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ORIGINAL ARTICLE

A porcine model for robotic training harvest of the *rectus abdominis* muscle

Un modèle porcin d'entraînement au prélèvement robot-assisté de muscle rectus abdominis

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KEYWORDS
Rectus abdominis muscle flap;
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Summary Conventional open surgical approaches for the harvesting of the *rectus abdominis* muscle carry a high risk of morbidity. It is possible to reduce these risks by using laparoscopy or robot-assisted techniques. This work hypothesizes that a porcine model could be used for learning the robot-assisted collection of the *rectus abdominis*. The *rectus abdominis* was taken in 3 stages in 3 pigs: installation of the robot, surgical approaches with 4 trocars, dissection and collection of the muscle. The average operating time was 1 h 20 min and the average muscular length was 16 cm. Our results showed a learning curve for the robot-assisted harvesting of the *rectus abdominis* on a porcine model.

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MOTS CLÉS
Rectus abdominis muscle flap ;
Robot Da Vinci ;
Technique mini-invasive ;
Robotic surgery

Résumé Dans le but de diminuer la morbidité des voies classiques de prélèvement de muscle *rectus abdominis*, il est possible d'utiliser une cœlioscopie conventionnelle ou robot-assistée. L'hypothèse était qu'un modèle porcin pouvait être utilisé pour l'apprentissage du prélèvement robot-assisté du *rectus abdominis*. Le *rectus abdominis* a été prélevé en 3 étapes chez 3 cochons: installation du robot, voies d'abord avec 4 trocarts, dissection et prélèvement du muscle. La durée opératoire moyenne était de 1 h 20 et la longueur musculaire moyenne était de 16 cm. Nos résultats ont montré l'existence d'une courbe d'apprentissage pour le prélèvement robot-assisté du *rectus abdominis* sur un modèle porcin.

Introduction

The *rectus abdominis* muscle is regularly used in reconstructive surgery to cover losses of substances from the abdominopelvic wall [1], anterior thorax [2], scalp [3], neck [4] and lower limbs [5]. To harvest *rectus abdominis* muscles, either free or pedicle, conventional surgical approaches require extensive medial, paramedian or suprapubic abdominal incisions [6], with significant morbidity [7,8]. To reduce the morbidity of open surgical approaches, some authors have shown that it is possible to use minimally invasive routes such as laparoscopy [9,10] or robot-assisted techniques [11,12]. The major disadvantage of these methods is the length of the learning curve. The primary hypothesis of this work was that a porcine model could be used for learning robot-assisted harvesting of the *rectus abdominis* muscle.

Materials and methods

This animal study was approved and adopted according to the guidelines of the Institutional Animal Care and Use Committee. Three domestic female swine (*Sus scrofa domesticus*), weighing 30 kg, was anesthetized using a ketamine (10 mg/kg)/midazolam (0.1 mg/kg) solution, followed by maintenance on pentothal (10 mg/kg/h). The pig was intubated and kept double-lung ventilated. After induction of general anesthesia, the pig was placed in supine position.

The *rectus abdominis* muscle collection was performed in 3 stages:

- installation of the robot;
- surgical approach with 4 trocars;
- dissection and sampling of the muscle (Video 1).

The surgical robot, model Da Vinci SI® (Intuitive Surgical ™, Inc., Sunnyvale, CA), was installed on the homolateral side of the muscle to be harvested. Three incisions, 1 cm long each, separated by about 10 cm, were made on the opposite side (Fig. 1a). The 3D camera allowed optical magnification up to 25 times. After the video camera was inserted into the central trocar, instruments (clamps, monopolar hook or scissors) were inserted on both sides of the video camera under direct vision (Fig. 1b). The trocar of the video camera was equipped with a CO_2 insufflation system, maintained at 14 mmHg to keep a clear field of vision and also to control the bleeding. A fourth trocar was installed on the white line, at the same level as the trocar of the video camera to install an auxiliary instrument.

The parietal peritoneum was incised longitudinally from top to bottom facing the white line of the abdomen, then transversally, first, facing the epigastrium, and, second, facing the hypochondrium. A lateral hinged peritoneal flap was thus obtained which was reclined downwards to gain access to the rectus abdominis muscle. The lower epigastric pedicle was spotted, dissected and placed on the lach. The posterior fascia of the muscle was incised longitudinally from top to bottom on its medial border. The muscle was detached from the anterior fascia along its entire length and then sectioned proximal and distal throughout its width. The pedicle was cut as distal as possible, the muscle was placed in an Endobag ™ (Covidien Medtronic, Minneapolis, MN) and the muscle was extracted from the abdominal cavity by enlarging the surgical hole of the video camera trocar.

Results

Retrieval of the rectus abdominis muscle was possible in the three trials (Fig. 1c). Two main technical problems were encountered during the first trial, one outside and the other inside the abdominal cavity. Outside the abdominal cavity, the dissection of the cranial and caudal extremities of the

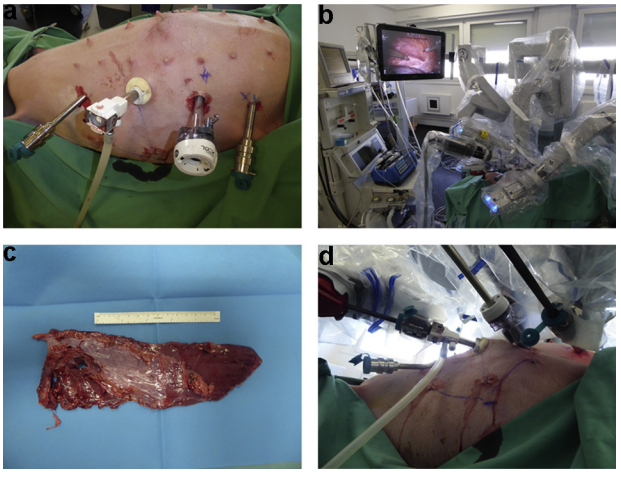

Figure 1 Porcine model of robot-assisted harvesting of the *rectus abdominis* muscle on the left side. a: the trocars are placed on the right flank; b: outside view. The pig is in supine Trendelenburg position; c: test room No. 3; d: the trocars initially placed opposite the anterior axillary line were moved toward the equivalent of the midclavicular line to eliminate the conflicts between the instrumental arms and the right hind leg.

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