Chapter

From Prehab to Rehab: The Functional Restoration of a Bariatric Individual

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Abstract

The bariatric population presents at a greater risk for functional decline with increasing weight and advancing age. This can be prevented at various time points through multidisciplinary rehabilitation interventions in a multitude of different settings to accommodate the severity of an individuals' disability and to target different functional goals. Bariatric rehabilitation is a multipronged approach that addresses the ongoing functional impairment, medical comorbidities, hospital-related deconditioning and prevents future cardiovascular and musculoskeletal complications from progressing. The emerging concept of utilising rehabilitation interventions and goal-centric approach as means to reduce post-operative complications and enhance surgical outcomes is also discussed. Pragmatic approaches to post-surgical bariatric rehabilitation are discussed highlighting the multi-faceted rehabilitation concerns to achieve optimal functionality in the face of a chronic medical condition.

Keywords: bariatrics, rehabilitation, recovery of function, exercise, behaviour modification

1. Introduction

Bariatric individuals not only present with specific medical complications and more prevalent risk factors for cardiovascular disease (CVD) and musculoskeletal (MSK) conditions, this population also has significantly greater potential for functional decline. Graded increase in activities of daily living (ADL) limitation was observed with increasing body weight [1]. Rehabilitation medicine approach to address the needs of a bariatric individual encompasses both ends of the management spectrum: to restore and prevent further deterioration of physical function associated or aggravated with excess body weight; as well as to enhance post-operative results with a sustainable weight management strategy.

The rehabilitation medicine approach to function can be viewed from The International Classification of Functioning, Disability and Health (ICF) concept to better understand the interactive nature of a chronic health condition such as obesity and formulate a rehabilitation plan to address physical, psychological and socio-environmental barriers to bariatric-related disability [2, 3] (**Table 1**). Individualisation of care from all disciplines involved in the bariatric population

Domains affected	Descriptors
Body function	Energy and drive function
	Weight maintenance functions
Activities and participation	Handling stress and other psychological demands
	Walking
	Moving around
	Looking after one's health
Environmental factors	Products of substances for personal consumption
	Immediate family

Table 1.
Brief ICF Core set for Obesity [3].

to produce long-term sustainable results can also be deduced by understanding the dynamics of a disease process through this concept. We shall discuss the approaches to a bariatric evaluation, rehabilitation intervention and functional outcome in two parts with special focus on prehabilitation and peri-operative rehabilitation.

2. Addressing bariatric functional limitations

Obesity affects physical, biopsychosocial aspects of an individual's health and function. The complex nature may require rehabilitation interventions to be carried out in various settings to accommodate for different functional goals and engaging a multidisciplinary rehabilitation team to tap into different expertise to achieve the desired functional milestones. The bariatric individual presents with unique challenges to the treating team in both functional limitations and the approaches that can be employed to address these impairments and prevent further functional deterioration. The ICF highlights the domains that are affected by excessive weight: pain, cutaneous sensation, neuromusculoskeletal issues and movement difficulties as well skin issues due to difficulty in reaching during cleaning and toileting are the most commonly impaired function and complications leading to limitation in general tasks, mobility and poorer quality of life [1]. Concurrent presence of medical comorbidities can add up to tip the individual into compromised functional independence [1]. Common comorbidities related to obesity such as osteoarthritis of the weight bearing joints and cardiopulmonary conditions impacts severely on an individual's functional reserves. Thus, the goal for bariatric rehabilitation program should include assisting the attainment of optimal weight reduction; to address current and potential medical complications especially metabolic syndrome, CVD and MSK conditions; to address functional limitations resulting from physical disabilities and improve quality of life through improving functional independence, self-confidence and empowering self-management.

Severe obesity with multiple comorbidities requires admission to medical facilities structurally adequate to assist in supporting and assisting individuals with excess body mass to transfer and mobilise with the use of bariatric- safe lifting devices, mobility equipment and transfer aids. Ideally these rehabilitation facilities are linked to a bariatric- dedicated medical and surgical specialities [4].

The bariatric patients frequently develop medical complications that may run a protracted course [5]. Common medical complications readily noted at admission include:

- Skin excoriations, rashes or ulcers in deep tissue folds with possibility of fungal infections.

- Edema or fluid retention and venous congestion that causes feeling of limb heaviness or leading to diaphoresis-fluid leakage that renders the skin sensitive to shear forces, skin tears and infection.

- Diabetes and respiratory problems including obesity hypoventilation syndrome or obstructive sleep apnoea.

These complications may indicate specialised nursing care or aids to protect during mobilisation. It may also preclude the use of some rehabilitation modalities i.e. hydrotherapy and priorities needs to be given to address medical conditions that delays resumption of weight bearing or therapeutic standing.

Hospitalisation-related complications that tend to occur are mainly as a result of prolonged recumbency, also known as deconditioning. While deconditioning is not exclusive to bariatric population, its effects are more pronounced as bariatric individuals face challenges for immediate resumption of upright posture especially those who were admitted acutely for medical complications such as cardiopulmonary emergencies, following falls or exacerbation of musculoskeletal conditions leading to pain on weight bearing. Deconditioning can affect both physical and psychological domains as prolonged bed rest affects nearly all body systems. Specific to bariatric population these complications may entail a prolonged stay and protracted course of recovery:

- Cardiovascular system: orthostatic hypotension and reduced exercise tolerance contributed by decreased cardiac output and resting tachycardia affecting sitting up, standing, transfers and physical activity participation.

- Pulmonary system: orthostatic pneumonia or atelectasis resulting in hypoxemia and reduced tolerance to physical activity may complicate obesity hypoventilation syndrome or sleep apnoea.

- Haematological system: deep venous thrombosis and pulmonary embolism may occur despite no lower limb neurological deficit as abdominal mass may compress on lower limb circulation and altered blood viscosity.

- Musculoskeletal system: muscle atrophy causing weakness; leading to longer periods of non-weight bearing and increasing the risk of osteoporosis, joint stiffness and worsening posture. Especially of concern is weakness of extensor muscles needed to assume or assist to an upright position.

- Gastrointestinal: constipation from lack of upright posture often complicate prescription diet plans due to the bloating sensation, abdominal discomfort and possibility of spurious diarrhoea complicating personal hygiene due to poor access to the perineal region combined with postural stasis that predisposes to the development of pressure ulcers.

- Endocrine: impaired insulin response with hyperglycemia; gastrostasis leading to sensation of nausea and oesophageal reflux symptoms.

The result impacts on a bariatric individual's functional reserves in terms of muscle power, balance, and coordination, jeopardising functional performance and

results in the development of psychological sequelae as a direct result of deconditioning or from the loss of function it entails. Confusion and disorientation are part of the deconditioning constellation seen earlier on the bedrest period which can culminate in clinically significant anxiety and depression once the impact of functional loss sets in as self-care, leisure activities and gainful employment becomes challenging. Reconditioning as a rehabilitation goal will be discussed further in the prehabilitation section. Given the prospect of functional deterioration that can occur at an accelerated rate in the bariatric population due to inherent difficulties in mobilisation, special attention should be given to addressing factors that negate upright sitting and to promote lower limb weight bearing in cases that permit them as soon as possible. These include identifying at risk bariatric individuals with hip and knee replacements, paralysis, amputations, contractures, osteoporosis, respiratory and cardiac conditions, and skin conditions such as pressure ulcers. Availability of bariatric mobility aids such as hoists, tilt tables, chairs or wheelchairs and walking aids greatly assist in preventing the ill effects on deconditioning and translates to better cost-efficiency to prevent such deleterious complications rather than treatment of the aforementioned complications.

Various models of bariatric rehabilitation exists to generally addresses 5 key factors: knowledge to empower action, goal-setting and self-care; beliefs surrounding causes and solutions to obesity; behavioural adaptation focusing on diet and physical activity, psychological coping strategies and adjustments of physical activity to include exercise, current functional capacity and that expected after bariatric surgery. A holistic model such as bio-psycho-social model explained via ICF helps to provide a multi-dimensional framework to evaluate the needs, identify the barriers and provide intervention or solutions to improve independence. Selection of the model to address such an individualistic experience such as function is paramount as the different considerations of the desired rehabilitation goals and outcomes of interest are given priority by different models [6]. The lack of obesity-specific outcome measures to quantify physical impairments and ADL limitations prevents stratification of bariatric individuals based on the magnitude of disability [7]. This is useful to establish as a threshold value for inpatient rehabilitation admission, and serves as an objective severity identification tool that impacts on the decision of appropriate rehabilitation setting and chart progress during rehabilitation. An example of such tool is the Obesity-related Disability Test (TSD.OC) developed by Donini et al. that aims to evaluate pertinent obesity- specific functional dimensions [8]. The main targets for bariatric rehabilitation are the cardiorespiratory, musculoskeletal and multi-systemic effects of deconditioning as described above. Strategies that reduce pain, increases strength and mobility as well as optimise functions can be delivered in various settings depending on the severity of obesity-induced disability. Inpatient rehabilitation facility offers an opportunity for more intensive rehabilitation input and caters well to bariatric clients admitted acutely for MSK or CVD that often runs a prolonged hospital stay and poorer functional recovery if left without rehabilitation input. The goals of inpatient rehabilitation are focused on attaining maximal functional independence for safe home discharge through improvements in strength, balance, and endurance coupled with initiation of CVD risk factor control and body weight reduction through dietary and physical activity prescription. An outpatient program may provide significant functional improvements in clients who can access both the centres and their lodging with appropriate means of transportation between them. This is attained by promoting increased pain-free joint range of motion, increasing muscle strength and cardiopulmonary endurance during functional activities. Concurrent efforts to optimise CVD risk factor and improve lean-to-fat mass ratio are also continued in the outpatient setting through education and individualised counselling on dietary and physical activity

plan to maximise functional capacity despite excessive weight. Capodaglio et al. conducted a prospective 4-week inpatient bariatric rehabilitation with orthopaedic conditions consisting of strengthening and aerobic exercises adapted to the patient's mobility; caloric restriction and nutritional education with psychological counselling [7]. The results exemplified that mild and severely disabled bariatric individuals with orthopaedic comorbidities can significantly experience functional improvements independent of the weight loss sustained; with the higher BMI and younger individuals showing the most functional gains. Similarly, Hanapi et al. employed an approach based on the cardiac rehabilitation model and resources for inpatient bariatric clients with CVD risk factors and orthopaedic comorbidities [9]. Employing adapted physical activity and exercise prescription, dietary modification, provision of psychological and social support, their approach successfully addressed weight, cardiometabolic profile optimisation prior to bariatric surgical intervention and conferring postoperative improvement in mood, dependency level, perceived physical and mental health during the postoperative phase with sustained functional capacity, endurance and quality of life up to 3 months post operatively.

Admission planning for an inpatient rehabilitation stay is crucial to ensure logistic requirements, staffing ratio, bariatric-compliant equipment, administrative support and a mobilisation plan is developed as part of a function-centric rehabilitation plan. By definition, bariatric individuals include individuals whose weight exceeds or appears to exceed the identified safe working loads for equipment, lacks mobility or presents with challenges in manual handling [10, 11]. Moving and handling of bariatric clients can accentuate the risks of musculoskeletal injuries and excessive spinal loading in health care workers. Planning of staff and equipment reduces the risks associated with the care of bariatric patients. Safety of patients and health care workers can be enhanced by developing a movement and handling plan as each bariatric admission often presents with unique issues that require problem solving and an understanding of equipment or patient transfer procedures. Involvement of occupational health and safety representatives as well as risk reduction efforts can minimise unplanned situations that may differ between patients due to individuals' risks, goals and resources available. Every aspect of patient- HCW interaction should be therapeutic from rehabilitation perspective including communication. Open discussion on equipment use and transfer techniques can lead the way to more serious discussions on dietary habits, adapting lifestyles and long-term functional goals. Education on the importance of physical activity and dietary management to aid weight loss and maintain functional independence helps boost motivation and compliance [9]. Discharge planning should include not just physical preparation of the destination. Consideration should be given to post-rehabilitation functional limitations that may require physical help or adaptive equipment as functional goals attainment may require repeated cycles of rehabilitation. Potential home modifications and long-term plans for adapted physical activity, dietary maintenance, psychological support, surveillance for relapses and complications as well as plans for higher functions such as return to work and driving should be discussed with the patients and their social support.

Outpatient bariatric rehabilitation continues the inpatient gains made with focus on long-term prevention of function and weight- gain relapse. The common impairments addressed are osteoarticular pain especially of the lower back and knees as well as joint malalignment. The effects of excessive weight on systemic inflammation, joint compression and premature degenerative disease of the joint can be offset by the role of adapted physical activity which is more pronounced in this setting to maintain compliance to caloric expenditure, CVD prevention and positive psychosocial reinforcement. A combination of both aerobic, resistance and flexibility exercises adapted to individual MSK conditions working on large muscle

groups alongside dietary modification has led to improvement in CV biomarkers, fat loss and skeletal muscle gains conferring enhanced functional improvements in programs that include resistance exercises [12, 13]. In comparison to diet modification intervention alone, multimodal exercises program combined with diet interventions conferred lean mass sparing effect [14]. This is also evident in a systematic review of sarcopenic obesity treatment whereby excess fat mass and reduced lean mass impairs physical performance in which weight loss attained through exercise in combination with dietary intervention is the best treatment strategy that improves metabolic consequences of excess fat mass while preserving lean muscle mass and promotes functional recovery [15]. Aerobic exercises for caloric expenditure, reducing joint pain and controlling weight which is a risk factor of osteoarthritis as well as resistance exercise for strengthening of the joint supporting musculature and cartilage health reduces obesity-related joint conditions [16, 17]. As the client returns to the community, psychological support to sustain weight loss motivation and purpose as well as addressing stigma associated with excessive weight is equally important to ensure sustained functional and weight loss gains are maintained. Chronic pain and its effect on gait, psychical activity, participation and quality of life also needs to be addressed.

In conclusion, bariatric rehabilitation addresses common medical comorbidities and obesity related MSK complications through multimodal rehabilitative and allied health interventions, including prescription exercises and diet modification to increase cardiopulmonary endurance and caloric expenditure while minimising fear of movement and joint pain. This in turn leads to progressive body weight reduction and improved comorbidities profile leading to better body composition and physical function capacity.

3. Prehabilitation: Maximising post-operative outcomes

Bariatric individuals often present with medical comorbidities arising from obesity-related changes or complications sustained from hospitalisation- related bedrest for acute medical crises. Functional impairments evident pre-operatively should be addressed to improve postoperative results and functional independence. The concept of deconditioning is discussed above- the bariatric individual runs a higher risk of developing deconditioning due to delayed weight bearing or resumption of an upright position. This is often multifactorial: common patient related factors such as sarcopenia, kinesiophobia, osteoarticular joint pain and exertional dyspnoea; logistic issues i.e. lack bariatric-safe equipment or staffs' lack of ergonomic awareness are among easily amenable factors [18]. Deconditioning impacts the geriatric age group more [19]. Adapted exercises have been successful to prevent multisystem deconditioning from zero-gravity environment or from prolonged bed rest [20, 21]. Hanapi et al. demonstrated a 6-weeks bariatric surgery prehabilitation [9] consisting of patient education and prescription of therapeutic exercises, dietary modification and nutritional-behavioural counselling, the use of technological advancement to facilitate early non-weight bearing aerobic and resistance exercises that had successfully prepared the bariatric patients for the demands of the surgery as well as facilitated early post-operative mobilisation that has been purported to reduce post-surgical morbidity [22, 23]. This model adapted the principles of cardiac rehabilitation in formulating the evaluation, intervention and outcomes including risk-stratifying the bariatric surgery candidates for cardiovascular risk during exercise participation, quantifying exercise capacity for exercise prescription and addressing CVD risk factors that can complicate anaesthetic and post-operative care. Priorities were given to utilising adapted physical activity and early

mobilisation to translate cardiorespiratory and musculoskeletal reserve improvements into functional mobility and independence in basic activities of daily living. This model along with other bio-psycho-social approaches have shown positive impact on long term functional capacity, endurance, dietary habits, weight loss and quality of life up between 3 to 12-month post-surgery [24].

In the management of a complex, chronic condition such as obesity a multidisciplinary approach has consistently shown the best outcomes [25]. This approach however must be integrated into individual clinical complexity of each individual bariatric patient. An approach that entail evaluation with the intent to individualise treatment plan utilising multimodal treatment strategies i.e. diet, physical activity and functional rehabilitation, educational therapy, cognitive-behaviour therapy, drug therapy, and bariatric surgery will most likely ensure quality of weight loss, addressing the medical and psychiatric comorbidities together, psychosocial problems and physical disability [26]. Older bariatric patients may face a more challenging rehabilitation course due to age-related changes such as sarcopenia, muscular fatty infiltration which leads to strength reduction and diminishing exercise capacity; as well as external factors such as increased inertia from excessive mass causing imbalance, longer exposure to effects of obesity causing pronounced musculoskeletal degeneration and pain as well as more damage in the peripheral tissues [7]. Sarcopenic obesity in advanced age contributes to more dependence in ADL [27]. Muscular and mobility deterioration in combination contributes to exacerbate physiological changes associated with ageing. Thus, identification of such patients earlier prior to surgery is paramount to ensure successful outcomes following bariatric surgery.

The economics of bariatric rehabilitation can be seen from 2 angles- in respect to functional restoration and from a long-term preventive viewpoint. Bariatric individuals who have undergone rehabilitation have shown functional improvement independent of the amount of weight lost, with more pronounced improvement in function observed in the severely disabled individuals [7]. This translates to earlier weight bearing, resumption of mobility and independence in self-care which in turns minimises the risk post-operative complications. Alongside improvement in muscular strength and lean mass, individuals who have undergone rehabilitation also had controlled CVD risk profiles, joint pain and reduced sedentary time conferring protection to future CVD in this high-risk group. However, to truly understand the cost–benefit effect of bariatric rehabilitation, long term outcomes expressed in multiple domains of function are needed to allow better understanding of the effect of different rehab interventions, optimal intensity and duration to therapeutic effect.

Capacity building in an organisation that caters for bariatric rehabilitation is essential to reduce personal risks to patients and staff as well as minimise disruption of bariatric rehabilitation services. This includes developing a bariatric rehabilitation pathway, continuous staff education and training and an audit of the outcomes from the pathway. A bariatric rehabilitation pathway details the appropriate facilities, staff and equipment are available at each stage of the bariatric individuals' rehabilitation process from admission to outpatient facilities. Although this may incur short term increase in expenditure, the long term return of investment can be quantified through better morbidity and mortality reduction of the bariatric population regardless of conservative or surgical management approach chosen to suit individual medical and functional needs.

4. Rehabilitation following bariatric surgery

Formulation of an individually-tailored rehabilitation program based on each bariatric patients' clinical complexity should be the priority to holistically manage

such clients using a multidisciplinary team approach. Multidisciplinary teams offer the best post-operative outcomes [28], addressing quality of weight loss, medical and psychiatric comorbidities, psychosocial problems and physical disability [29]. To ensure a smooth transition from prehabilitation through postoperative rehabilitation, the physical, biopsychosocial model continues to be relevant and emphasis should be placed on preventing surgical-related complications, secondary prevention of CVD, addressing bariatric-related disabilities, psychological and socio-environmental barriers, enhancing physical function through adapted physical activities, education on nutritional management as well as implementation of sustainable weight management strategies.

The post-bariatric surgery management will require coordinated care from a multidisciplinary team of healthcare providers starting from immediate post-op followed by long-term management. The integration of several medical specialties including clinical nutrition, endocrinology, psychiatry [1], rehabilitation medicine, as well as allied health professionals including physiotherapy, occupational therapy, and nursing should be included as part of the core management team. Each team member should provide detailed assessment of impairments, outline prevention strategies and provide solutions for disease management alongside implementation of a functional restoration program. A functional restoration program post-operatively should aim to not only achieve marked weight loss, but also prevention of weight regain, progression of obesity-associated comorbidities, restoration of physical functioning and increase health-related quality of life.

A post-op functional restoration program can be broadly grouped into two categories:

1. Medical
    i. Nutritional management
    ii. Weight management
    iii. Comorbidities
2. Rehabilitation
    i. Physical activity and exercise training
    ii. Psychosocial

4.1 Medical

4.1.1 Nutritional management

The goal of weight loss procedures in general is to either reduce the amount of consumed calories (restrictive) per day or to alter the absorption of the fat (malabsorption) in the food one consumes. For restrictive procedures such as vertical banded gastroplasty (VBG) or laparoscopic adjustable gastric banding (LAGB), that has no malabsorption effect, the volume of food intake will be reduced overall, hence, some nutritional deficiencies may occur. Malabsorptive surgeries such as or biliopancreatic diversion (BPD), gastric sleeve (GS) or Roux-en-Y gastric bypass (RYGB) causes alterations in the intestinal tract and creates challenges in maintaining healthy levels of nutrients including proteins, vitamins and minerals as well as reduction in the absorption of calcium and iron [30].

Management of these potential nutritional deficiencies is therefore paramount for patients undergoing bariatric surgery and strategies should be employed to compensate for food reduction or food intolerance to reduce the risk for clinically important nutritional deficiencies. Signs and symptoms of protein deficiency such as hair loss, fatigue and leg swelling should be monitored. Heber et al. recommended the nutritional management should include: an average of 60 – 120 g of protein daily in all patients to maintain a lean body mass during the weight loss and for the long term to prevent protein malnutrition and its effects, and this is especially important in those treated with malabsorptive procedures to prevent protein malnutrition and its effects [28].

Long-term vitamin and mineral supplementation is recommended in all patients undergoing bariatric surgery with those who have had malabsorptive procedures requiring potentially more extensive replacement therapy to prevent nutritional deficiencies [28]. Specific signs and symptoms of common vitamin and mineral deficiencies include bone pain (calcium), fatigue (iron, vitamin B12), brittle nails (zinc), poor wound healing (vitamin E), easy bruising (vitamin K), numbness and tingling in the hands and feet (vitamin B1). Deficiencies in fat-soluble vitamins A, D, E and K is expected therefore, it is essential for patients to take specially formulated vitamins (A, D, E, and K in water-soluble form). B-complex vitamins, iron, and calcium must also be supplemented at higher than daily recommended levels, because of the impact of the gastric bypass procedure on their absorption. Due to the body's limited ability to a absorb calcium postoperatively and the acidic environment needed for absorption, a citrated form of calcium is recommended and taken in amounts that meet or exceed daily recommended levels [30]. For maximal absorption, elemental calcium supplements should be taken in divided doses not to exceed 500 mg, three times daily [30]. Iron deficiency is also very common after malabsorptive procedures and iron-fortified foods such as leafy greens, legumes, seafood, iron-fortified grains, red meat and poultry should be consumed on a regular basis. Routine laboratory testing of the iron stores postoperatively may be required with iron supplementation either orally or parenterally administered accordingly by the healthcare provider.

Dumping syndrome may occur as a result of malabsorptive procedures such as RYGB where the food content empties into the small intestine faster than usual. Patients may experience symptoms such as abdominal cramping, nausea and vomiting due to the small intestine being unable to absorb the nutrients from food that have not been fully digested in the stomach. Reactive hypoglycaemia may also occur due to the large surge of insulin after "dumping". Dietary changes is the mainstay of treatment for dumping syndrome. Avoidance of simple carbohydrates such as white flour and sugar, consumption of more complex carbohydrates such as whole grain and sources of protein such as fish, meat, beans, legumes and soy are recommended. Frequent loose stools is also a potential side-effect of malabsorptive procedures. It is critical that patients stay adequately hydrated to reduce the risk of dehydration. Lack of mobility may also predispose patients with regular soiling of the perineum to skin pathologies including development of pressure areas. Nutritional education is vital to the success of the surgery and prevention of complications. Regular follow-up and periodic monitoring of nutritional deficiencies postoperatively will be required for detection and correction. Lifelong supplementation of daily mineral, multivitamin and micronutrients must be considered.

4.1.2 Weight management

Following weight loss surgery, patients may lose weight fairly rapidly at first, and then as time passes the weight loss becomes more gradual. Commonly, weight

will stabilise at about 18 months after RYGB [30]. During these 18 months, weight loss can be erratic with alternating periods of significant weight loss followed by a plateau. Other than the loss of fat mass, there are many other factors that may contribute to the fluctuations in weight loss during the initial phase. This includes variations in water weight which is dependent upon the individuals' hydration status, contents of the gastrointestinal tract, gain of muscle mass, or menstrual cycles [30].

Sustainable weight loss strategies should include tailored exercise programs with monitoring of the exercise frequency and intensity to boost metabolic rate for a more rapid weight loss. A generic exercise program with lack of progressive targeted goals may lead to weight loss plateaus. Increase in physical activity and strength training will cause slower weight loss as the fat is replaced by muscle mass, which are denser tissues. This should not be perceived as a deterrent, but rather a positive trend that will lead to a leaner frame and stronger body. The recommended nutritional plan should be adhered to diligently to ensure adequate nutrition and muscle mass is maintained. Most weight regain or plateaus in weight loss boils down to eating habits. It is recommended that a patient eat several small meals a day with the ultimate goal of eating a regular diet in smaller amounts. Binge eating, snacking or grazing should be avoided as the extra calories will add up to the weight gain.

Several anatomic factors may influence weight loss, and this include the size of the gastric pouch which may change over time with the RYGB. As it enlarges over time, it will accommodate larger meals, causing a reduction in weight loss. Anostomotic dilatation between the stomach pouch and the intestine may also occur and this allows quicker emptying of the pouch, reducing its effect on satiety and potential weight loss [30]. This is also the underlying reason why one should not drink during meals after gastric bypass as it will result in a more rapid transition of solid food from the gastric pouch, eliminating the effect on satiety resulting in ingestion of larger portions. The resultant change in anatomic structure after malabsorptive procedures such as the RYGB also alters the absorption of food with higher absorption of fats, thus reducing the benefit of the surgery [30]. Eating small meals high in protein may help mitigate this effect.

Plateaus and fluctuations in weight loss are to be expected throughout various phases post-surgery. Constant reassurance, providing patient education on the expected outcomes and exploring together the underlying causes of weight plateaus can increase understanding, avoid miscommunication, avert patient depression or frustration with the surgery. A regular exercise regimen and adherence to correct eating behaviour and nutritional intake may lead to greater outcome and a more sustainable long-term weight loss.

4.1.3 Comorbidities

Frequently, patients undergoing bariatric surgery have associated comorbidities including Type 2 Diabetes Mellitus, cardiovascular disease, lipid abnormalities, fatty liver, degenerative joint disease, hypertension, gastroesophageal reflux disease, and obstructive sleep apnea with considerable impact on disability and quality of life. To reduce the likelihood of weight regain and to ensure that comorbid conditions are adequately managed, all patients should receive careful medical follow-up postoperatively. Monitoring postoperative glycaemic control should consist of achieving glycated HBA1c of 7% or less with fasting blood glucose no greater than 110 mg/dl and postprandial glucose no greater than 180 mg/dl [28]. Lipid abnormalities should be monitored and treated with lipid-lowering therapy that remain above desired goals should be continued. However due to the dramatic reductions in lipid levels, the doses of lipid-lowering drugs should be periodically evaluated [28]. Ideally, a

multidisciplinary team should be in place before the operation is performed. The bariatric surgeon should be part of this comprehensive team that provides pre- and postoperative care. The inclusion of other medical specialties in the team including endocrinologists, gastroenterologists and rehabilitation physicians allow a more holistic approach for the treatment of patients with multiple comorbidities and associated impairments and disabilities.

4.2 Rehabilitation

4.2.1 Physical activity and exercise

Surgery-induced weight loss by itself was associated with a series of beneficial health effects, including increased objectively measured habitual physical activity and cardiorespiratory fitness [29]. Using a cardiac rehabilitation model is effective to cause significant improvement in bariatric individuals' cardio-metabolic profile [31]. Hanapi et al. demonstrates the application of cardiac rehabilitation principle for post-bariatric surgery patients which include risk stratification through the use of submaximal exercise stress testing to objectively quantify the patient's cardiovascular capacity for exercise participation, subsequent exercise prescription based on the individuals' physical impairments and cardiovascular functioning, lifestyle modification to manage cardiovascular risk factors and translating the gains of cardiorespiratory and musculoskeletal fitness into more functional activities [9].

Postoperative exercise is imperative and remains the most important factor that can help a patient achieve long-standing and successful weight loss. Exercises can begin as early as day one postoperatively and short term and long term goals should be set early on and revised as activity and exercise capacity increases. The exercise program should incorporate muscle strengthening, physical endurance or aerobic exercises to improve cardiorespiratory fitness, balance training, functional mobility, musculoskeletal reconditioning, joint protection as well activity of daily living (ADL) training, tailored individually within the limit of patients' cardiovascular capacity.

To sustain weight loss, effective behaviour changes towards increasing energy expenditure through occupational, leisure time and planned physical activity needs to occur alongside dietary management [32]. Physical activity can be incorporated to daily activities which helps with caloric expenditure or decreasing the amount of sitting time or sedentary leisure activities. Education on the importance of physical activities to aid weight loss and maintain functional independence helps boost motivation and compliance. This ultimately affects their level of independence, quality of life and self-efficacy [9].

In addition to loss of fat mass, there are other numerous benefits to exercise. These benefits include prevention of loss of muscle mass when losing weight rapidly after surgery, and improved overall weight loss. Exercise may also reduce a person's appetite, increases immunity and reduces fatigue which may lead to improved self-confidence, and overall improved sense of well-being.

4.2.2 Psychosocial

A substantial number of patients experience poor long-term outcomes following bariatric surgery which may be contributed by difficulty in making and sustaining changes in dietary intake and physical activity as well as post-surgery binge eating, which has also been associated with poorer weight outcomes [33]. A thorough pre-operative assessment to evaluate patients' understanding of the disease condition, identifying any misconceptions, assessing readiness and commitment to undergo

a radical change in lifestyle and behaviour modification, as well identifying issues that may pose as barriers may be the key to a successful and sustainable weight management postoperatively. Sheets et al. recommend that preoperative assessment should include identifying patients strengths and weaknesses, educating patients thoroughly about postoperative changes including dietary intake and physical activity, coaching on lifestyle change strategies as well as offering specific recommendations to address any areas of concern [34]. The period post bariatric surgery is still a vulnerable time for most individuals as the reality sinks in as adjustment of behaviours and new habits take place. The need for continuous care and screening of psychosocial issues throughout both pre-and postoperative periods cannot be undermined. Screening for aberrant eating behaviours and depressive symptoms should be assessed whilst administering interventions to address emotional and psychological issues, behavioural modification strategies, increase compliance, and provide support [34]. It is the responsibility of each team member to detect or identify the presence of any psychological issues, and administer interventions through early referral to mental health professionals to improve outcomes of these individuals.

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