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ORIGINAL STUDY

A growing stake in orthopaedic surgery and traumatology for the future management of obese patients

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The prevalence of obesity is increasing. In orthopaedic surgery, the impact of obesity is felt. The aim is to take stock of the consequences of obesity for patients at each stage of management.

In this mini-review, we identify the main pathophysiological factors, specific orthopaedic complications and consequences to consider at each stage of management.

Obese patients are subjected to a chronic inflammatory state and biomechanical stress.

This augments the risk of sepsis and trauma, musculoskeletal damage, the frequency of organ failure and thus, morbidity and mortality.

This results in more complex and longer supportive care.

At each stage of care, surgeons and doctors have to adapt to optimize care. It is necessary to obtain timely and accurate information from the patient. Patient information is necessary.

Being obese in orthopaedics is a factor in poor prognosis. Treatments need to be adapted. This requires specific preparation at each step.

Keywords : obesity ; orthopaedic ; surgery.

INTRODUCTION

Obesity is defined as a BMI greater than or equal to 30 kg/m² for an adult. For a child, this corresponds to exceeding the 95th percentile of the norms for the identical age and sex. According to the WHO, in 2014, more than 600 million adults were obese in the world, which is approximately 13% of the world's adult population. The prevalence of obesity more than doubled between 1980 and 2014 *(1)*. In France, obesity represents 16.9% of the total population *(13,41)* and is therefore a true problem of public health. Moreover, this problem can only worsen in the future as the number of obese people is expected to double in France from now until 2030. In orthopaedic surgery, the impact of obesity is particularly felt. The aim of this article is to take stock of the consequences of obesity for patients at all stages of management.

PHYSIOPATHOLOGY

From a physiopathological point of view, several elements explain how obese individuals are patients at greater risk of pre- and post-operative complications. This inflammation

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depends on three factors: a disequilibrated hormonal balance (overexpressed adipokines), an alteration of physiological functions *(31)* and an immunodeficiency, notably through protein malnutrition. With their morphotypes and thus, the mechanical constraints that result from them, physiopathology is altered. For example, lung function, subject to abdominal overpressures, is defective and thus more easily subject to congestion and then to infections. These patients, on the other hand, are more often carriers of weakening comorbidities: diabetes, HBP, and cardiopathy.

In orthopaedic surgery (table 1), the impact of obesity is particularly clear. First, soft tissues are subject to chronic inflammation and excessive tension, contributing to infection *(8)*. Secondly, skeletons are under excessive biochemical constraints *(45)*, and the adipose tissue is responsible for biochemical processes *(4)*, all of which contribute to osteoarthritis. This multifactorial obesity-osteoarthritis relationship can mainly be found in the lower limbs *(20)* with a 2.4-fold increased risk above 30 kg/m² in the knees, compared with people whose BMI is lower than 22 *(9,39)*. In the hips, it is not so clearly demonstrated, but some authors find that when BMI is superior to 28 kg/m², there is a significant increase in the relative risk of osteoarthritis by 1.9 compared with BMI lower than 24 *(10)*. One point of BMI seems to increase the relative risk of osteoarthritis by 15%. Upper limbs are not spared, notably the hands, with a relative risk of 1.9 in the case of overweight *(62)*. Mechanical overload is not the only explanation for excessive osteoarthritis in the upper limbs. Metabolic syndrome (obesity, high blood pressure, hypertriglyceridaemia, diabetes) induces cartilaginous damage via adipokines, an overexpressed mediator in this context that induces an inflammatory syndrome, promoting chondrolysis *(4)*. Finally, tendons are also subject to important mechanical constraints. Achilles' tendon pathology exemplifies these pathologies very well. The relative risk of tendinopathies, with respect to patients whose BMI is normal, is 2.6 with BMI <30, 3.8 with BMI at 30-35, 3.77 with BMI at 35-40, and 6.56 with BMI >40 (17-20). In the same way, injuries to foot plantar fasciae are significantly promoted by obesity *(23,44,56)*.

In traumatology, obesity is a factor of severity. According to studies, obesity affects 17% to 30% of injured patients. Low kinetic traumas of the dislocation or complex comminuted fracture type *(18,25,45)* can be observed while they deal with high kinetic traumas in general. Likewise, abdominal fat tissue has the advantage of protecting organic and digestive pelvic injuries but increases the risk of pelvic bone injuries *(18,49,54)*.

Specific complications of obesity in orthopaedics.

Several complications linked to obesity exist (table 2):

- Over mortality. There exists a significant increase in mortality for the same trauma severity or the same type of surgery. It doubles when BMI is greater than 40 kg/m² according to Paratte et al. *(41)*. Severely traumatized obese individuals (Injury Severity Score-ISS- greater than or equal to 15) have greater mortality than non-obese patients. Post-traumatic complications, in people who have or have not been operated on, are significantly more frequent *(3,7,14,60)*, and thus they are exposed to a risk of over mortality. The increase in ISS by single obesity is still being discussed *(55)*.
- An increased risk of infection. Infections are significantly more frequent. The more obese the patients, the higher their risk of infections. When BMI is higher than 30 kg/m², the risk of infection doubles *(41)*, reaching up to 12% in

Table I. — Orthopaedic problems

	Infection	Tendon pathology	Sever trauma	osteoarthritis
Metabolic syndrome	X			X
Mechanical constraints		X	X	X
Excessive soft tissue tension	X	X		
Inflammation	X	X		X

Table II. — General health problems

	Mortality	Infection	Visceral failures	Respiratory disorders
Inflammation	X	X	X	X
Metabolic syndrome		X	X	
Mechanical constraints				X
Excessive soft tissue tension		X	X	

severely traumatized obese individuals *(3,7,14)* and up to 20% in patients whose BMI is greater than 40 kg/m². The predisposed sites are the lungs and the operative sites (superficial on scars or deep inside). Other sites are affected more frequently: urine, the gastrointestinal tract (Clostridium difficile) and access points (catheters, drains, etc.).

- An increased risk of visceral failures. Significantly more frequent in severely traumatized obese individuals, they are global (multivisceral failure syndrome) or monoorganic: acute respiratory distress syndrome or acute kidney failure *(3,7,14,55,60)*.
- A higher risk of respiratory disorders. As mentioned above, obese patients are more frequently exposed to pulmonary infections or to respiratory distress *(15,60)*. Therefore, mechanical ventilation is longer in severely traumatized obese individuals (2 to 3 additional days), in order to offset the disorders (infections or/and failures).
- Their problems are still being debated. No significant proof exists, but physiopathology and studies suggest that obese individuals are more often exposed to venous thromboembolic disorders (double the risk when BMI is higher than 30 kg/m² *(41)* and other complications from the supine position (bedsores).

Consequences for peri- and pre-operative management (table 3)

The management of obese patients is thus more risky, as the figures show. Anaesthesia and surgery take a significantly longer time when BMI is higher than 40 kg/m² and hospitalization is also longer *(7,14)*. This is not always significant for the total duration of hospitalization, but it is the same for the time spent in intensive care for severely traumatized obese individuals *(7,14)*, which then leads to at least two more hospitalization days. A third of patients whose BMI is higher than 40 kg/m² require hospitalization in intensive care after an operation *(41)*.

The management of these patients thus becomes a medico-economical problem. It is essential to prevent and combat obesity; nevertheless, the

Table III. — Consequences at every stage

	Pre-operative	Per-operative	Post-operative
Logistical	- Speed up management - Properties in large load capacities	- Position: compression, pulmonary function - Pneumatic venous compression	- Intensive care - Early mobilisation
Paraclinical exams	- Large format devices - New devices		- Frequent X-ray control
Drugs	- Variable - diffusion, doses, speed and frequency	- Volume adaptation	- Unfractionated heparins - Posology: painkillers, antibiotics, anticoagulants
Surgery	- Information	- Instruments - Techniques: incisions - Fight against contamination	- longer hospitalisation
Anaesthesia	- Suitable venous access - Difficult intubation	- Difficult ventilation	- Longer mechanical ventilation

system must adapt to the management of these patients. The quality of management imposes an adaptation of the logistical means and of staff training. There must be a preoperative preparation, an adaptation of the preoperative means and an anticipation of postoperative follow ups. All of this has an important cost, which is difficult to estimate, as the necessary equipment and surgical complications in obese patients suggest.

Pre-operatively, it is necessary to always fight against this obesity at the community level with national prevention campaigns but also individually. Patients should be helped to lose weight before they are operated on. A multidisciplinary team *(24,51)* should deal with weight loss and the often-associated comorbidities *(30)*: diabetes, (protein) malnutrition and blood volume disorders. The pre-operative logistics to welcome these patients must also be adapted. As early as pre-hospitalization, the teams must assess their capacity to cope with obese individuals. Severely traumatized obese patients can take 10 h longer to be operated on than normal-weight individuals after traumas *(7)*. Logistics must be adapted in order to notably speed up this long and deleterious management. For example, stretchers/beds or operating tables with a sufficient capacity in terms of size and potential for bearable weights can be provided. At the moment, operating tables support a maximum load of approximately 180 kg. It is therefore advisable to check the capacities of operating tables, stretchers and other logistical means on the premises.

Venous and superficial access points are more difficult to find and can be infected more easily. The necessary type of access point should therefore be anticipated upstream *(6,41)*: central catheters for severely affected patients and PICC lines if prolonged intravenous treatments are necessary.

Imaging departments should take into consideration patients' morphotypes *(6,37,41,45)*. X-ray contrasts are different for obese individuals, owing to a different absorption by their soft tissues *(45)*. Like operating tables and hospital beds, CT scan and MRI tables are subject to maximum load capacities (approximately 200 kg for CT scans). Furthermore, the diameters of CT scanners and MRIs have to be taken into consideration. Due to the maximum diameter of 70 cm of CT scanners, some obese individuals may not go into these devices. It is therefore necessary to learn in advance about the capacities of available facilities. Some imaging departments have adapted to obese individuals. Open MRIs or EOSTM devices can welcome this population of patients (no limits to morphological diameters).

Peri-operatively, anaesthetists must also adapt their techniques to obese patients *(15,24,26)*. Orotracheal intubations are more difficult (a specific material has to be anticipated) and lung function is more unstable (sleep apnea syndrome, more complex ventilation etc.). Treatments used are subject to important variations, imposing a continuous assessment of their efficacy and tolerance more closely *(11)*. The volume and potential of drug diffusion in obese individuals are subject to important variation with regard to other patients. Doses, speed and frequency of treatment administration have to be adapted to obese individuals. The surgeon must also adapt their reflection and their procedures to obese individuals. They must rethink the patients' operating position *(15,24)*. Obese patients' morphotypes may oblige them to adapt the position in order not to be impeded during the procedures; however, the surgeon must also think of the least deleterious operating position for the patients. It may have a negative impact on the pulmonary function or cause compression areas (nervous or vascular ones). The procedure the surgeon decides to perform must take into account the obese individuals' morphotypes *(5,35,41)*. They must adapt their choice of instruments *(32)*, their technique *(45,54)* and their indications to obese individuals *(22,60)*. The surgeon should therefore rethink their operating techniques: the types of incisions (wider or other approach) and means of exposure of the operating site, adapted material and instruments, precautions taken against contamination and reduction of septic risks (by covering incision areas with dressing). Pneumatic venous compression is a pre-operative preventive means of thromboembolic risks usable in obese individuals. It is interesting to use it in long procedures or in operations imposing a prolonged venous compression of the lower limbs.

Pre-operative information given to patients is thus particularly important in view of the increase in risks. Obese individuals should be informed that their condition exposes them to a higher risk of complications (infections, visceral failures, thromboembolic diseases) and overall mortality. They should be informed that owing to their weight, surgery, anaesthesia and hospitalization would certainly be longer and more complex than normal.

Post-operatively, prevention of complications in obese individuals turns out to be highly necessary. Monitoring in intensive care units will have to be performed in the case of unstable situations in order to manage ventilator problems and hydroelectrolytic balances, for instance. Pneumatic venous compression and antithrombotic therapies are highly necessary in cases of thrombotic risk *(46)*. Unfractionated heparins will be preferred to other therapies, for their management (doses, diffusion in volumes, dosages and antidotes) is more adapted *(45,46)*. Posology has to be reconsidered according to patients' weight. So, painkillers (morphemic), antibiotics and anticoagulants will have their doses adapted and controlled (blood titration) if need be. Diets will be all the more important, as the obese patients' condition is severe. Considered as being undernourished, patients will therefore have high-protein diets that will help with skin healing and immune defence.

In orthopaedic patients, early mobilization for an accelerated functional recovery is all the more appropriate in obese individuals. It will also permit improvement of respiratory function by reducing excess abdominal pressure on ribcages, and will reduce congestion and pulmonary septic risks. It will reduce the risk of complications due to the supine position (bedsores, venous thrombosis, nervous compressions etc.).

Long term monitoring is still more appropriate. The above-mentioned infectious risks are still possible, even after long postoperative delays. Obese individuals' mechanical constraints increase secondary fracture displacement and dismantling risks at surgical sites. Metabolic unbalances, in addition to mechanical constraints, increase the risk of non-consolidation.

Particular case of arthroscopic surgery.

Obesity has an impact on technical arthroscopic procedures, specifically, the degree of difficulty in the approach and use of instruments, which are too small for patients' morphotypes *(40)*.

As opposed to conventional surgery, obese patients treated with arthroscopy do not display more complications than those whose BMI is less than 25 kg/m² *(40)*. For example, in knee arthroscopy, local complications are not more frequent and general complications are mainly venous thrombosis with a slightly more important frequency. Obesity does not seem to increase the risks of ACL (anterior cruciate ligament) ruptures, but it increases the general risks of trauma to the knees (a relative risk of 1.9 when BMI is greater than 29 kg/m²). The involved injuries are then chondral injuries, joint fractures or meniscal injuries. They are a source of important functional handicaps. Trauma to the knees in obese individuals has a poor prognosis. After an ACL rupture that has not been operated on, osteoarthritis appears earlier when BMI is greater than 30 kg/m² *(48,52)*. ACL injuries are associated with the above-mentioned elements (mechanical overwork, biochemical effects) to promote early osteoarthritis in obese individuals.

Regarding tendinopathies in rotator cuffs and periarticular (epicondylar) ones in elbows, obesity seems to increase their incidence, but studies have produced either divergent results or no significant conclusions *(12,61)*. For rotator cuff surgery, objective postoperative results are not as good, but paradoxically subjective functional results are deemed very good by the patients.

In sum, obesity does not increase the frequency of pathologies treated with arthroscopies. If need be, the management of these patients requires good equipment, notably with instruments whose sizes are adapted to morphotypes *(37)*. Obese individuals are not subject to a significant excess risk of post-arthroscopic complications, as observed in open surgery.

CONCLUSION

Being obese in orthopaedics is a factor in poor prognosis. Obese patients have an additional risk

of complications and mortality. Surgical outcomes and operations themselves are more complicated. This requires a logistical, technical and personal preparation, and this preparation requires reflexions on preoperative, operative and postoperative steps. Medicinal and surgical treatments will be adapted. Obese patients will therefore have to be all the more informed.

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