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REVIEW

Prognostic value of sarcopenia in liver surgery

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Summary Current knowledge indicates that malnutrition increases the rate of post-operative complications, particularly respiratory and infectious, after major surgery. Almost all liver surgery is performed in patients with cancer, a factor that increases the risk of malnutrition. The primary risk factors for post-operative complications are pre-operative hypo-albuminemia and a body mass index less than 20 kg/m^2. To improve the prediction of complications in these patients, some teams have suggested measurement of muscle thickness by computed tomography. Muscular mass can thus be quantified by measuring the total surface of the psoas muscle or the total surface of all muscles (*i.e.* external and internal oblique, transverse, psoas and paravertebral muscles) seen on an axial CT slice at L3. As well, data exist suggesting that sarcopenia is an independent predictive factor of post-operative morbidity and poor long-term survival after resection for cancer. Nonetheless, the literature on the subject is limited, there are no standardized definitions for sarcopenia, and the need of special software to calculate the surfaces limits its usefulness. Lastly, there are little if any data concerning the nutritional or pharmacologic means to treat sarcopenia. This update, based on a literature review, deals with the value and the prognostic impact of sarcopenia in surgery for liver tumors. The current definition of sarcopenia, validated internationally, the methods of measurement, and the consequences of sarcopenia on the outcome of liver resections are detailed in this review.

Introduction

Current knowledge indicates that malnutrition increases post-operative complications, particularly respiratory and infectious complications, after major surgery. Most liver surgery is performed in patients with cancer who have increased risk of malnutrition. The main prognostic factors for post-operative morbidity and mortality found in the literature are pre-operative hypo-albuminemia [1—4] and BMI less than 20 kg/m^2 [2,5]. To improve the pre-operative prediction of complications before liver surgery, several teams have

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attempted to measure muscle thickness by computed tomography (CT) and to evaluate the impact of sarcopenia on the prognosis of patients undergoing operation for liver tumors. This update, based on a review of the literature, concerns the value and prognostic impact of sarcopenia on the outcome of liver surgery. The current internationally validated definition of sarcopenia, the methods of measurement and the consequences of sarcopenia on the outcome of liver resection are detailed in this review.

Definition of sarcopenia

''Sarcopenia'' was defined in 1989 as a loss of skeletal muscular mass [6]. Since then, this purely qualitative definition has evolved toward a quantitative and qualitative definition that correlates decreased muscular mass with reduced muscular strength and function. In 2010, a European working group defined sarcopenia as ''progressive loss of skeletal muscular mass, strength and function, increasing the risks of physical dependence, alteration of quality of life, and mortality'' [7]. This definition has now been validated internationally [8]. It is important to differentiate sarcopenia due to malnutrition from cachexia, for which there are precise diagnostic criteria. Both sarcopenia and cachexia are related to malnutrition.

Malnutrition is defined as insufficient protein-energetic intake relative to the metabolic needs of the organism, measured by loss of weight, albuminemia and nutritional status [9]. Cachexia classically associates anorexia, progressive muscle deterioration and wasting of fatty mass reserves. In concrete terms, cachexia is defined as involuntary loss of weight >5% in 6 months or a BMI <20 kg/m^2 and loss of weight >2% or sarcopenia [10]. Sarcopenia is defined as progressive loss of muscular mass [7].

Measurement of sarcopenia by evaluation of muscular atrophy by CT scan

The current definition of sarcopenia is based on quantitative (muscular mass) and functional (muscular strength and function) criteria. Currently, there is no single technique available that can measure all these criteria. The first step in defining a patient with sarcopenia is quantitative and consists in quantifying the skeletal muscular mass. This quantitative evaluation is accomplished by different techniques, of which imaging has a major part. Biphototonic absorptiometry is currently the technique of reference to evaluate the muscular mass (''lean mass'') of extremities and is related to differences in attenuation of X-rays as they traverse the tissues [11]. Three different types of tissues can be differentiated: the fatty mass, the lean mass, and the bony mineral content. Sarcopenia is evaluated by measuring the lean mass of the soft tissues of the four limbs that can be approximated to the muscular mass of the four limbs (called appendicular muscular mass) [11]. The skeletal muscular mass is defined by the ratio of the appendicular muscular mass to the square of height. The limits of this technique are its costs, availability and radiation exposure, which means that it is not widely used in current practice.

Computed tomography (CT) provides excellent images of muscles and has the advantage of being more available than biphotonic absorptionmetry. Sarcopenia can be evaluated on an axial CT slice, at the level of the third lumbar vertebrae, by measuring the total surface of the psoas muscles (Figs. 1 and 2) or that of all the muscles present at this level (external and internal oblique, transverse, psoas and paravertebral muscles). The skeletal muscular mass is defined by the ratio between the muscular surface area at L3 to the square of height [12]. Thresholds have been proposed to define sarcopenic patients. In a recent study,

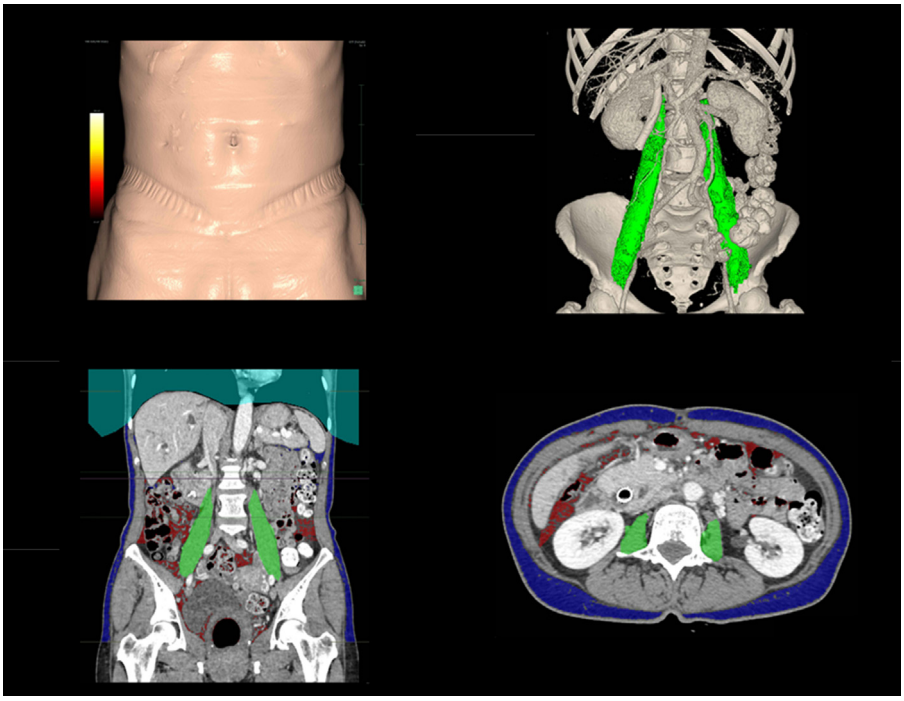

Figure 1. Measurement of the surface area of the two psoas muscles at L3 by computer-tomography and post-treatment software (SYNAPSE 3D [Fujifilm, Japon]) permitting semi-automatic detection of muscles. Example of a 61-year-old sarcopenic patient: she weighs 52 kg with a height of 162 cm, *i.e.* BMI of 19.8 kg/m^2. The surface area of the two psoas muscles is 12 cm^2, *i.e.* skeletal muscular mass index of 4.6 cm^2/m^2.