

Comparing the performance of three software programmes for manual and (semi-)automatic liver volumetry

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Abstract

Purpose:

Multiple software programs are available for manual or (semi-)automated liver segmentation. The aim of this study was to evaluate the performance of three segmentation software programs (Synapse 3D (Fujifilm), OsiriX® (Pixmea), and Syngo.via (Siemens Healthineers)) for liver segmentation and volumetry, and secondly to assess variability between observers and among the software programs.

Methods:

Patients (≥ 18 years) with abdominal computed tomography (CT) images without liver pathology were included. Total liver volume (TLV) and segment II/III (SII/III), as surrogate for future liver remnant (FLR), volume were measured. Two independent researchers conducted volumetry blinded. The intraclass correlation (ICC) was calculated for interobserver variability for the first 30 scans between both researchers, and for intraobserver variability among the software programs for 200 randomly selected patients (53% men; mean age: 63.5 years).

Results:

Mean TLV and SII/III volumes for Synapse 3D, Syngo.via and OsiriX® were 1705 ± 462 mL and 304 ± 115 mL, 1672 ± 463 mL and 282 ± 109 mL, and 1627 ± 449 mL and 277 ± 108 mL, respectively. Highest interobserver agreement ($n = 30$) was for TLV with Synapse 3D (ICC:0.999;95%CI:0.998–0.999), and highest intraobserver ICC was between Synapse 3D and Syngo.via for TLV (ICC:0.997;95%CI:0.985–0.999). Mean sFLR for Synapse 3D, Syngo.via and OsiriX® were 18.6%, 17.2%, and 16.9%, respectively.

Conclusion

Although absolute volumes varied slightly, sFLR remained constant across the software programs, making them all suitable for reliable CT liver volumetry.

Introduction

Liver volumetry, often used to calculate the future liver remnant (FLR), is usually performed by radiologists, surgeons or other treating physicians using segmentation software programs on computed tomography (CT) images [1–3]. Adequate liver segmentation takes the complex and variable shape of the liver, presence of tumors, and anatomical variabilities into account [4][4]. In the past 15 years, software programs have been improved substantially. Calculation of liver volumes can either be performed using manual or (semi-)automated segmentation software programs [2, 5–7]. Manual segmentation is more time intensive and is prone to interobserver variability [2]. Few studies have

compared manual and (semi-)automatic software programs [1, 8–12]. Both methods lead to similar liver volumes but demonstrate reduced segmentation time when an automated approach is used [9–12]. Most studies evaluated a single segmentation software tool or compared one (semi-)automated software program to a manual approach in patients undergoing surgery. This could lead to variability in liver volumetry outcomes between programs and can confound the comparison of software performance, as manual adjustments are prone to higher inter-observer variability due to pathological anatomical changes. Moreover, studies comparing multiple (semi-)automatic software tools with manual segmentation in large sample sizes remain limited. Therefore, the aim of this study was to evaluate the performance of three segmentation software programs for liver segmentation and volumetry, and secondly to assess variability between observers and among the software programs.

Methods

Study Design & Patient characteristics

Patients ≥ 18 years, who underwent contrast-enhanced abdominal CT-imaging with full depiction of the liver in Maastricht University Medical Centre+ between January 2023 and May 2023 were included. Exclusion criteria were: (history of) liver pathology or surgery, free abdominal fluid or air, history of oncological diseases, and poor imaging quality (e.g. metal or movement artefacts). Additionally, patients were excluded when baseline characteristics or imaging data were missing. A total of 200 patients were randomly selected. The data were stored in an online secured database (Castor EDC, v2020.2.20). All imaging data were pseudonymized. The local medical ethics committee approved the study protocol and waived the need for obtaining informed consent (METC 2023 – 0185).

CT liver volumetry

Portal venous series with 3mm slice thickness from contrast-enhanced CT-scans were used for liver volumetry. More information regarding the utilized scanning protocols is shown in Supplementary 1. The segmentation software programs we compared were Syngo.via Client 10 (Siemens Healthcare, Munich, Germany), Synapse 3D (Fujifilm Corporation, Tokyo, Japan), and OsiriX® (Pixmea, Switzerland) for Apple Mac OS. Synapse 3D and Syngo.via have (semi-)automated liver segmentation analysis functions with automated liver volume calculation. In OsiriX®, liver segmentation was performed with manual delineation of the liver. Segmentation was performed for total liver volume (TLV) and Couinaud liver segment II and III (SII/III) in milliliter (mL) [13]. SII/III volume was considered as surrogate for the FLR. To minimize systematic differences in liver volumetry, SII/III volumes were selected as their anatomy allows reliable delineation. TLV segmentation in Syngo.via and Synapse 3D were checked and corrected manually when needed. During total liver segmentation, intrahepatic vascular and hepatic biliary structures were included on all slices on all three software programs. Anatomical structures excluded from segmentation were the vena cava inferior and the gallbladder. Prior to liver volumetry, observer 2

(RK, with > 3 years' experience) instructed observer 1 (LvdV, without experience, directly after formal training with the software) how to use all three software programs.

For SII/III, volume calculation/delineation was performed manually by the two observers. The first 30 CT scans were segmented independently by both observers on all three software programs. During segmentation, both observers were blinded for volumetry results of each other and for patient characteristics. Time of liver volumetry per patient was measured in seconds using a stopwatch by both observers and was measured from the first contour drawing with OsiriX® or start of semi-automated segmentation of the whole liver in Syngo.via or Synapse 3D until segmentation of both TLV and SII/III was finalized.

Statistical analysis

Demographic and clinical data such as age, sex, weight, and length were collected from the electronic patient files. Categorical data were presented as absolute and relative frequencies (n, %) and continuous data as mean and standard deviation (SD) or median and interquartile range [IQR], depending on the data distribution.

Comparison between observers (interobserver variability)

For testing the interobserver variability between observer 1 and 2, the intraclass correlation coefficient (ICC) was calculated as described by Koo et al. after the first 30 scans [14]. Categorization for amount of agreement in ICC was as follows: poor (ICC < 0.500), moderate (ICC 0.500–0.750), good (ICC 0.750–0.900), or excellent (> 0.900) agreement. The two-way-random-effects model for consistency was used to calculate the interobserver variability for the difference in TLV, and SII/III between the observers. If the ICC was considered at least good between both observers, the remaining 170 scans for segmentation were divided between the two observers. $FLR\% = \frac{SII/III \text{ volume}}{TLV} * 100$ was calculated to gain insight in whether a systematic difference within the program influenced the outcome of each program. By expressing the FLR as a percentage of TLV, it is possible to determine whether a program systematically over- or underestimation occurs among the software programs, thereby identifying potential software-related bias in the volumetric results.

Additionally, standardized FLR (sFLR) was calculated as $sFLR = \frac{SII/III \text{ volume}}{-794 + 1267 * BSA} * 100$, according to the method presented by Ribero et al., in which liver volume correlates to the body surface area (BSA) [15]. In this manner, a clinically relevant metric was provided to compare the outcomes across the three software programs. Differences in absolute TLV, SII/III volumes, time of liver volumetry, sFLR and FLR% between the two observers were tested using Wilcoxon signed rank test.

Comparison among the software programs (intraobserver variability)

For testing the intraobserver variability among the three software programs, a two-way mixed-effect ICC for absolute agreement was used, as described by Koo et al., with similar agreement categorization as previously described. The ICC among the software programs was calculated for all (n = 200) scans. Bland-Altman plots with 95% limits of agreement were used to compare OsiriX®, Syngo.via and Synapse 3D [16]. For TLV and SII/III volumes, the difference was plotted against the mean, and the 95% limit of agreement were provided. sFLR and FLR% of all three software programs were also calculated for all scans.

The paired-samples t-test was used to analyze significant differences in mean volume, segmentation time, FLR%, and sFLR among the software programs for all scans. Statistical analyses and graphical plots were performed using R (version 4.2.1). Results were considered statistically significant when p-value ≤ 0.05.

Results

Baseline characteristics

Abdominal CT-scans of 200 patients with healthy livers were evaluated. Details of baseline characteristics are shown in Table 1.

Table 1. Baseline characteristics of included patients.

Patient characteristics	N=200
Male (n, %)	105, 53%
Age in years (mean, SD)	63.5 ±15.7
BMI (mean, SD)	26.7 ±5.2

Comparison between observers

The ICCs for TLV and SII/SIII volumes for the first 30 abdominal CT-scans between observer 1 and observer 2 were in excellent agreement for all three software programs (Table 2). Highest agreement was found for Synapse 3D TLV (ICC=0.999; 95%CI: 0.998-0.999). Lowest agreement between the observers was found for SII/III volumetry with Syngo.via (ICC=0.958, 95%CI: 0.912-0.980).

Table 2. The ICC between the two observers in each liver volume program.

	n	ICC	95%CI
Syngo.via TLV	30	0.999	0.997-0.999
Syngo.via SII/III	30	0.958	0.912-0.980
OsiriX® TLV	30	0.996	0.992-0.998
OsiriX® SII/III	30	0.977	0.952-0.989
Synapse 3D TLV	30	0.999	0.998-0.999
Synapse 3D SII/III	30	0.975	0.948-0.988

Abbreviations: ICC= intraclass correlation coefficient, TLV=total liver volume, SII/III= segment II/III

The differences in volumes for TLV and SII/III between both observers are shown in Table 3. For all three software programs, statistical differences were found for TLV and SII/III volumes between the two observers (p-value<0.020).

Regarding median FLR% and median sFLR, significant differences were found for all three software programs between the observers. The FLR% of observer 1 and observer 2 were 15.7% [13.2-18.7] versus 17.6% [13.9-19.6] (p-value=0.008) for Syngo.via, 18.3% [15.6-20.6] versus 20.1% [17.8-22.3] (p-value<0.001) for Synapse 3D, and 18.3% [14.5-20.8] versus 18.4% [15.4-21.5] (p-value=0.015) for OsiriX®, respectively. The sFLR of observer 1 and observer 2 were 14.7% [12.3-19.6] versus 16.7% [12.9-21.5] (p-value=0.006) for Syngo.via, 17.9% [12.6-22.6] versus 19.2% [13.5-23.1] (p-value=0.004) for Synapse 3D, and 17.2% [12.8-21.2] versus 18.5% [13.0-22.0] (p-value=0.010) for OsiriX®, respectively.

In regard to time of volumetry, longer segmentation duration was seen for observer 1 for Syngo.via (median: 390s [255-420] versus 180s [180-240]; p-value<0.001) and Synapse 3D (median: 240s [180-300] versus 180s [120-180]; p-value=0.003) compared to observer 2 (Table 3).

Table 3. Liver segmentation volumes from the observers and all scans.

	Observer 1	Observer 2	P-value	Median percent difference between observers
<i>OsiriX®</i>				
TLV – Median [IQR]	1523 [1436-1846]	1513 [1422-1812]	0.019	1.4% [-0.7-2.5]
SII/III - Median [IQR]	289 [228-349]	287 [222-347]	0.020	-4.4% [-8.4-0.8]
Time in secs – Median [IQR]	480 [420-600]	660 [540-720]	0.013	-
<i>Syngo.via</i>				
TLV – Median [IQR]	1524[1392-1873]	1544 [1417-1894]	<0.001	-0.9% [-2.2-0.0]
SII/III - Median [IQR]	253 [215-290]	282 [215-329]	0.002	-6.4% [-13.9-1.0]
Time in secs – Median [IQR]	390 [255-420]	180 [180-240]	<0.001	-
<i>Synapse 3D</i>				
TLV – Median [IQR]	1525 [1428-1945]	1530 [1463-1955]	0.006	-0.13% [-1.7-1.3]
SII/III - Median [IQR]	284 [236-350]	316 [263-367]	<0.001	-10.4% [-13.8-6.1]
Time in secs – Median [IQR]	240 [180-300]	180 [120-180]	0.003	-

Abbreviations: TLV=total liver volume, SII/III= segment II/III.

Comparison of the volumetry software programs

For all scans, the calculated ICC among the software programs for TLV and SII/III volumes are shown in Table 4. For TLV, excellent agreement was met between all software programs ranging from the lowest ICC for Synapse 3D versus OsiriX® (ICC=0.989; 95%CI: 0.933-0.996; p-value<0.001), and the highest ICC between Synapse 3D and Syngo.via (ICC=0.992; 95%CI: 0.974-0.996; p-value<0.001). For SII/III volumetry, the lowest ICC was met for Synapse 3D versus OsiriX® (ICC=0.939; 95%CI: 0.715-0.975; p-value<0.001), and the highest ICC was met for Synapse 3D versus Syngo.via showing an ICC of 0.944 (95%CI: 0.927-0.958; p-value<0.001).

Table 4. The ICC among the three liver volumetry software programs for all scans (n=200).

	ICC	95%CI	P-value
Syngo.via vs. OsiriX® TLV	0.989	0.933-0.996	<0.001
Synapse 3D vs. OsiriX® TLV	0.990	0.655-0.997	<0.001
Synapse 3D vs. Syngo.via TLV	0.997	0.985-0.999	<0.001
Syngo.via vs. OsiriX® SII/III	0.944	0.927-0.958	<0.001
Synapse 3D vs. OsiriX® SII/III	0.939	0.715-0.975	<0.001
Synapse 3D vs. Syngo.via SII/III	0.937	0.834-0.968	<0.001

Abbreviations: ICC= intraclass correlation coefficient, TLV=total liver volume, SII/III= segment II/III.

The mean TLV and SII/III volume for all scans were 1705±462 mL and 304±115 mL for Synapse 3D, 1672±463 mL and 282±109 mL for Syngo.via and 1627±449 mL and 277±108 mL for OsiriX®, respectively. Mean (percent) differences in TLV and SII/III are shown in Table 5. Mean TLV differences were significant for all software programs (p-value<0.001). Regarding mean SII/III volumes, significant differences were found for Syngo.via versus Synapse 3D (p-value<0.001), and Synapse 3D versus OsiriX® (p-value=0.001). Bland Altman analysis for OsiriX®, Synapse 3D and Syngo.via showed good agreements with mean differences close to zero for both TLV and SII/III (Figure 1 and 2).

Table 5. Differences in mean volumes among Syngo.via, OsiriX® and Synapse 3D for all scans.

	Mean differences in mL (SD)	Mean percent differences (SD)	P-value
TLV			
OsiriX® versus Syngo.via	-45.3 (±49.0)	-2.6 (±3.0)	<0.001
OsiriX® versus Synapse 3D	-78.5 (±48.8)	-3.9 (±3.6)	<0.001
Syngo.via vs. Synapse 3D	-33.2 (±42.0)	-1.7 (±3.9)	<0.001
SII/III			
OsiriX® vs. Syngo.via	-4.4 (±36.0)	-0.8 (±14.0)	0.111
OsiriX® vs Synapse 3D	-26.2 (±29.8)	-8.5 (±9.5)	<0.001
Syngo.via vs. Synapse 3D	-21.8 (±33.6)	-6.8 (±11.1)	<0.001

Abbreviations: TLV=total liver volume, SII/III= segment II and III.

Mean FLR% for Synapse 3D, Syngo.via and OsiriX® were $17.9 \pm 4.9\%$, $16.9 \pm 4.7\%$ and $17.3 \pm 4.8\%$, respectively, with significant differences between Synapse 3D and Syngo.via, and Synapse 3D and OsiriX® (p-value<0.001). For sFLR, statistical differences were found between Synapse 3D versus Syngo.via ($18.6 \pm 6.6\%$ versus $17.2 \pm 6.3\%$; p-value<0.001), and Synapse 3D versus OsiriX® ($18.6 \pm 6.6\%$ versus $16.9 \pm 5.9\%$; p-value<0.001).

The mean times of segmentation of TLV and SII/III combined were 187 ± 72 s, 250 ± 99 s, and 518 ± 141 s for Synapse 3D, Syngo.via and OsiriX®, respectively. Significant differences in segmentation time were found between OsiriX® versus Synapse 3D (p-value<0.001), and OsiriX® versus Syngo.via (p-value<0.001).

Discussion

In this study, two (semi-)automated software programs (Synapse 3D and Syngo.via) and one manual program (OsiriX®) for liver volumetry were evaluated in healthy livers. By focusing on non-pathological liver parenchyma without tissue heterogeneity or presence of lesions, we aimed to assess the algorithmic performance of these software programs as accurate as possible. This approach allowed us to establish a baseline for comparison among the three software programs under ideal anatomical conditions, minimizing the influence of confounding factors. Our findings showed minor differences between manual delineation and (semi-)automated delineation for liver volume calculations among the three used software programs. Manual delineation for liver volume calculations is often described as time consuming and can result in incorrect FLR volumes for patients undergoing liver resection, possibly increasing the risk of PHLF [17, 18]. However, our findings suggest that all three software programs provide reliable liver volume calculations.

Excellent agreement between the observers was seen. However, significant differences in median volume of TLV and SII/III were observed indicating a certain level of interobserver variation. Taking the experience of the two observers into account, a learning curve might also have influenced the results. Although a significant difference was found for FLR%, the absolute difference between the observers ranged from 0% to 2% across the software programs.

Looking at differences among the software programs, excellent agreement was met for both TLV and SII/III volume for all three software programs. The widest 95%CI were seen for Synapse 3D versus OsiriX® for both TLV (95%CI: 0.655-0.997) and SII/III (95%CI: 0.715-0.975), indicating the largest individual variation. This could be attributed to differences in the segmentation process (manual versus semi-automatic), and/or underlying segmentation algorithm. This possibly also explains the higher percent differences for SII/III compared to TLV between Synapse 3D versus OsiriX® or Syngo.via in our study. Mean TLV and SII/III volumes significantly differed between Synapse 3D and OsiriX®/Syngo.via, with Synapse 3D consistently showing highest mean estimations, and OsiriX® lowest. The consistently higher measured volume in Synapse 3D can probably be ignored when the same software is used for consecutive measurements within a patient. However, when different software programs are used

interchangeably to calculate the sFLR, one should be aware of a systematically higher volume, as this can result in overestimation of the FLR volume. This can influence correct clinical decision-making, particularly for cases in which the FLR is borderline for safe surgery. However, when comparing the FLR% between the programs, a systematic difference is normalized as it both seen in FLR and TLV volumes. In our analyses, this reduced the difference to 1-2% between Synapse 3D and OsiriX® or Syngo.via. Although this result was statistically significant, it can be questioned whether this small percent difference of 1-2% is clinically relevant. These findings imply that all three software programs are reliable to use for liver volumetry prior to hepatectomy. In terms of time efficiency, Synapse 3D is most beneficial followed by Syngo.via. As Synapse 3D has a more automatic approach to liver vessel and contour delineation, extensive manual adjustments for TLV and SII/III are reduced, resulting in decreased volumetry time when compared to Syngo.via and OsiriX®.

Similar results have been demonstrated in a study conducted by Maki et al., in which Syngo.via, Synapse 3D, and manual volumetry were compared for FLR in 30 patients who underwent right hepatectomy for colorectal liver metastases [12]. Volumetry was performed by three observers. FLR was significantly smaller in manual tracing compared to Synapse 3D (30.1% versus 32.0%; p-value<0.002) and Syngo.via (30.1% versus 32.0%; p-value<0.001), and the longest volumetry time was observed for manual delineations. Besides these similar results regarding the FLR volume and volumetry time, our study showed also smaller liver volumes for manual volumetry. Smaller volumes when manual delineation is performed can be attributed to physicians possibly drawing contours within the true liver boundaries to avoid including extra-hepatic tissue or low-attenuation tissue. On the contrary, (semi-) automated software programs may use attenuation thresholds in which sometimes other structures with similar Hounsfield Units are being included because of less prominent defined boundaries.

Importantly, in both our study and in Maki et al. segmentation was performed on lesion free livers. However, in Maki et al. the FLR varies in composition making it more representative of differences in clinical settings [12]. In contrast, in our study SII/III was consistently used as FLR which highlights the systematic differences among the software programs. It is therefore important to note that discrepancies in FLR measurements among programs may increase in clinical settings when segmentation is performed for FLR other than SII/III, and on anatomically challenging livers such as presence of multiple lesions and surgical history complicating accurate liver volumetry. This will especially hamper safety in patients with borderline sFLR that might need preoperative regenerative procedures such as portal vein embolization prior to hepatic surgery.

Some limitations of this study need to be mentioned. First, the assessment of consistent performance across the full dataset may be influenced by the fact that only the first 30 patient scans were evaluated by both observers for interobserver variability, while the remaining 170 scans were divided between the two researchers. In the study of Koo et al. it was advised to analyze reliability with at least 30 cases among at least three raters [14]. Although our study was conducted with only two observers, the sample size used for interobserver reliability was sufficient. Second, only abdominal CT images with specific reconstructions and 3 mm thick slices derived from CT-scanners of one vendor were included. As image

quality and reconstruction characteristics can vary across vendors and protocols, this can limit the generalizability of the software performance comparisons to other scanning conditions. Nevertheless, this standardization enhances internal validity by minimizing variability in image acquisition, resulting in a more controlled and systematic comparison of the performances of the three software programs. Third, inclusion of patients without liver pathology cannot fully encompass real-world challenges during pre-operative FLR volume assessment, such as presence of liver pathology, or previous local liver therapies. It is known that liver pathologies such as steatosis increase liver volume [19]. Lastly, no external ground truth (i.e. surgical specimen) was available, as this is not ethical in this research population. By using healthy livers, however, we avoided manual delineation errors as much as possible for TLV.

Future research should expand on our findings by evaluating liver segmentation software performance in patients with liver pathologies such as steatosis or cirrhosis, where tissue heterogeneity and irregular morphology could affect volumetric accuracy and the learning curve. Since this study focused on healthy livers, the excellent interobserver and intraobserver variability may not directly translate to diseased livers. Therefore, we are unable to determine the most accurate method for liver volumetry before liver surgery for this patient group. On the other hand, this study has some notable strengths. First, the use of a randomly selected large patient cohort minimizes selection bias and enhances the generalizability of the study. Second, CT-imaging in the portal venous phase with 3mm slices were consistently used with similar scanning protocols. Additionally, the segmentation analyses were conducted in a blind manner, with both observers unaware of the patients' baseline characteristics. This approach reduces the risk of observer bias, thereby strengthening the validity and reliability of the results. Moreover, three different software programs were compared in a large sample size, improving generalizability of the results.

Conclusion

All three software programs can be utilized for liver volumetry prior to hepatectomy depending on the clinician's preference. However, regard time efficiency, Synapse 3D outperformed the other two software programs. Absolute volume measurements varied among the software programs, highlighting the importance of using FLR% or sFLR in clinical decision-making, as these metrics remained consistent across all three software programs.

Declarations

Declarations of interests

The following declaration of interests needs to be reported: J.W. reports institutional conflicts of interests at Clinical Trial Center Maastricht and Department of Radiology and Nuclear Medicine for Abbott, Anaconda Biomed, Asklepios, Bayer, Becton & Dickinson Medical, Bentley, Boston, Brainlab, GE Healthcare, Gleamer, Hologic, Inari Medical, Johnson & Johnson, LCRB, Medtronic, Merit Medical

Systems, Microvention, Nico-Lab, Nova Techs, Oldelft Benelux, Ontario Association of Radiologists, Penumbra, Philips, Screenpoint Medical, Siemens, Stryker, Tajpan Sro, and speakers bureau for Bayer, Siemens (paid to institution). R.D. reports the following conflicts of interests for research grants and study materials from Abbott Laboratories, Guerbet. All are outside the submitted work. C.L. van der Leij reports the following conflict of interest for research grant received from Innovative Health Initiative, European Union. Outside the submitted work. The other authors declare no conflict of interest.

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Author Contribution

R.K. A.V., R.D and C.L. designed the study methodology . A.V. and R.K. performed analyses and wrote the main manuscript and text. S.J. contributed in manuscript writing. H.R. and R.B. evaluated results from the software programs. S.K. contributed in methodology focussing on statistics. J.W. and R.D. provided knowledge regarding the subject and critically revised and edited the manuscript where needed. All authors reviewed the manuscript and gave consent for publication.

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Figures

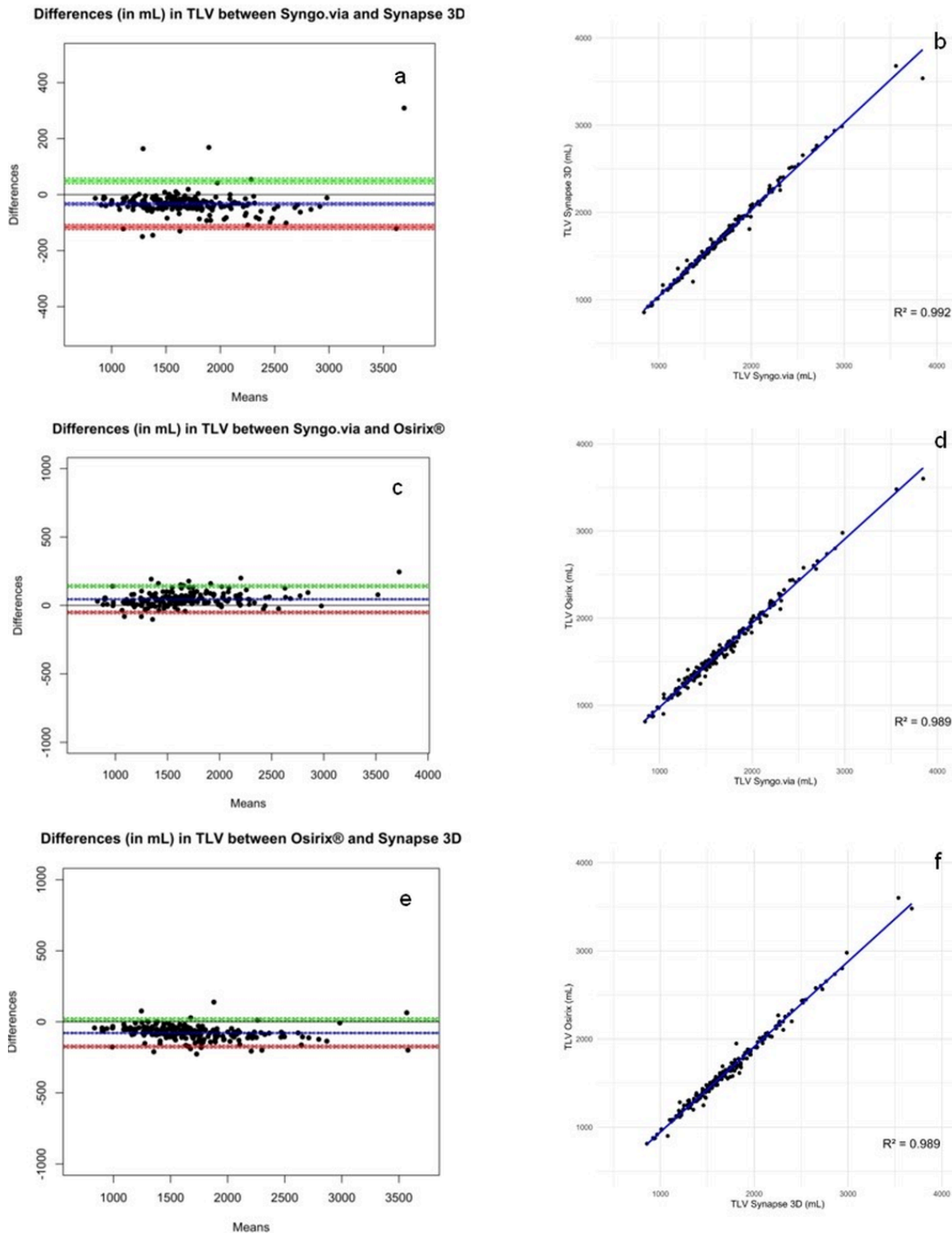


Figure 1

Bland Altman plots and scatter plot of the total liver volumes among the three software programs

a. Bland Altman plots of mean differences between Syngo.via and Synapse 3D, b. Scatter plot of mean differences between Syngo.via and Synapse 3D, c. Bland Altman plots of mean differences between Syngo.via and OsiriX® for total liver volume, d. Scatter plot of mean differences between Syngo.via and

OsiriX® e. Bland Altman plots of mean differences between Osirix® and Synapse 3D, f. Scatter plot of mean differences between OsiriX® and Synapse 3D.

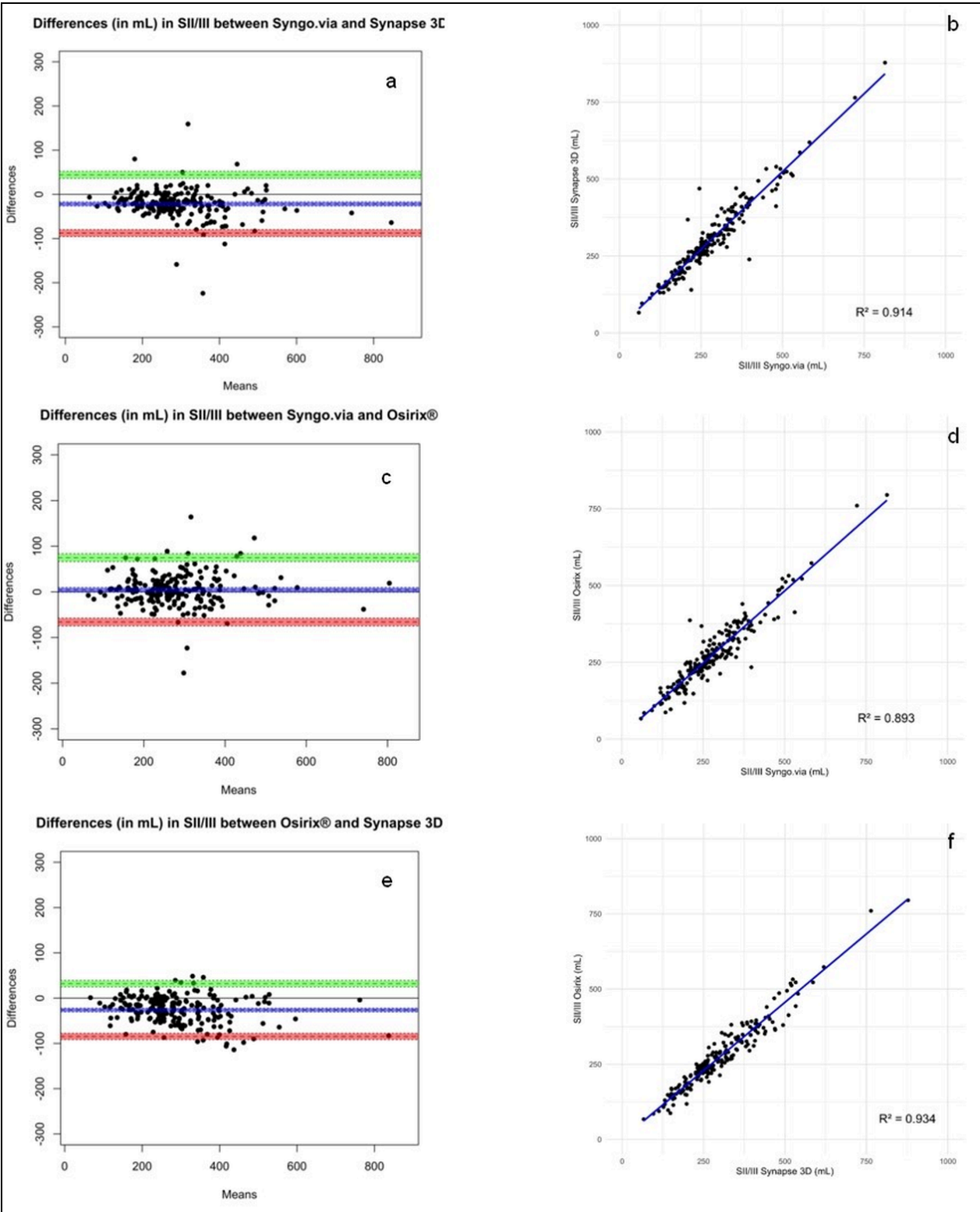


Figure 2

Bland Altman plots and graphs of segment II/III among the three software programs

a. Bland Altman plots of mean differences between Syngo.via and Synapse 3D, b. Scatter plot of mean differences between Syngo.via and Synapse 3D, c. Bland Altman plots of mean differences between Syngo.via and OsiriX® for total liver volume, d. Scatter plot of mean differences between Syngo.via and OsiriX®. Bland Altman plots of mean differences between OsiriX® and Synapse 3D, f. Scatter plot of mean differences between OsiriX® and Synapse 3D.

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