



Comparative Volumetric Analysis of Hermes and Synapse Software Systems in the Setting of Liver Surgery

K. Joshi¹ · A. Nutu¹ · M. Wilson² · R. Marudanayagam¹ · J. Isaac¹ · R. P. Sutcliffe¹ · B. V. M. Dasari¹

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Abbreviations

FLR	Future liver remnant
PHLF	Post-hepatectomy liver failure
SPECT	Single photon emission computed tomography
sFLR	Standardised future liver remnant
SLV	Standardised liver volume
LV _{Rem} %	Anatomical remnant volume

Liver volumetry is routinely performed to calculate the total and remnant liver volumes to assess the risk of PHLF. Semi-automatic software programs such as Mevis, Synapse, Image J, and Osirix are commonly used to assess the liver volumes in a pre-operative setting.¹ Hermes remnant liver analysis software (Medical Software Affinity viewer™, Hermes Medical Solutions, Inc, Sweden) is a newer platform mainly used in SPECT-CT studies. Its application has been extended to dynamic planar and SPECT/CT examination of the uptake and excretion of technetium^{99m} mebrofenin allowing assessment of anatomical as well as functional liver volumes. Synapse Vincent® medical imaging system (Fujifilm Medical Co., Ltd., Tokyo, Japan), that is in use for liver volumetric studies, has the additional advantage of 3D rendering and automatic liver/vessel extraction for a better understanding of the relationship between tumour and vessels. The objective of this study is to evaluate the reliability of anatomical volumetric assessment performed using Synapse Vincent® and Hermes Medical Software Affinity viewer™ softwares in the setting of liver resection surgery. A retrospective liver volumetric analysis was performed using both the softwares on 144 patients who underwent right and left hemi-hepatectomy between January 2015 and March 2019 at Queen

Elizabeth Hospital, Birmingham, UK. Twenty-eight out of 144 patients developed PHLF (19.4%)—grade A (13.0%), grade B (4.2%), and grade C (1.4%) (ISGLS definition). The dry weights of the specimens were obtained from the histopathology report. The median weight of the resected specimen was 823 g (IQR: 616.5–1080 g). The median estimated volume of the resected specimen with Synapse was 882.20 ml (IQR: 638–1104 ml), and with Hermes, it was 979.7 ml (IQR: 784.31 ml). Estimated FLR volume calculated from Synapse and Hermes showed a median value of 793 ml (IQR: 589–1059 ml) and 517 ml (IQR: 393.74), respectively.

In the literature, clinically significant over- or underestimation of the LV_{Rem}% (by ≥ 5%) was reported in 31.9% patients undergoing major liver resection for colorectal liver metastases.² There is also a difference between in vivo CT volumetry and ex vivo water displacement volumetry, which is likely due to blood perfusion of the liver.³ Body mass index is another factor to influence the difference between measured and estimated liver volumes ($P < 0.001$). Taking these factors into consideration, standardised liver volumes that account for a variety of different parameters (BSA, age, gender, weight, or height) were proposed.^{4–6}

In the current study, there was a positive correlation between the volumes estimated by Synapse with that of Hermes volumetry ($R^2 = 0.71$; $P < 0.001$). There was a positive correlation between actual weight of the resected specimen and estimated volumes of resection with Hermes ($R^2 = 0.70$, $P < 0.001$) (Fig. 1) and Synapse ($R^2 = 0.89$, $P < 0.001$) (Fig. 2). Significant positive correlation was demonstrated between sFLRs calculated by Hermes and Synapse softwares and sFLRs based on the Urata, Heine-man, and Vauthey formulas with R^2 values of 0.7 and 0.6, respectively (P value < 0.001). However, AUROC analyses of sFLRs in predicting PHLF by Hermes were better (AUC: 0.76; 95%CI: 0.659–0.864; P -value < 0.001) than that of Synapse (AUC: 0.68; 95%CI: 0.545–0.815; P -value 0.01). The study reports that both of these software systems

✉ B. V. M. Dasari
Bobby.Dasari@uhb.nhs.uk

¹ The HPB and Liver Transplant Unit, Queen Elizabeth Hospital, Edgbaston, Birmingham B15 2WB, UK

² Department of Nuclear Medicine, Queen Elizabeth Hospital, Birmingham, UK

Fig. 1 Scatter plot showing distribution between volumes resected with Hermes and actual weight of the specimen

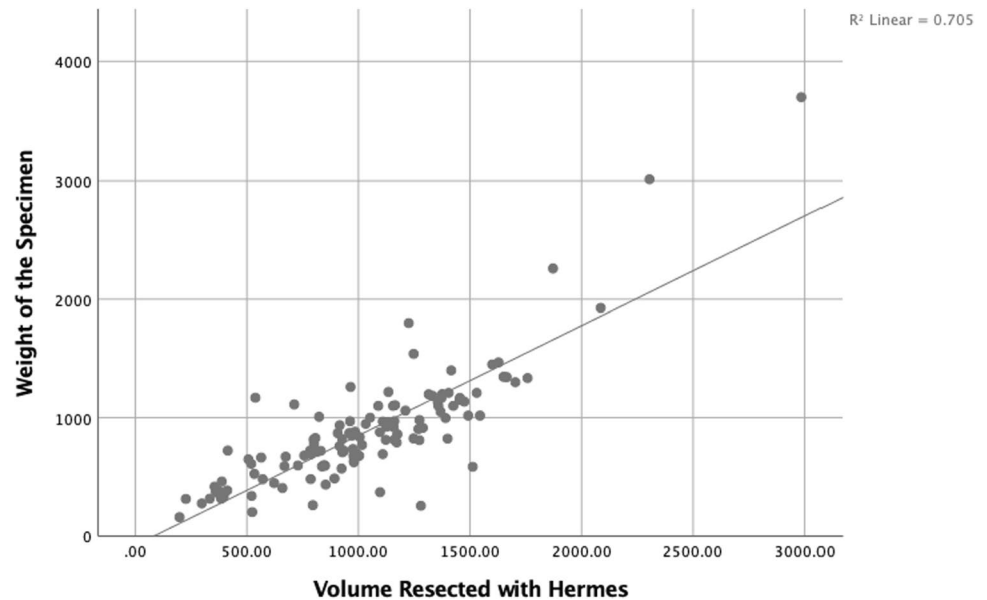
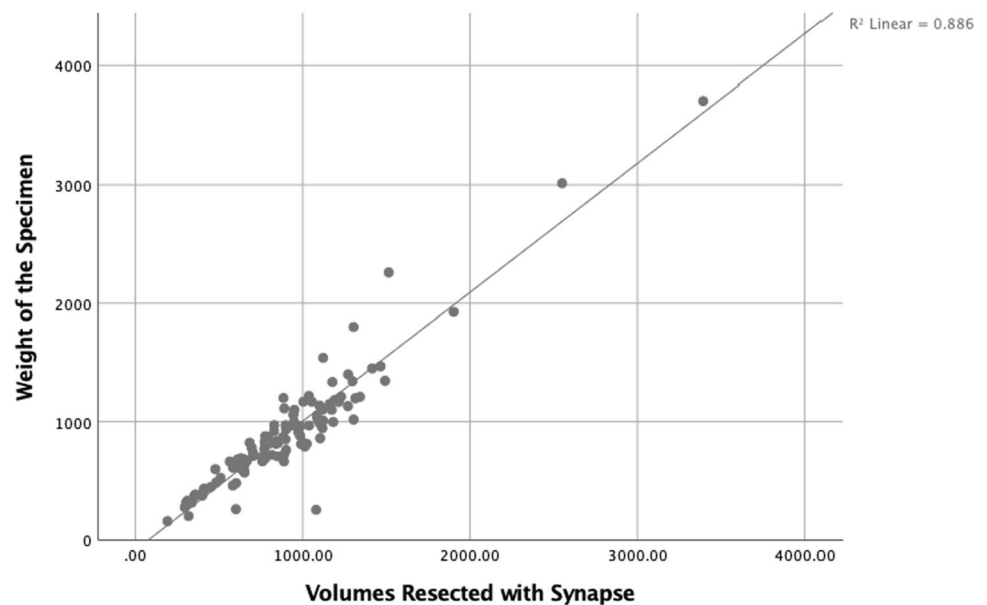


Fig. 2 Scatter plot showing distribution between volumes resected with Synapse and actual weight of the specimen



provide comparable anatomical volumetric analyses that can be used in liver surgical practice.

Author Contribution Conception of the idea: BD, KJ, and AN. Technological input for software usage: AN, KJ, BD, and MW. Data analysis: KJ, AN, BD, and MW. Draft preparation: KJ, AN, and BD. Draft review and expert input: KJ, AN, MW, JI, RM, RS, and BD. Final draft: KJ, AN, MW, JI, RM, RS, and BD.

Declarations

Ethics approval Not applicable.

Consent to Participate This is a retrospective cohort. For this type of study, formal consent is not required. Informed consent was obtained from all individual participants included in the study. This article does not contain patient data.

Competing Interests Mr Dasari has given a lecture on the experience of using Hermes software at a webinar conducted by Hermes Medical Solutions.

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