Supplementary Information

Installation of a surgical drape on the clinical prototype for intraoperative imaging

Once a sterilized probe muzzle is recovered, a sterile drape is installed. A sterile C-Arm drape (1013 Steri-Drape™, 3M, USA) is used to cover the probe body (see **Fig. S1**), the articulated arm and the fiber bundles which cannot be sterilized. This is achieved by first securing the sterilized probe nose to the sterile drape with a tight seal (i.e. with a sterile tape or rubber band) as shown in **Fig. (A-B)**. The sterile drape is then passed on to a circulating nurse which will cover the probe body, articulating arm and fiber bundle **Fig. (C)**. The probe nose is then fixed to the probe body by press fit with an audible 'click' sound **Fig. (D)**. Ball springs on the probe body help keep the probe nose in place. The surgical drape is then secured at the probe body, the articulated arm and the fiber bundles using commercially available sterile tape and/or rubber bands **Fig. (E-F)**.

Fig. S1: Raman imaging probe in a clinical setting with a sterile drape covering the probe body and the articulated arm. The surgical drape is secured using sterile rubber bands and sterile tape. The probe muzzle is sterilized, ready to be inserted in a patient surgical cavity and it presents a minimal infection risk to the patient.

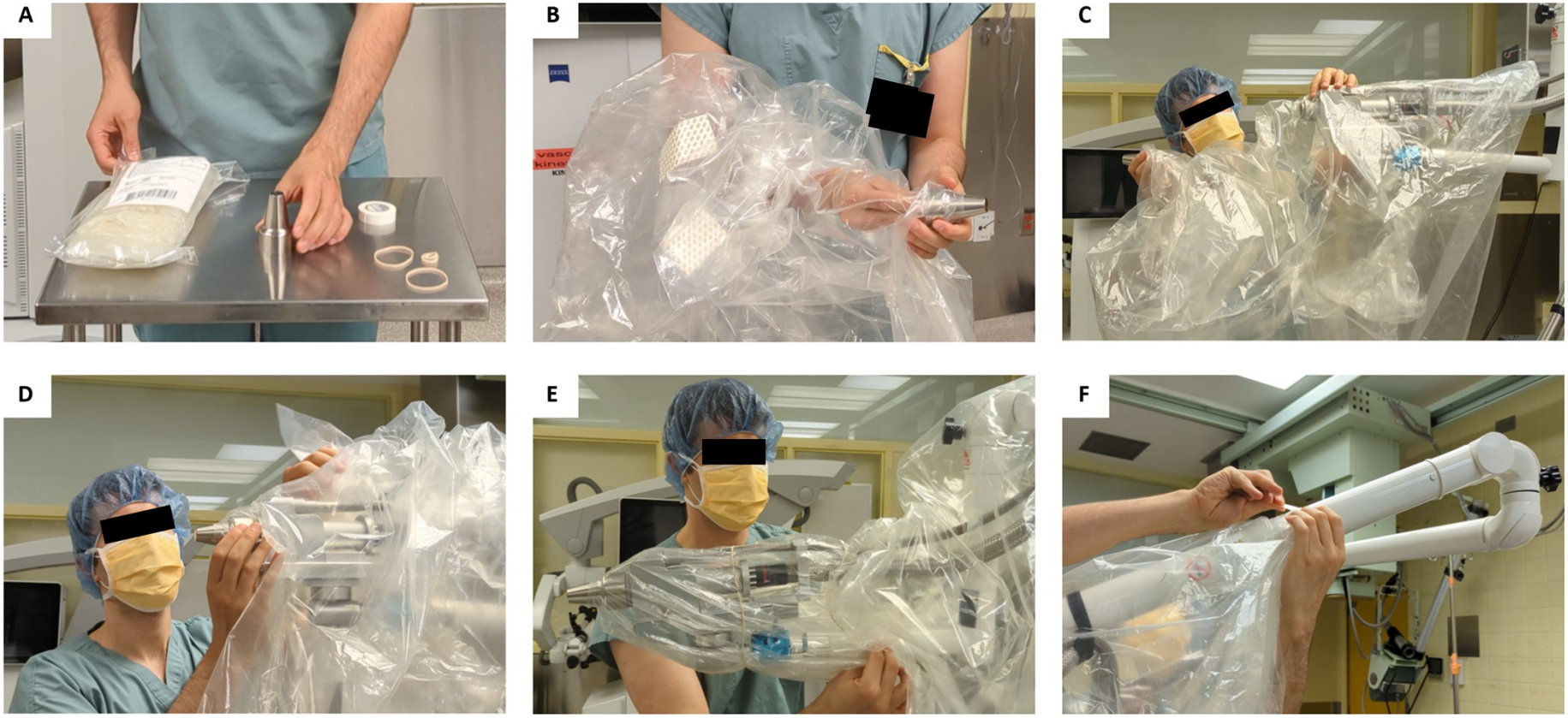

Fig. S2: Imaging probe drape covering procedure consisting of 6 steps: (A) recover the sterilized probe nose and remove the sterile drape from its packaging, (B) secure the probe nose to the sterile drape, (C) cover the probe body and articulated arm with the sterile drape, (D) secure the probe nose to the probe body, (E) secure the sterile drape to the probe body using sterile tape or rubber bands and (F) secure the sterile drape to the articulating arm and fiber bundles.

Imaging system parameters for laser safety assessment

To evaluate the maximum permissible exposure (MPE) with a laser for eyes and skin, several parameters were recovered from the imaging system technical specifications. These technical specifications are listed in **Table S1** and are the parameters used for all MPE calculations. MPE equations, parameters and correction factors were taken from ANSI Z136.1 Laser safety standard.

Table S1 Imaging system parameters for MPE calculations

Parameter name	Parameter symbol	Value	Units
Excitation wavelength	λ	785	nm
Maximum laser power	P_{max}	905	mW
Horizontal laser beam dimension at focus	x_0	400	µm
Vertical laser beam dimension at focus	y_0	1.0	cm
Horizontal beam full angle	α_x	154	mrad
Vertical beam full angle	α_y	98	mrad

From the imaging system parameters in table S1, we first calculate the intensity at maximum power I_{max} of the imaging system:

$$I_{max} = \frac{P_{max}}{x_0 \cdot y_0}\left[\frac{W}{cm^2}\right] = \frac{9.05 \times 10^{-1}}{4.00 \times 10^{-2} \cdot 1.00}\left[\frac{W}{cm^2}\right] = 22.6\left[\frac{W}{cm^2}\right]$$

According to Table 8a. of ANSI Z136.1 laser safety standard, the beam intensity is to be averaged on a limiting aperture of 3.5 mm when evaluating laser hazard in skin. We therefore calculate I_{exp} as follows:

$$I_{exp} = \frac{I_{max} \cdot x_0 \cdot y_a}{0.175^2 \cdot \pi}\left[\frac{W}{cm^2}\right] = \frac{22.6 \cdot 4.00 \times 10^{-2} \cdot 0.35}{0.175^2 \cdot \pi}\left[\frac{W}{cm^2}\right] = 3.29\left[\frac{W}{cm^2}\right]$$

Where y_a is the height of the laser line profile considered for the calculation of laser hazard over the limiting aperture area.

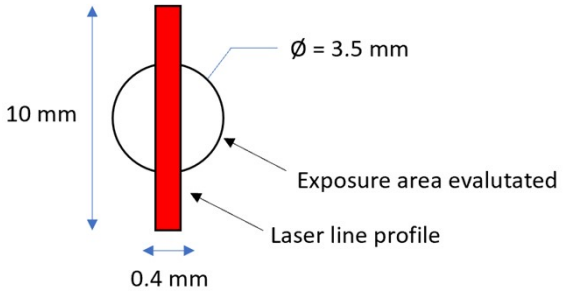

Figure S1. Laser line profile dimensions of the imaging system compared with the exposure area (i.e. limiting aperture) evaluated in maximum permissible exposure calculations.

Maximal permissible exposure to skin calculation

From ANSI Z136.1 Table 7b: MPE for skin exposure to a laser for wavelength from λ = 785 nm we extract the equation to calculate the MPE for skin for *t < 10 s* and *t > 10 s.*

$$MPE_{skin}(t < 10\ s) = 1.1 \cdot C_A \cdot t^{0.25}\left[\frac{J}{cm^2}\right]$$

$$MPE_{skin}(t > 10\ s) = 0.2 \cdot C_A\left[\frac{W}{cm^2}\right] = 0.30\left[\frac{W}{cm^2}\right]$$

Where *t is the exposure time and* C_A is a correction factor:

$$C_A = 10^{0.002(\lambda - 700)} = 10^{0.002(785 - 700)} = 1.48$$

From these equations, we evaluate what is the maximum permissible laser intensity for different exposure times (see **table S2**).

Table S2 Laser MPE for skin using the Raman imaging system.

Exposure Time [s]	MPE [J/cm²]	MPE Intensity [W/cm²]
0.3	1.20	4.01
0.4	1.29	3.23
0.5	1.37	2.74
1	1.63	1.63
2	1.93	0.97
3	2.14	0.71
4	2.30	0.58
5	2.43	0.49
6	2.55	0.42
7	2.65	0.38
8	2.74	0.34
9	2.82	0.31
≥10	2.89	0.30

From table S2 and I_{exp} calculated, we evaluate that a laser exposure time exceeding 0.4 s is not permissible for skin.

Maximal permissible exposure to eyes calculation

The laser beam exiting the Raman imaging probe is not collimated and has a divergence which quickly reduces the laser intensity the further away the beam is from the imaging probe muzzle tip. The quick drop of laser intensity may become safe from a certain distance from the imaging probe muzzle tip. We therefore calculate the beam dimensions x_L and y_L at the distance L from the probe muzzle tip:

$$x_L = 2 \cdot \left(L \cdot tan\left(\frac{\alpha_x}{2}\right) + \frac{x_0}{2} \right)$$

$$y_L = 2 \cdot \left(L \cdot tan\left(\frac{\alpha_y}{2}\right) + \frac{y_0}{2} \right)$$

From the new laser beam dimensions, we evaluated the laser intensity I_L to which an observer would be exposed at a distance L from the probe muzzle tip:

$$I_L = I_{max} / (x_L \cdot y_L)$$

The intensity of the laser beam from the tip of the imaging probe muzzle according to distance is shown in table S3.

Table S3 Intensity of laser beam evaluated for several distances from the tip of the imaging probe muzzle.

Distance from tip of the probe muzzle [cm]	Max Intensity [W/cm²]
0	22.63
1	4.25
2	2.18
3	1.39
4	0.99
5	0.75
6	0.59
7	0.48
8	0.40
9	0.34
10	0.29
11	0.25
12	0.22
13	0.20
14	0.17
15	0.16
16	0.14
17	0.13
18	0.12

We then calculate the MPE threshold for eyes and compare it to the results in table S3. Since the source is extended and shaped as a rectangle, we use the extended source parameters and correction factors for a wavelength of 785 nm presented in the ANSI Z136.1 Table 6b. From this table we calculate the correction factor CE:

$$CE = \frac{\alpha_x * (\alpha_{max} + \alpha_y)}{(2 * \alpha_{max} * \alpha_{min})} = 101$$

Where α_{min} and α_{max} are parameters. α_{min} = 1.5 mrad and α_{max} = 100 mrad. The exposure duration (time) beyond which extended source MPEs based upon thermal injury are expressed as a constant irradiance: *T2* = 100 s. Finally, we calculate the MPE for extended source ocular exposure to a laser beam for a wavelength of 785 nm using table 5f from the ANSI Z136.1 laser safety standard.

MPE for eyes for $10^{-6} < t < T2$

$$MPE_{eyes}(t) = 1.8 * C_A * C_E * t^{0.75} * 10^{-3} \left[\frac{J}{cm^2}\right]$$

We evaluate the MPE for eyes for exposure times of 1 s and 10 s respectively:

$$MPE_{eyes}(t = 1\ s) = 1.8 * C_A * C_E * t^{0.75} * 10^{-3} = 0.27 \left[\frac{J}{cm^2}\right] => 0.27 \left[\frac{W}{cm^2}\right]$$

$$MPE_{eyes}(t = 10\ s) = 1.5 \left[\frac{J}{cm^2}\right] => 0.15 \left[\frac{W}{cm^2}\right]$$

According to Table S3, distances ≥ 11 cm from the probe muzzle tip are safe for laser exposures to the eyes for exposures of ≤ 1 s. Additionally, distances ≥ 16 cm from the probe muzzle tip are safe for laser exposures to the eyes for laser exposures of ≤ 10 s.

Prominent Raman features in porcine muscle and adipose tissue.

Listed in Table S4 can be found the prominent Raman bands used for the tissue classification in the study, their assigned molecular bonds and respective molecular family[1–3].

Table S4. Prominent Raman features for porcine muscle and adipose tissue.

Raman Band (cm^{-1})	Molecular Bonds	Molecular Family
1004	Phenylalanine breathing mode	Protein
1062	C-C anti-symmetric stretch & C-N Stretch	Lipid & protein
1265	$=CH_2$ in plane deformation & amide III band	Lipid & protein
1295	CH_2 twist	Lipid & protein
1340	CH deformation & CH_2/CH_3 wagging	Protein
1459	CH_2 symmetric deformation, CH_2/CH_3 antisymmetric deformation & CH_2 Bending	Lipid & protein
1652	Amid I band, C=C stretch & C=O stretch	Lipid & protein
1734	C=O ester stretch	Lipid

References

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2 A. Beganović, L. M. Hawthorne, K. Bach and C. W. Huck, *Foods*, 2019, 8.

3 F. Daoust, T. Nguyen, P. Orsini, J. Bismuth, M.-M. de Denus-Baillargeon, I. Veilleux, A. Wetter, P. McKoy, I. Dicaire, M. Massabki, K. Petrecca and F. Leblond, *J. Biomed. Opt.*, 2021, **26**, 1–18.