonography in monitoring fetal conditions [12, 16]. In the present paper we report our experience on 24 fetuses treated by intrauterine transfusion (I. U. T.) for severe anemia due to anti-D isoimmunization.

2 Patients and procedures

During three years, 81 pregnant women affected by anti-D isoimmunization were treated in

Curriculum vitae

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our Perinatal Department; 24 fetuses (29.8%) underwent intrauterine transfusions.

When Coomb's titer was 1/16 or higher, amniotic fluid optical density at 450 nm ($\Delta OD-450$) was analyzed as early as 21 weeks of gestation. The results were interpreted according to the criteria in use in our Centre since 1970, which have extended LILEY's original zones to earlier than 28 weeks of gestation [7].

Clinical decisions were based on the absolute value and trend of successive $\Delta OD-450$ values, assuming a reliable spectral absorption curve and on past obstetrical history. Ultrasonographic fetal monitoring provided further data

for obstetrical management. The severity of ascites was semiquantitatively assessed by a three-grade scale: initial fluid collection with perihepatic fluid falda (mild), fluid collection with abdominal viscera clearly separated from the pelvic wall and bladder (moderate), overdistended abdominal wall (circumference above the 95th percentile), liver and spleen and packed intestinal loops floating in the ascitic fluid (severe). When scalp and soft tissue edema appeared the fetus was defined hydropic.

The ground-glass appearance of the placenta and its thickness were observed as was amniotic fluid volume. Additional parameters have subsequently been introduced but will not be discussed in this report.

The transfusion procedures were ultrasonically guided. Fetal lie and insertion of the placenta were determined in order to identify the needle insertion site and direction. The fetal liver margin was carefully avoided. Sector scanners then provided easy real time control of needle insertion (19 Gauge) through the abdominal wall into the peritoneal cavity. Where ascites was present a few milliliters of isolytic solution allowed a bubbling effect to be observed when the needle tip was free. Attempts were invariably made to remove as much amniotic fluid as possible.

In case of little abdominal fluid collection or of no ascites at all we confirmed the needle positioning by a cineradiographic sequence lasting a few seconds after injection 3–4 milliliters of contrast fluid. After obtaining the proof of the correct needle tip position, transfusion was started and completed in five to ten minutes.

Where bradycardia was observed, the injection was interrupted until normalization. In our experience these episodes have always been transient and benign.

Fetal transfusion were repeated every 10 to 15 days and the amount of packed red cells to be transfused (O, Rh negative, hematocrit 70–75%) was determined according to the week of gestation (approximately 10 ml for each week after the 21st). Post-transfusional monitoring included ultrasonic assessment of

fetal parameters and non-stress testing. This latter was still the main diagnostic test for timing delivery after the 29th week. All transfused fetuses were delivered via cesarean section before the 35th gestational week after corticosteroids lung maturity induction and L/S evaluation.

3 Results

Twenty four fetuses were treated with 68 I. U. T.s (2.8 I. U. T.s per fetus). Eight fetuses did not show ascites at any time (33%), 5 developed ascites or hydrops in spite of the transfusion therapy, and 11 were ascitic or hydropic at the time of the first transfusion.

Details of these groups divided by sonographic evaluation and monitoring are reported in table I. In addition to the mean values of the last $\Delta OD-450$ value before I. U. T., we also reported a qualitative assessment of the $\Delta OD-450$ trends as flat, slow rise and acute rise. Mean values of the last $\Delta OD-450$ reading progressively increased in the three groups in spite of the decreasing gestational age at which they were observed. None of the titers in the non-ascitic/hydropic fetuses showed a steep rising trend.

In no case was treatment started after the 31st week. Seventeen fetuses were transfused before the 26th week (71%). In 13 fetuses transfusions were started before ascites had appeared. Only 5 fetuses worsened and the three which became hydropic eventually died, two in utero and one 4 hours after delivery. The $\Delta OD-450$ of these 5 cases before therapy (absolute value and trend) already indicated that they were more severely affected. The fourth case of death in this group was a non-ascitic fetus referred to our hospital at 30 weeks in which an ultrasonic finding of cardiomegaly was underestimated and four hours after I. U. T. the non-stress test showed no baseline variability, severe late decelerations and final persistent bradycardia. Under real-time control a dramatic overdistension of the cardiac chambers was observed. Death occurred within the first hour of life. Hemoglobin on cord blood was 2.9 g/l.

Table I. Intrauterine fetal transfusion.

	Persistently non ascitic fetuses	Ascites or hydrops during IUTs	Ascites or hydrops at first IUT
N. of cases	8	5	11
Week ($\bar{x} \pm \text{s.d.}$)	27 ± 3	26 ± 3	25 ± 2
Last $\Delta\text{OD } 450$ ($\bar{x} \pm \text{s.d.}$)	0.330 ± 0.055	0.440 ± 0.141 $p < 0.05$	0.496 ± 0.267 n.s.
$\Delta\text{OD } 450$ Trend			
Flat	4	—	1
Slow rise	4	1	2
Acute rise	—	—	5
First IUT before 26 weeks	5	3	9
Sonographic monitoring	First-Last IUT	First-Last IUT	First-Last IUT
Normal fetus	8 8	5 —	— 2**
Ascites +	— —	— —	2** 2*
Ascites ++	— —	— 2	5* —
Ascites +++	— —	— —	1 —
Hydrops	— —	— 3	3 7
Interval between IUTs (days $\pm$ s.d.)	14 ± 1	12 ± 2	13 ± 2
N. IUTs survivors ($\bar{x}$, range)	3.3 (2–4)	3	3.5 (2–5)

First and last sonographic examination in the 3 improving cases.

In the third group by contrast, only 3 of the 11 fetuses that were already ascitic or hydropic at the first transfusion underwent any reduction of fluid collection, although two of them still showed a marked hepatosplenomegaly. Their $\Delta\text{OD-450}$ value was among the least severe in their group and treatment was started at 23 weeks for two of them ($\bar{x} = 0.330$).

The mean number of transfusions among survivors was 3.3 in non-ascitic and 3.5 in ascitic hydropic fetuses. In 2 cases the procedure failed at the first attempt, but it was successfully repeated 24 hours later. We had only one documented lesion, a small blood say located extra-peritoneally in the left flank of the baby, which was drained after birth.

Fetal and neonatal outcomes are reported in table II. No fetal loss occurred after 29 weeks. Three fetal deaths occurred within 24 hours after I. U. T., and can be attributable to the procedure (3.3% of the total number of I. U. T.s performed). However, in a case the ΔOD value rose from 0.240 to 0.624 in 12 days at 27 weeks; a second transfusion was performed after massive hydrops had developed. A second case was referred late to our hospital. At 27 weeks ΔOD was 1040 and the fetus was severely hydropic and died in utero after the second transfusion at 28 weeks.

Three neonatal deaths occurred at 29 (marked cardiomegaly), 32 (severe hydrops) and 31 weeks (severe hydrops). The values of hemoglo-

Table II. Fetal and neonatal outcomes.

	Persistently non ascitic fetuses	Ascites or hydrops during IUTs	Ascites or hydrops at first IUT
N. of cases	8	5	11
IUD	0	2	6
NND	1	1	1
Survivors	7	2	4
Delivery (Weeks: range, x + s.d.)			
IUD	—	25–29	25 ± 1
NND	31	29	32
Survivors	33 ± 2	32–34	32 ± 2
Weight (gr. range, x + s.d.)			
IUD	—	1550–1680	1625 ± 700
NND	1750	2000	2100
Survivors	2264 ± 502	2030–2350	1875 ± 318
Hemoglobin (g/l: range, x + s.d.)			
NND	2.9 §	10.3	10
Survivors	14.1 ± 4	9.6–9.1	10.3 ± 3
	p < 0.05		
Hematocrit			
NND	10 §	36	38
Survivors	44 ± 12	29–26	34 ± 14
	n.s.		

IUD = Intrauterine death; NND = Neonatal death; § = Marked cardiomegaly was observed in utero (see text).

bin differed significantly ($p < 0.05$) between the two groups of non-ascitic and ascitic babies at birth.

The overall proportion of survivors among non-ascitic fetuses was 88% and in ascitic/hydropic fetuses 38%. If we consider as ascitic or hydropic only those fetuses which were in this severe condition at the time of the first transfusion, the relative rates would be 69% and 36% respectively.

4 Discussion

The transformation of intrauterine fetal transfusion into a relatively simple procedure is the most evident contribution provided by ultra-

sound to the management of anti-D isoimmunized pregnancies.

Amniographic techniques have caused 20% fetal mortality per transfusion in the experience of some authors [14]. BOWMAN reported a 16.4 per 100 I. U. T.s of fetal traumatic deaths [2]; whereas HARMAN et al. from the same center but on the basis of a more recent experience report no failures or traumatic deaths [12].

In the present series we observed only 2 failed attempts (3%), 1 traumatic lesion (1.5%) and 3 fetal losses (4.4%) per I. U. T. However in two of these cases a severe and acute worsening of the fetal condition had occurred just before the last I. U. T. Between 1974 and 1978, 5.5 per 100 I. U. T.s of fetal traumatic losses [4] attributable to transfusion occurred in 85

patients transfused in utero under X-ray control in our centre (2.3 I. U. T.s per fetus).

Other groups have not observed similar trends in these safety standards. In any case the whole series so far reported is still far from reaching a statistical size [1, 3, 6, 9, 10, 12, 16]. Moreover a comparison of survival rates between the sonographic and pre-sonographic series may not be possible due to the effect of major improvements in tertiary neonatal care in the second half of the 1970s. Results are in fact similar in different centres. In the experience of the Winnipeg Rh laboratory survival rates increased from 70% in 1970–1978 [2] to 92% during 1980–1982 [3]. Similarly the survival rate of hydropic fetuses in the two periods improved from 50% to 75%. The Harvard Group [10] observed a positive trend in fetal survival rates from the series published in 1977 to the 35 cases of I. U. T.s under sonographic control reported in 1982. Survivors increased from 7% to 29% in hydropic fetuses and from 53% to 62% in non-hydropic fetuses. In our center the comparison between the 1978 series [9] with results obtained in the 24 fetuses treated since the routine introduction of sonography shows a similar trend in survival rate, rising from 13% to 38% in hydropic fetuses and from 51% to 88% in non-hydropic fetuses. A new dramatic improvement in the treatment of hydropic fetuses before 25 weeks by intravascular fetoscopic transfusion has been recently reported by RODECK and co-workers [15]. In this series they obtained survival rate of 85%. In non hydropic fetuses the data so far presented by this group did not differ much from more traditional approach, i. e. 70%.

In more recent papers and in our own experience ultrasound has played an important role in monitoring fetal conditions. In our series 3

fetuses were already severely hydropic and 8 ascitic at the time of the scheduled amniocentesis. These findings suggest that in addition to amniocentesis, Rh-affected fetuses must be monitored by ultrasound at least weekly depending on the severity of clinical history. In this way it would be possible to perform the amniocentesis and I. U. T. earlier in worsening cases. We treated two cases with favorable results from 23 weeks of gestation with only moderate ascites. Similarly good results were obtained by DE VORE [8] in two fetuses in which I. U. T.s were started just after the initial fluid collection in the pericardial sac at 22 and 24 weeks of gestation.

This is possible, thanks to the detailed analysis of the fetus provided by sonography. However, in some recent reports the terms ascites and hydrops are used interchangeably. We chose to express the evaluation of the fetal condition as judged by sonography, of ascites developing into hydrops. These gross sonographic parameters we adopted matched the ΔOD values well. The absolute values and trend of $\Delta OD-450$ before I. U. T. in the cases which developed ascites after the first I. U. T. are much more similar to those already in this state at first transfusion than to persistently non-hydropic fetuses ($p < 0.05$). Similarly in the three fetuses in which an improvement was observed after the transfusions, the $\Delta OD-450$ value was lower than in the other fetuses in their group.

However this grading is still far from being an answer to the questions posed by isoimmunization of the fetus. It is likely that larger prospective series and a fresh dynamic approach to fetal hazards such as blood flow studies [13], provide additional and more sensitive parameters for monitoring and treating this severe fetal disease.

Summary

Twentyfour out of 81 fetuses affected by anti-D isoimmunization underwent ultrasonic guided intrauterine transfusions (2.8 I. U. T.s per fetus). The absolute value and trend of $\Delta OD 450$ micron value was correlated with the severity of fetal condition as evaluated by

ultrasonography following simple semiquantitative grading of ascites (mild, moderate, severe) and diagnosis of hydrops. The evaluation of disease was monitored in this way during transfusion therapy. Transfusion procedures have been ultrasonically guided. When ascites was

present a few milliliters of isolytic solution allowed the bubbling effect to be observed. In the case of no ascites we confirmed the needle positioning by a cineradiographic sequence lasting a few seconds. Fetal transfusions were repeated every 10 to 15 days and the amount of packed red cells to be injected was determined according to the week of gestation. Post-transfusion monitoring included ultrasonic reevaluation of fetal parameters and non-stress testing. All fetuses were delivered via cesarean section before the 35th week of gestation. In no case was treatment started after the 31st week. Seventeen fetuses were transfused before the 26th week (71%). In 13 fetuses transfusions were started before ascites had appeared. Only 5 fetuses worsened and the 3 which became hydropic eventually died. The $\Delta OD-450$ value of these 5 cases before therapy had already indicated that they were more severely affected. Survival rate in this group was 69%. Eleven fetuses showed different degrees of ascites or hydrops at the time of the first transfusion. A marked improvement was observed only in the 3 cases in which treatment was started early and/or with only a mild to moderate ascites. Survival rate in this group was 36%.

No fetal loss occurred after 29 weeks. Three fetal deaths occurred within 24 hours after I. U. T. Three neonatal deaths occurred at 29 (marked cardiomegaly), 32 (severe hydrops) and 31 weeks (severe hydrops). The transformation of intrauterine fetal transfusion into a relatively simple procedure is the most evident contribution pro-

vided by ultrasound to the management of anti-D immunized pregnancies.

In the present series we observed only 2 (3%) failed attempts, 1 (1.5%) subcutaneous traumatic lesion and 3 (3.3% fetal losses per I. U. T.). Between 1974 and 1978 in our Centre 5.5% of fetal traumatic losses attributable to the transfusion procedure occurred in 85 patients transfused in utero under X-ray control. These results are in fact similar to those reported by different centres. Moreover the proportion of survivors rose in the two series from 13% to 36% in hydropic fetuses and from 51% to 69% in non-hydropic fetuses. In recent papers, as well as in our own experience, ultrasound has played an important role in monitoring fetal conditions. This allows the physician to perform scheduled amniocentesis and I. U. T.s earlier in worsening cases. We chose to express the evaluation of the fetal condition as judged by sonography, of ascites developing into hydrops. These gross sonographic parameters we adopted matched the ΔOD values well. The absolute value and trend of $\Delta OD-450$ before I. U. T. in the cases which developed ascites after the first I. U. T. are much more similar ($p = n.s.$) to those already in this state at the time of first transfusion than to persistently non-ascitic fetuses ($\bar{u} < 0.05$). Similarly in the ascitic fetuses in the three fetuses in which an improvement was observed after the transfusions, the $\Delta OD-450$ was lower than in the other fetuses in their group.

Keywords: Erythroblastosis, isoimmunization, real-time ultrasound.

Zusammenfassung

Bedeutung des Ultraschalls beim Management von Schwangerschaften mit Rhesusinkompatibilität

Wir führten bei 24 von insgesamt 81 Feten mit Rhesusinkompatibilität intrauterine Transfusionen (IUT) unter Ultraschallkontrolle durch; (durchschnittlich 2,8 IUT's pro Fet). Der absolute Wert der optischen Dichte des Fruchtwassers ($ODD-450$) sowie die Titerverläufe korrelierten mit dem fetalen Zustand. Die Zustandsdiagnostik erfolgte per Ultraschall über eine semiquantitative Einstufung des Aszites (geringgradig, mäßig, hochgradig) sowie den Nachweis eines Hydrops. Während der Transfusionstherapie wurden die Krankheitsverläufe nach obigem Schema dokumentiert. Wie ausgeführt, erfolgte die Transfusion unter Ultraschallkontrolle. Bei Vorhandensein von Aszites konnte der richtige Sitz der Nadel nach Injektion von wenigen Millilitern isotoner Lösung und dem dabei auftretenden Sprudeleffekt bestätigt werden. War kein Aszites nachweisbar, überzeugten wir uns vom richtigen Sitz der Nadel mit Hilfe einer wenige Sekunden andauernden Durchleuchtung. Die Transfusionen wurden in Abständen von 10–14 Tagen wiederholt. Die Menge des Erythrozytenkonzentrates richtete sich nach der Schwangerschaftswoche. Nach den Transfusionen erfolgten Ultraschallkontrollen sowie eine Überwachung mit Non-Stress-Tests. Alle Kinder wurden

vor der 35. Schwangerschaftswoche per Sectio caesarea entbunden. Nach der 31. Woche wurde die Transfusionstherapie nicht mehr begonnen. Bei 17 Feten (71%) begann die Therapie vor der 26. Woche. In 13 Fällen war vor der Therapie noch kein Aszites nachweisbar. Bei 5 Feten verschlechterte sich der Zustand; die 3 Feten, die einen Hydrops entwickelten, starben schließlich. Die $ODD-450$ bei diesen 5 Fällen zeigte bereits vor der Therapie an, daß diese Kinder schwerer betroffen waren. Die Überlebensrate in dieser Gruppe betrug somit 69%. 11 Feten hatten bei Beginn der Transfusionstherapie einen unterschiedlich ausgeprägten Aszites oder Hydrops. Eine Besserung des fetalen Zustands wurde nur in den 3 Fällen erreicht, wo zu Beginn der Therapie ein geringgradiger bis mäßiger Aszites vorlag. Die Überlebensrate in dieser Gruppe betrug 36%.

Nach der 29. Woche trat kein intrauteriner Tod ein. Dreimal kam es innerhalb von 24 Stunden zum Absterben des Feten. Zum Tod in der Neonatalphase kam es in 3 Fällen: einmal in der 29. Woche bei ausgeprägter Kardiomegalie, zum zweiten in der 32. Woche bei schwerem Hydrops und zum dritten in der 31. Woche aus dem gleichen Grund.

Die Bedeutung des Ultraschalls beim Management von Schwangerschaften mit Rhesusinkompatibilität liegt

darin, daß mit seiner Hilfe die IUT zu einem relativ einfachen Prozeß wird.

In der vorliegenden Studie ist die IUT in 2 Fällen (3%) nicht gelungen; in einem Fall (1,5%) kam es zu einer traumatischen Läsion der Subkutanschicht und in 3 Fällen zum Abort (d. i. 3,3% pro IUT). Zwischen 1974 und 1978 waren in unserem Zentrum 5,5% Aborte zu beobachten, die auf Transfusionen bei 85 Patienten unter Röntgen-Kontrolle zurückzuführen waren. Verschiedene andere Zentren geben ähnliche Zahlen an. Der Vergleich zeigt, daß sich die Überlebensrate bei hydropischen Feten von 13 auf 36% und bei nichthydropischen Feten von 51 auf 69% erhöht.

Neuere Arbeiten sowie unsere eigenen Erfahrungen zeigen, daß der Ultraschall bei der fetalen Zustandsdiagno-

stik einen wichtigen Platz einnimmt. Er ermöglicht gezielte Amniozentesen und bei Verschlechterung des Zustands rechtzeitige IUT's. Sonographisch kann erkannt werden, wann der Aszites in einen Hydrops übergeht. Diese Parameter entsprechen auch gut dem Verlauf der ODD-Werte. Die absoluten Werte sowie der Trend der ODD-450 sind vor der ersten IUT in den Fällen, die nach der Transfusion einen Aszites entwickeln, mit denen nach der IUT vergleichbar ($p =$ nicht signifikant). Dies gilt nicht für Feten, die niemals einen Aszites entwickeln. Hier ist der Unterschied auf dem 5%-Niveau signifikant. Auch bei den 3 Feten mit Aszites, wo sich nach der Transfusion der Zustand verbesserte, lag die ODD-450 niedriger als bei den anderen Feten dieser Gruppe.

Schlüsselwörter: Erythroblastose, Isoimmunisierung, Real-Time-Ultraschall.

Résumé

Contribution des ultrasons à la prise en charge des fœtus atteints d'iso-immunisation sévère

24 fœtus sur 81 atteints d'allo-immunisation anti-D ont nécessité des transfusions in utero sous échographie (2,8 IUT par fœtus). On a corrélé la valeur absolue et l'évolution du titre d'ODD 450 avec la gravité de l'état fœtal appréciée par échographie sur l'évaluation simple semi quantitative de l'ascite (moyenne, légère, importante) et sur le diagnostic d'hydrops. On a surveillé l'évaluation de la maladie de la sorte au cours de la thérapeutique transfusionnelle. Les transfusions ont été guidées par l'échographie. En cas d'ascite, l'injection de quelques millilitres d'une solution isotonique permet d'observer l'effet de bouillonnement. En l'absence d'ascite, nous confirmons la position de l'aiguille par une séquence cinéradiographique de quelques secondes. Les transfusions fœtales sont répétées tous les 10 à 15 jours et le volume de globules rouges à injecter est déterminé en fonction de l'âge gestational. La surveillance post-transfusion comporte une réévaluation échographique des paramètres fœtaux et un non stress-test. Tous les fœtus ont été extraits par césarienne avant la 35ème semaine de gestation. Le traitement n'a jamais débuté après la 31ème semaine. Dix sept fœtus ont été transfusés avant la 26ème semaine (71%). Chez 13 fœtus, les transfusions ont été commencées avant l'apparition de l'ascite. 5 fœtus seulement s'aggravèrent et les 3 qui devinrent hydropiques décédèrent finalement. L'ODD 450 de ces 5 cas avant tout traitement indiquait déjà qu'ils étaient plus sévèrement atteints. Le taux de survivant dans l'ensemble de ce groupe a été de 69%. Onze fœtus présentaient différents degrés d'ascite ou d'hydrops au moment de la première transfusion. Une amélioration nette n'a été observée que pour les 3 cas chez lesquels le traitement avait débuté précocement et/ou chez lesquels il n'y avait qu'une ascite légère ou modérée. Le taux de survivant dans ce groupe a été de 36%.

Il n'y a pas eu de morts fœtales après 29 semaines. Trois morts fœtales sont survenues dans les 24 heures après I. U. T. Trois morts néonatales sont survenues à 29 semaines (cardiomégalie majeure), à 32 semaines (hydrops important) et à 31 semaines (hydrops important).

La contribution la plus évidente des ultrasons à la prise en charge des grossesses avec immunisation anti-D est la transformation de la transfusion in utero en une technique relativement simple.

Dans cette série, nous n'avons observé que 2 échecs (3%), 1 lésion traumatique sous-cutanée (1,5%), et 3 morts fœtales par I. U. T. (3,3%). Dans notre centre entre 1974 et 1978, 5,5% des pertes fœtales traumatiques attribuables à la technique transfusionnelle sont survenues chez 85 patientes transfusées in utero sous contrôle radiologique. Ces résultats sont en fait similaires à ceux rapportés par les différents centres. En outre, la proportion de survivants s'est élevée dans les deux séries de 13% à 36% chez les fœtus hydropiques et de 51% à 69% chez les fœtus non hydropiques. Dans les articles récents comme dans notre propre expérience, les ultrasons jouent un rôle important dans la surveillance de l'état fœtal. Ils permettent de réaliser une amniocentèse supplémentaire et des I. U. T. plus précocement dans les cas désespérés.

Nous avons choisi d'exprimer l'évaluation de l'état fœtal sur l'appréciation échographique du développement de l'ascite vers l'anasarque. Ces paramètres échographiques grossiers que nous avons adoptés concordent bien avec les valeurs de l'ODD. La valeur absolue et l'évolution de l'ODD 450 avant I. U. T. dans les cas où une ascite apparaît après la première I. U. T. sont beaucoup plus similaires ($p =$ NS) à ceux qui ont déjà une ascite au moment de la première transfusion qu'à ceux des fœtus qui resteront sans ascite ($p < 0.05$). De même que chez les fœtus avec ascite, chez les 3 fœtus ayant eu une amélioration après transfusions, les ODD 450 étaient plus bas que chez les autres fœtus de leur groupe.

Mots-clés: Echographie en temps réel, érythroblastose, iso-immunisation.

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