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Prospective Study to Analyze the Concordance Between a Standardized Visual Method With Pathology to stratify Nonalcoholic Fatty Liver Disease in Cadaveric Liver Grafts Evaluated for Transplantation

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Background. The main challenge of liver transplantation is the discrepancy in demand and availability. Marginal grafts or full organs from donors with expansion criteria have been considered to reduce the shortage and assist a greater number of patients. Nonalcoholic fatty liver disease (NAFLD) is one of the most important defining criteria for expanded criteria organs. The present study proposes that an organized visual analysis method could correctly identify and classify NAFLD and organ viability without the need for liver biopsy and its logistical concerns. **Methods.** Pictures from the grafts were taken at a standardized method (same distance, light conditions, and register device) before and after the perfusion. The visual liver score (VLS) was applied by transplant surgeons; biopsies of the grafts were analyzed by a pathologist in a double-blind design. Score performance and interobserver agreement for NAFLD detection and grading, as graft viability evaluation, were calculated. **Results.** Fifty-seven grafts were analyzed. At least 1 previous expansion criterion was presented by 59.64% of donors. The prevalence of NAFLD was 94.73%, with 31.57% borderline nonalcoholic steatohepatitis and 5.26% nonalcoholic steatohepatitis. Steatosis was identified with 48.68% (preperfusion) and 64.03% (postperfusion) accuracy. NAFLD stratification was performed with 49.53% (preperfusion) and 46.29% (postperfusion) accuracy. Viability related to NAFLD was identified with 51.96% (preperfusion) and 48.52% (postperfusion) accuracy. Interobserver agreement was moderate for total VLS and poor for individual components of VLS. **Conclusions.** Although a standardized method was not reliable enough for visual evaluation of NALFD compared with pathology, efforts should be made to expand access to biopsy. Further studies are needed to understand whether the VLS needs to be adapted or even excluded in the liver transplant scenario, to assess the importance of ectoscopy related to posttransplant clinical outcomes, and to determine its role in graft selection.

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The increasing disparity between the demand for donated organs and their availability is one of the primary challenges in the field of liver transplantation today.[1] As a result, marginal grafts or organs from donors

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that meet expanded criteria have been considered as a strategy to alleviate the shortage and reduce the transplant waiting list.[2] Nonalcoholic fatty liver disease (NAFLD)[3] is one of the most important defining criteria for expanded criteria organs.

Although steatosis is a risk factor for worse results after orthotopic liver transplantation,[4-6] the usage of steatotic livers contributes significantly to expanding the donor pool. Thus, it is crucial to have an accurate assessment of hepatic steatosis for the selection of these high-risk organs.[7] The yellowish coloration in the liver can be due to the presence of steatosis or lipofuscin deposition in the organ. Pretransplant ..... donor evaluation should benefit from the frozen section technique, if available, to permit a distinction between those 2 conditions.[5] Because diagnosing NAFLD is challenging,[8,9] a liver biopsy microscopic analysis is a gold standard for its diagnosis by a pathologist. Although pathology is rarely available at the time of need, in many centers, organ availability depends only on the ectoscopic (ie, external visual) analysis of steatosis and organ quality performed by the field surgeon.

Unfortunately, when there is doubt about graft pathological involvement and there is no possibility of histological confirmation, organ discard is mandatory. The data on the accuracy of visual assessment in the discrimination of NAFLD are conflicting and ambiguous.[10-14] The methodology is significantly variable among those studies, with no evidence guiding the selection of pieces for biopsy in the intraoperative suspicion of NAFLD scenario, particularly discerningly nonalcoholic steatohepatitis (NASH) or fibrosis.

Recently, a standardized visual scoring system (visual liver score [VLS]) was developed that was a simple, accurate, and reproducible tool used for the assessment of NAFLD-related abnormalities incidentally encountered during laparoscopic surgery. Mainly, VLS stratified patients into low, intermediate, and high risk for NASH more reliably than the subjective assessment, guiding the diagnostic performance of a intraoperative liver biopsy.[15] The present study proposes an organized visual analysis method that could correctly identify and classify NAFLD and organ viability related to it without needing the liver biopsy, thus increasing the number of available grafts.

MATERIALS AND METHODS

Ethical approval was obtained at Angelina Caron Hospital Ethics Committee from the Brazilian National Research Ethics Committee (reference number: 91928218.7.0000.5226) according to Conselho Nacional de Saúde resolution 466/12. The need for additional informed consent was dismissed because there has been prior authorization for the scientific purpose use of the donor grafts in the Paraná State Transplant Central (PSTC) Donation Informed Consent, signed by the donor's family (**Figure S1, SDC,** http://links.lww.com/TXD/A576). The VLS color component criteria are exemplified in Figure 1, where the color in preperfusion and postperfusion can be seen in each criterion. This was a prospective study of consecutive eligible liver grafts between June 2018 and November 2019 at the hospitals where the donors were admitted by the Angelina Caron Hospital transplant team, when assigned by PSTC, according to the transplant prioritization list.

Patients were included if (1) they were aged older than 18 y or more, (2) had absence of nonviability of the graft for another cause (eg, traumatic injury, cirrhosis), (3) had no positive serology for active viral hepatitis, and (4) had absence of alcohol abuse in the previous 2 y (>294 g/wk for men, >196 g/wk for women). Patients were excluded if they were living, had split graft and multivisceral graft, or were circulatory death donors. A complete record of previous and current medical history and laboratory tests was obtained from the PSTC Summarized Donation Report, using an electronic form (**Figure S2, SDC,** http://links.lww.com/TXD/A576). From these data, we investigated the frequency of risk factors for NAFLD and the main expansion criteria in liver transplantation: (1) age older than 60 y, (2) intensive care unit (ICU) length of stay >5 d, (3) serum sodium >155 mEq/L, and (4) hypotension or high flow of vasoactive drugs.

Procurement Operation

After macroscopic evaluation of the graft by the transplant surgeon, 2 wedges (1 × 0.5 × 2 cm) of liver biopsies were taken from segment III and segment V, before organ perfusion. An experienced pathologist graded the biopsies in a blinded manner, according to the NAFLD activity score (NAS)[9] and classifications of liver fibrosis by Kleiner et al.[10] NAS is a score from 0 to 8 based on steatosis severity (0–3), inflammation severity (0–3), and hepatocyte ballooning presence (0–2). A total NAS of ≥5 is diagnostic for NASH; NAS 3 to 4 is a possibility for NASH, and NAS 0 to 2 is negative for NASH. Initially, this scoring system was mainly developed for research purposes and not strictly for clinical diagnosis of NASH.[16] Fibrosis was staged from F0 to F4, with F1 being perisinusoidal or periportal fibrosis, F2 being perisinusoidal and portal/periportal fibrosis, F3 being bridging fibrosis, and F4 being cirrhosis.

Pictures from the grafts were taken at a standard distance and adequate light conditions, using the same high-resolution register device (8 megapixels), pre– and post–organ perfusion, for posterior analysis.

VLS

As previously indicated, the VLS was applied to the grafts in 2 distinct moments: preperfusion and postperfusion.[15] Liver appearance was scored on the basis of the categories of color (0–2), size (0–3), and surface nodularity (0–3), with a total score calculated by the sum of these categories. The grading system is detailed in **Table S1** (**SDC,** http://links.lww.com/TXD/A576. Four experienced transplant surgeons participated in this study. During the analysis, the surgeons were asked to evaluate the photographic registers and grade the liver grafts according to the VLS, preperfusion, and postperfusion. This was a double-blind study: surgeons had no access to the clinical or histological information, such as the pathologist not seeing the clinical or macroscopic graft information. There was no interference in the procurement surgeon's decision to use graft.

Statistical Analysis

Continuous variables were expressed as mean ± SD for parametric data and as median and interquartile range for nonparametric data. Categorical variables were expressed as numbers (with percentages). Fleiss Kappa statistic was used for interobserver agreement. The sample size was calculated

on the basis of a pilot study with 20 donors to reach a beta value of 0.8 and alfa value of = 0.05. In this logic, 55 organs were needed to the study answer our question.

Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated considering the total number of opportunities in which the score or its components (depending on the analysis considered) were used, being the sum of the evaluations made by all 4 observers.

To evaluate the VLS efficiency in detecting and quantitatively stratifying steatosis, values attributed to the VLS color component were separately compared with the histological quantitative grading, according to the NAS steatosis grade component (Table 1). In Figure 2, examples where the VLS total score is corresponding with the histological findings can be seen.

Total VLS was stratified into low (VLS ≤1), intermediate (VLS 2–3), or high risk (VLS ≥4) for NASH, as suggested in its original description.[15] This stratification was correlated with NAS categories for NASH (Table 2).

Isolated steatosis was considered quantitatively significant when VLS color component was 2 or NAS steatosis grade was ≥2. Grafts were considered unviable when attributed VLS was ≥4 or NAS ≥5.

RESULTS

Patients

Sixty-two livers of diseased donors were included in the study. Five samples were excluded, 2 because of photographic register loss and 3 because of incorrect preservation of biopsies. The baseline characteristics of the 57 organs analyzed are shown in Table 3.

A considerable proportion of donors had at least 1 previous expansion criteria (59.64%), such as age, ICU stay, and high dose of vasoactive drugs or high sodium. Additionally, 70.58% of these patients, and 82.6% of those with no immediately identifiable expansion criteria presented with overweight, obesity, systemic arterial hypertension, diabetes, or dyslipidemia, the most important risk factors for NAFLD.

TABLE 1.

Analytical comparison between VLS color component and NAS steatosis grade component

VLS	NAS
Color component	Steatosis grade component
0	0
1	1
2	2
	3

NAFLD, nonalcoholic fatty liver disease; NAS, NAFLD activity score; VLS, visual liver score.

TABLE 2.

Analytical comparison between VLS and NAS

VLS		NAS	
0–1	Low risk for NASH	0–2	NAS absent
2–3	Intermediate risk for NASH	3–4	NASH undetermined
≥ 4	High risk for NASH	≥5	NASH confirmed

NAFLD, nonalcoholic fatty liver disease; NAS, NAFLD activity score; NASH, nonalcoholic steatohepatitis; VLS, visual liver score.

TABLE 3.

General characteristics of population

Variable	Patients (N = 57)
Demographic	
Age, y, mean ± SD	46.4 ± 15.2
>60 y	15 (26%)
Male gender, %	52.5%
Race, n (%)	
Caucasian	44 (77%)
Afro descendant	12 (21%)
Native Brazilian	1 (2%)
Alcohol use, n (%)	19 (33%)
Clinical	
ICU length of stay, d, n (%)	
≤ 5	38 (67%)
>5	19 (33%)
CPA, n (%)	11 (19%)
Systolic blood pressure, mm▓Hg, mean ± SD	113.2 ± 19.4
BMI, kg/m², mean ± SD	26.2 ± 4.3
Very low weight, n (%)	2 (4%)
Low weight, n (%)	1 (2%)
Normal, n (%)	17 (30%)
Overweight, n (%)	26 (46%)
Grade 1 obesity, n (%)	9 (16%)
Grade 2 obesity, n (%)	2 (4%)
Causa mortis, n (%)	
Head trauma	14 (25%)
Ischemic stroke	5 (9%)
Hemorrhagic stroke	26 (46%)
Hypoxic–ischemic encephalopathy	6 (11%)
Subarachnoid hemorrhage	5 (9%)
Meningitis	1 (2%)
Metabolic comorbidities, n (%)	
SAH	19 (33%)
Diabetes	8 (14%)
Dyslipidemia	2 (4%)
Vasoactive drugs, n (%)	35 (61%)
Norepinephrin or equivalent, µg/kg/min, mean ± SD	0.33 ± 0.5
High flow, >0.5 µg/kg/min , n (%)	4 (7%)
Treated infection	18 (32%)
Laboratory, mean ± SD	
Serum sodium, mEq/L	144.7 ± 8.4
Sodium >155 mEq/L, n (%)	6 (11%)
Total bilirubin, mg/dL	0.53 ± 0.27
ALT, U/L	84.1 ± 212.1
AST, U/L	57.9 ± 56.1
GGT, U/L	112 ± 152.2
Hepatitis B core antibody positive, n (%)	3 (5%)

ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; CPA, cardiopulmonary arrest; GGT, gamma-glutamyl transpeptidase; ICU, intensive care unit; SAH, systemic arterial hypertension.

Significant fibrosis (F ≥2) was not found in the present population. NAFLD was highly prevalent (94.73%), although most samples (77.19%) had grade 1 steatosis, and only 5.26% fulfilled the histological criteria for definitive steatohepatitis (Table 4). The correlation between NAFLD stratification and the number of donor-related expansion criteria is shown in Table 5.

VLS and Assessments

Considering the visual analysis of the evaluators, a trend toward an increase in the points attributed to color score after

TABLE 4.

Pathology findings

Variable	Samples (N = 57), n (%)
NAFLD	54 (94.73%)
Kleiner (fibrosis)	24 (42.1%)
F0: absent	
F1: periportal or perisinusoidal	33 (57.89%)
Type of steatosis	3 (5.26%)
Absent	
Microgoticular	7 (12.28%)
Macrogoticular	3 (5.26%)
Mixed	38 (66.66%)
Non specified	6 (10.52%)
Grade of steatosis	3 (5.26%)
Grade 0: <5%	
Grade 1: 5%–33%	44 (77.19%)
Grade 2: >33%–66%	7 (12.28%)
Grade 3: >66%	3 (5.26%)
Lobular inflammation	45 (78.94%)
0: absent	
1: <2 foci	12 (21.05%)
Hepatocyte ballooning	10 (17.54%)
0: absent	
1: few ballooned cells	35 (61.4%)
2: many ballooned cells	12 (21.05%)
NAS	36 (63.15%)
0–2: NASH absent	
3–4: borderline NASH	18 (31.57%)
5–8: NASH	3 (5.26%)

NAFLD, nonalcoholic fatty liver disease; NAS, NAFLD activity score; NASH, nonalcoholic steatohepatitis.

TABLE 5.

Correlation between NAFLD stratification and number of previous expansion criteria

NAFLD stratification	Donor-related expansion criteria
NAS 0–2 = 36 grafts	1 criterion = 20 (55.55%)
	2 criteria = 2 (5.55%)
	3 criteria = 1 (2.77%)
NAS 3–4 = 18 grafts	1criterion = 8 (44.44%)
	2criteria = 4 (22.22%)
NAS ≥5 = 3 grafts	1 criterion = 3 (100%)

NAFLD, nonalcoholic fatty liver disease; NAS, NAFLD activity score.

organ perfusion was noticed (Figure 3A). The same trend was not seen when considering size scores, surface scores, or total VLS points (Figure 3B).

Diagnostic Accuracy

The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy for various threshold values of the total VLS and its assessments are shown in Table 6.

From the analyzed data, the color score performance to identify the presence of steatosis and its grade were evaluated, preperfusion and postperfusion. Additionally, the isolated capacity of the color score to detect significant steatosis (NAS grade of steatosis 2–3, steatosis >33%) was analyzed.

Considering the 54 grafts presenting with NAFLD, the total VLS performance to correctly stratify NAFLD severity was correlated to the total NAS risk ranges.

To assess the total VLS ability to determine graft viability, in the context of NAFLD, unviability thresholds were VLS of ≥4 or NAS of ≥5. In this scenario, viable grafts would be discarded according to the visual evaluation, by all 4 evaluators (Figure 4).

Conversely, only 3 grafts were considered definitively unviable according to NAS. All 4 evaluators assigned them viable total VLSs at some moment of pre or postperfusion analysis (**Figure S3, SDC,** http://links.lww.com/TXD/A576).

Interobserver Agreement

Different statistical methods were tested to analyze the interobserver agreement considering total VLS and its components, as shown in Figures 5 and 6, with Fleiss Kappa being the most reliable model.

The total VLS had a moderate agreement among the 4 evaluators, being better in postperfusion ($\kappa = 0.48$) than in preperfusion analysis ($\kappa = 0.36$). There was poor agreement on the individual components of VLS, tending to show better results after organ perfusion (color: $\kappa = 0.11$ and 0.23; size: $\kappa = 0.02$ and 0.07; surface: $\kappa = 0.01$ and 0.08).

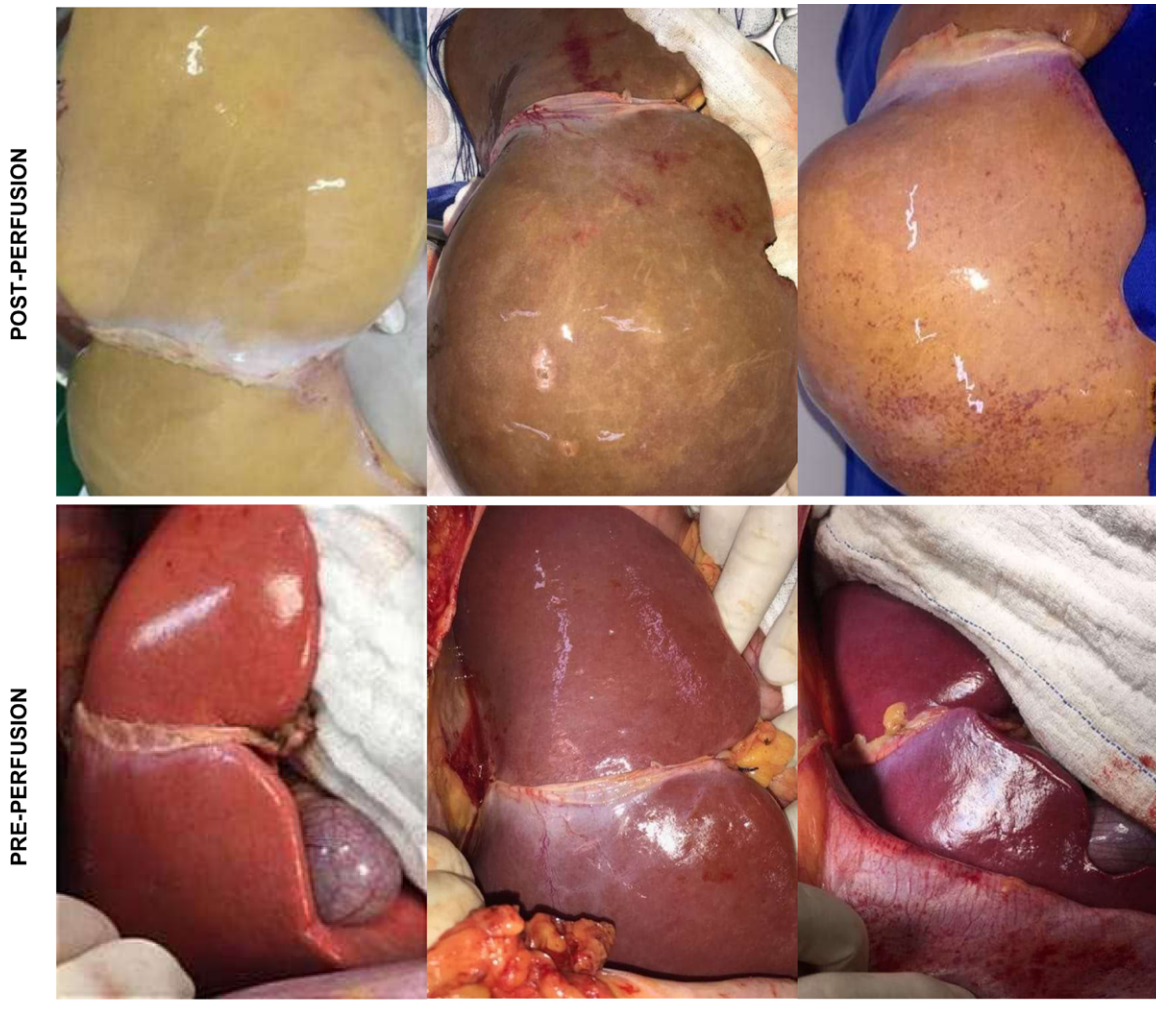
DISCUSSION

This was the first study to investigate the accuracy of a standardized visual method (VLS) when detecting and stratifying NAFLD in liver grafts during organ procurement surgery, compared with pathology. The main finding shows that organ biopsies to be transplanted are mandatory to avoid discharging viable organs. If a compromised organ is transplanted, this poses a serious risk for the recipient. In contrast, the availability of organs for transplant is far fewer than the number of patients in need of liver transplantation, so viable organs must not be discarded.[1,2]

Epidemiological data highlight the frequency of expansion criteria among donors nowadays. More than that, the considerable proportion of donors presented with risk factors or confirmed NAFLD corroborates the necessity of a donor pool that allows a larger organ offer to the community and reduces list waiting time for transplants. This finding relates to the fact that the epidemic of diabetes and obesity in the Western world has increased the number of obese or steatotic donors during the past 2 decades.[17,18] On the other side, a low frequency of intensive care management-related expansion factors (such as hypernatremia or high flow of vasoactive drugs) was identified. This is probably due to donor screening and care policies implemented in Paraná, Brazil, in the past 10 y.[19]

Studies show that the association of expansion criteria in the same donor, such as age older than 60 y, serum sodium >155 mEq/L, ICU stay ≥5 d, cold ischemia time >12 h, and hypotension or vasoactive drugs in high flow rate, can increase the likelihood of liver graft dysfunction from 2.2% in the absence of expansion factors for up to 30% in the presence of ≥4 elements. The probability of primary graft nonfunctioning increases from 1.1% to up to 40% in the same setting.[20] Thus, the correct detection and stratification of NAFLD through an available, feasible, and reproducible method are fundamental in the current scenario of a high frequency of expanded criteria donors.

Among those with undetermined NAS (scores 3–4), 66.6% (12/18) presented at least 1 expansion criterion other than



COLOR COMPONENT	DESCRIPTION	DETAILS
0	Normal color	Tan color
1	Moderate steatosis	Sparse/moderate yellow color
2	Significant steatosis	Homogenous yellow color

FIGURE 1. Color component guide.

NAFLD. Considering that the number of expansion factors is directly related to graft dysfunction,[21] identifying NAFLD in the decision process of graft used is important. Modifiable expansion factors, such as cold ischemia time, could be intensively managed when another constitutional expansion factor is detected.

Longitudinal studies in bariatric populations suggest that when routine biopsies are not performed, 86% of NASH and 88% of advanced fibrosis diagnoses are missed.[10,22] However, even in these studies, rates of severe NAFLD are less frequent than simple steatosis, resulting in a significant number of unnecessary biopsies performed.[23] Additionally, the risks, costs, longer operative time

TABLE 6.

Diagnostic accuracy of various thresholds for total VLS and its assessments

	Preperfusion					Postperfusion				
	Sens	Spec	PPV	NPV	Acc	Sens	Spec	PPV	NPV	Acc
Steatosis detection (color 1–2 attributed to NAS grade of steatosis 1–3)	41.48%	82.5%	91.76%	23.07%	48.68%	61.7%	75%	92.06%	29.41%	64.03%
Correct stratification of steatosis by grade					41.22%					50%
Correct stratification of significant steatosis (≥33%)	12.5%	98.9%	71.42%	84.16%		32.5%	89.89%	40.62%	86.2%	
NAFLD severity stratification (NASH absent/undetermined/present)					49.53%					46.29%
VLS 0–1			68.59%					68.8%		
VLS 2–3			33.82%					32%		
VLS ≥4			3.7%					3.12%		
Identification of viability (VLS 0–3 attributed to NAS 0–4)	87.25%	8.33%	94.17%	3.77%	51.96%	84.8%	8.33%	94.02%	3.12%	48.52%

Acc, accuracy; NAFLD, nonalcoholic fatty liver disease; NAS, NAFLD activity score; NPV, negative predictive value; PPV, positive predictive value; Sens, sensitivity; Spec, specificity; VLS, visual liver score.

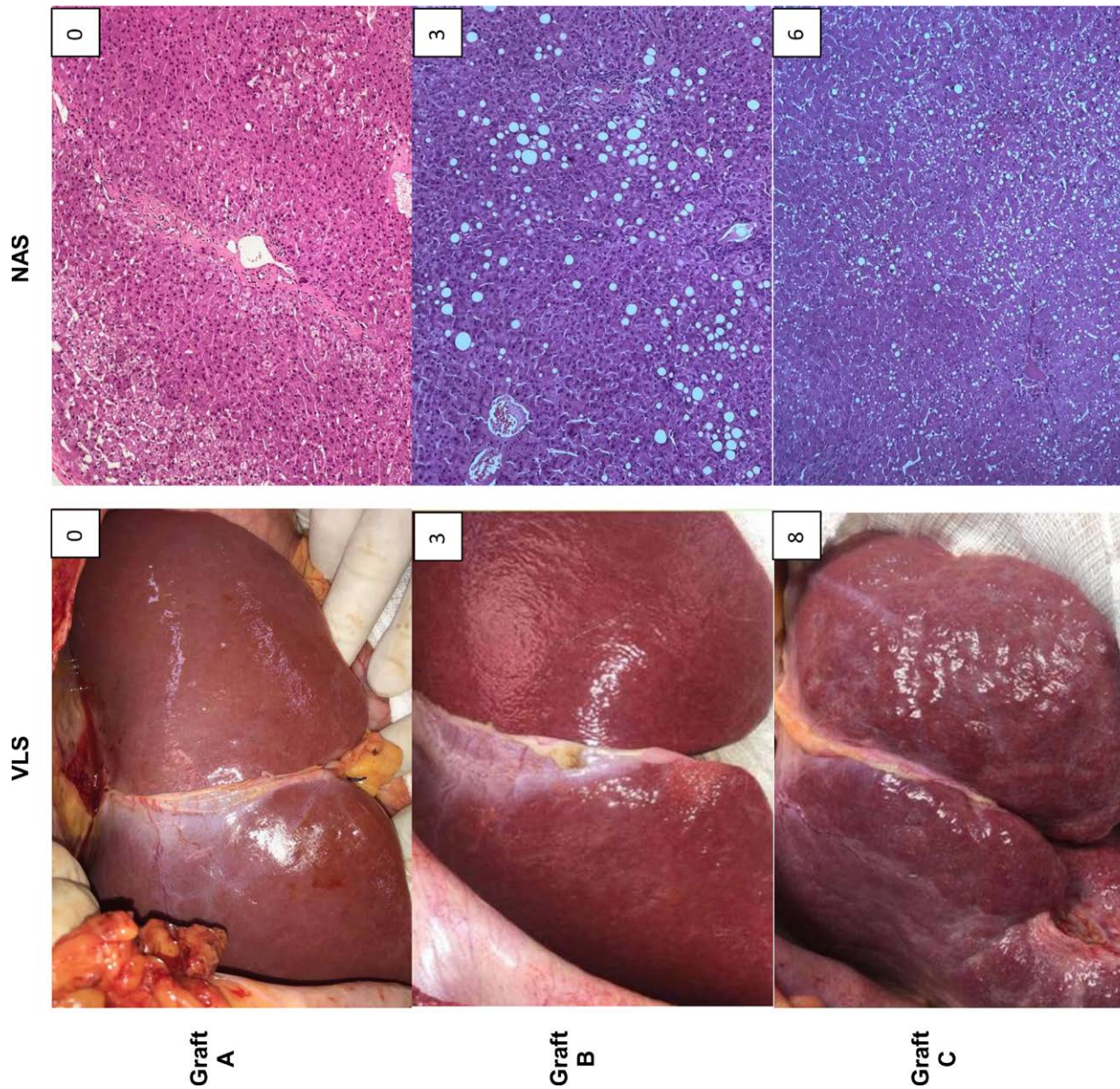


FIGURE 2. Examples of VLS total scores for liver grafts with corresponding histological findings. Graft A is considered a VLS 0 (normal color component = 0, normal size = 0, smooth surface = 0) and NAS 0 (absence of steatosis= 0, absence of hepatocyte ballooning = 0, absence of lobular inflammation). Graft B is considered a VLS 3 (moderate steatosis = 1, mild enlargement = 1, mild nodularity = 1) and NAS 3 (steatosis >40% = 2, a few hepatocyte ballooning = 1, absence of lobular inflammation). Graft C is considered a VLS 8 (significant steatosis = 2, severe enlargement = 3, cirrhotic = 3) and NAS 6 (35% steatosis =2, many hepatocyte ballooning = 2, lobular inflammation = 2). NAFLD, nonalcoholic fatty liver disease; NAS, NAFLD activity score; VLS, visual liver score.

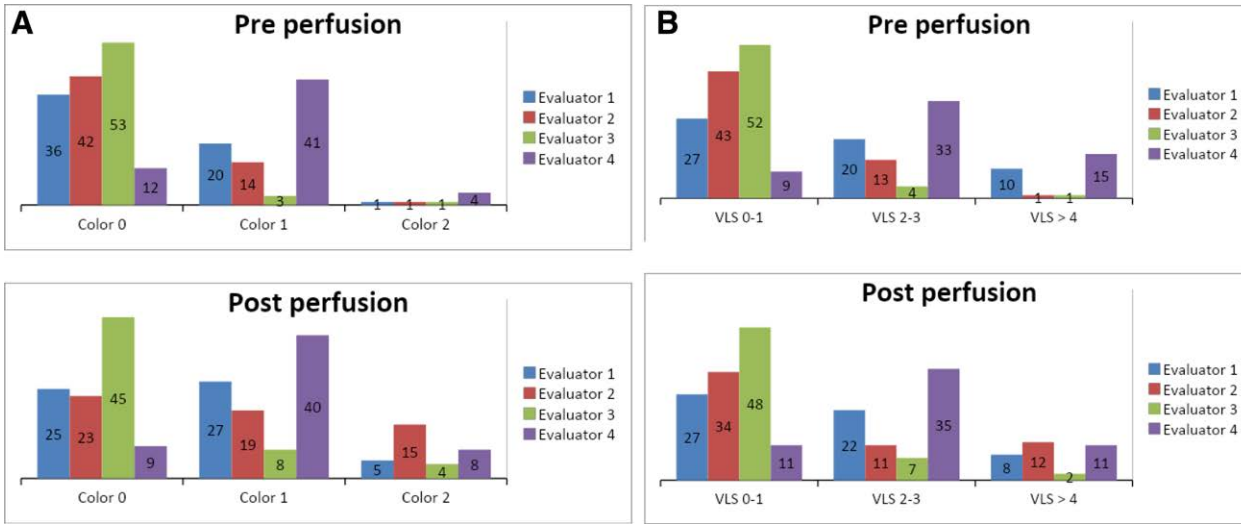


FIGURE 3. A, Points attributed to color score organ perfusion, according to each evaluator. B, Size scores, surface scores, or total VLS points, according to each evaluator. VLS, visual liver score.

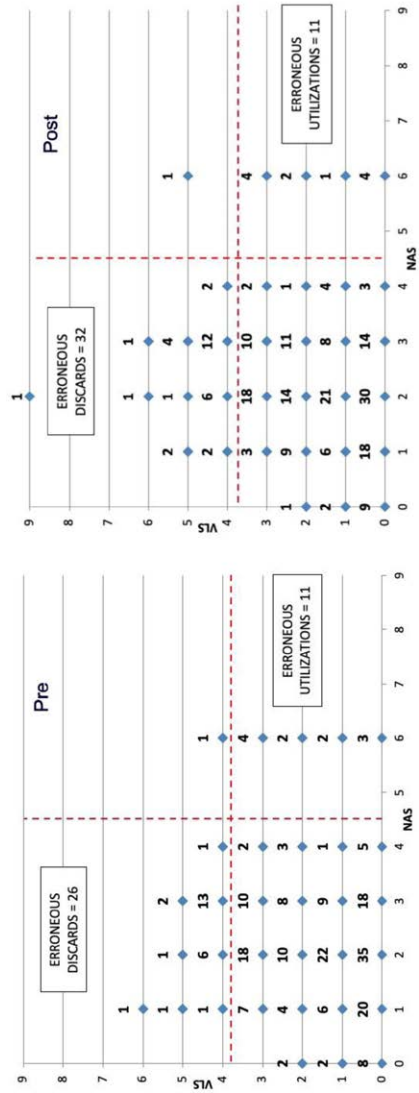


FIGURE 4. Presenting the grafts presenting with NAFLD, the total VLS performance, analyzed correlating it to the total NAS risk ranges. NAFLD, nonalcoholic fatty liver disease; VLS, visual liver score.

during the procedure, unavailability of a pathologist for prompt analysis, and cold ischemia time tolerated by the liver graft until definitive histological analysis are relevant issues,[24,25] making them an unpractical strategy in the transplant scenario.

The VLS color component showed moderate accuracy in steatosis detection, being better after organ perfusion (64.03% versus 48.68% preperfusion). The positive predictive values were high in both preperfusion and postperfusion analyses (91.76% and 92.06%) and also the specificity (82.5% and 75%). However, the method showed moderate sensitive detecting steatosis (41.48% preperfusion and 61.7% postperfusion), with low negative predictive values in both perfusion times (23.07% preperfusion and 29.41% postperfusion). Thus, the method seems reliable when detecting NAFLD and classifying grafts with minimum or absent steatosis but frequently fails to identify fatty infiltration, as previously shown.[26]

Regarding the performance of correctly estimating the severity of NAFLD, total VLS accuracy was low when compared with pathology (49.53% preperfusion and 46.29% postperfusion). Positive predictive values were progressively lower as higher scores were assigned (VLS 0–1 = 68.59% preperfusion and 68.8% postperfusion; VLS 2–3 = 33.82% preperfusion and 32% postperfusion; VLS ≥4 = 3.7% preperfusion and 3.12% postperfusion), suggesting a trend toward overrating the severity of NAFLD when there is a worse perception of macroscopic findings.[23]

Although the VLS was proposed to increase the ectoscopy precision when evaluating NAFLD, incorrect analysis of severity was still frequent, with the immediate result of organ disposal; all 4 evaluators classified viable grafts as unviable at some point (preperfusion or postperfusion). This is the same obstacle faced when a nonstandardized visual analysis is performed.[27]

The color component showed low accuracy in stratifying the steatosis grading when fat infiltration is present (41.22% preperfusion and 50% postperfusion).[11] The sensitivity to identify steatosis is... >33% (correlating color = 2 and NAS steatosis grade = 2–3) is low (12.5% preperfusion and 32.5% postperfusion), suggesting an underestimation of fat infiltration when it is important.

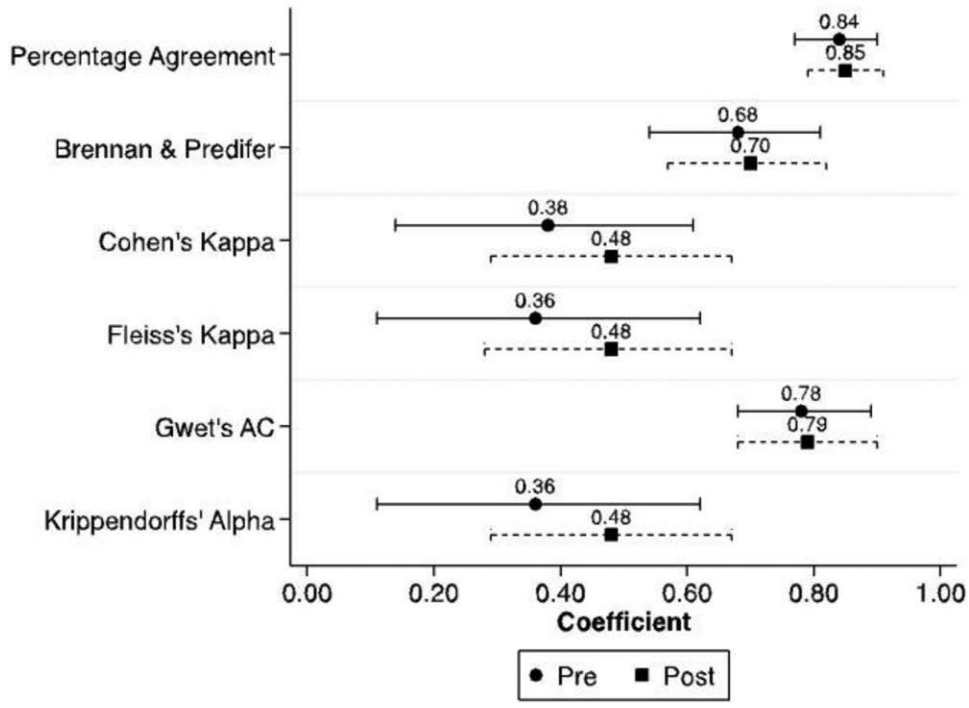


FIGURE 5.

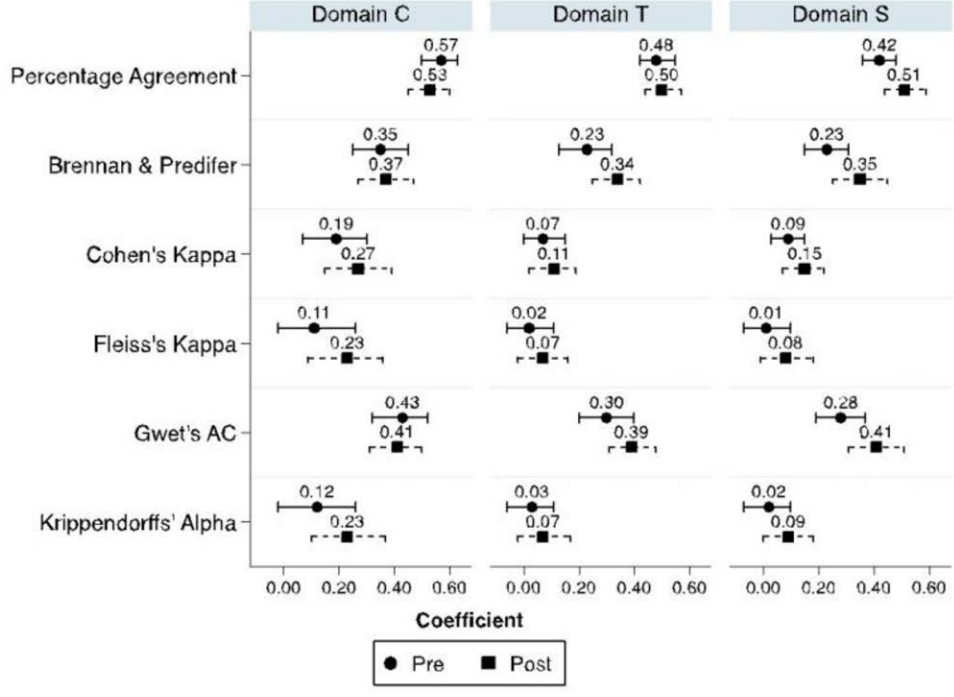


FIGURE 6.

A remarkable finding was a decrease in the positive predictive value when classifying steatosis >33% after organ perfusion (71.42% preperfusion and 40.62% postperfusion). This is probably due to a more intense yellowish color observed when blood is flushed away from the graft by the preservation solution.

However, the color component was very specific (98.9% pre and 89.89% postperfusion) in assessing grafts as having minimum or absent steatosis. It was associated with a high negative predictive value for steatosis of >33% (84.16% preperfusion and 86.2% postperfusion), being reliable when classifying steatosis as nonsignificant.

Total VLS could not effectively exclude unviable grafts (specificity for the viability of 8.33% preperfusion and postperfusion). Additionally, a significant amount of viable grafts would be excluded with the actual VLS cutoff for NASH (negative predictive value for viability 3.77% preperfusion and 3.12% postperfusion), ranging from 12% (preperfusion) to

15% (postperfusion). Although a total VLS of 0 to 3 presented good sensitivity (87.25% preperfusion and 84.8% postperfusion) in identifying viability (NAS = 0–4), its imperfection leads to the disposal of viable organs, which does not increase graft offer.[27] Similarly, the high positive predictive value in the assessment of viability (94.17% preperfusion and 94.02% postperfusion) provides safety using grafts when indicated. However, there is the risk of using livers with steatohepatitis and their consequent high risk for dysfunction.[7]

In this study, increasing the cutoff value for viability by 2 units (VLS ≤6) would reduce the number of viable grafts discarded without including unviable organs. However, in that scenario, there would be no graft selection by score, supporting universal use, with the associated risk of using unviable livers.

Even performing the analysis of the grafts using the same photographic records and standardized scores, different evaluators often assign different characteristics depending on their perception of color, luminosity, and dimension.[28] In this cohort, poor interobserver agreement was found when considering separate VLS components analysis (color, size, and surface) and moderate agreement when considering total VLS analysis. These findings reflect the subjectivity of ectoscopic analysis in the evaluation of NAFLD, showing how different observer biases conclude the final score in a moderately similar way but with a heterogenous evaluation of the score components.

Despite the strengths of the study, there are some limitations. Firstly, the study was conducted at a single center, and although it is the largest transplant center in the state, it is necessary to confirm whether the VLS would be equally evaluated by other centers. Secondly, the visual assessment was performed using photographs and, despite the high quality of the images, we do not know whether the VLS would be the same if evaluated directly by visualizing the organ.

CONCLUSION

Because the VLS was not reliable enough for visual assessment of NALFD compared with pathology, it was unable to exclude the necessity of liver biopsy to prevent viable organs from being discarded or unviable organs from being used. Efforts should be made to expand access to pathology by procurement teams, recognizing the logistical and economic problems to be solved. Further studies are needed to understand whether the VLS needs to be adapted or even excluded in the liver transplant scenario, to assess the importance of ectoscopy related to posttransplant clinical outcomes, and to determine its role in graft selection.

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