Research Article

Osteoporosis and Sarcopenia in Frailty: Moving Forward

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Abstract

Often considered to be a pre-disability condition, frailty is gaining rapid consensus among clinicians and caretakers alike. This in turn, has called for a unified consensus defining frailty among the medical community that can be used by health professionals. Traditionally, geriatric medicine was considered to be the sole medical branch responsible for defining, treating and managing frailty. However, due to the changing demographics of elderly population and recent research defining multitude of factors responsible for frailty, only a single branch of medicine cannot be held responsible for management of such condition. Since frailty is not an organ specific disability and cannot be bound to a single idea, it should be approached in a multi- disciplinary manner. However, most clinicians and caretakers admit to osteoporosis and sarcopenia being a major contributor to frailty. Osteoporosis and sarcopenia among the elderly is a widely varied subject with an even wider etiology. Combining the idea of osteoporosisand sarcopenia with frailty has gained much traction in recent years.

Keywords: Osteoporosis; Sarcopenia; Frailty; Old age care

Introduction

Clinical identification of frailty is a major step in taking care of elderly population. Previously, due to poor understanding and lack of definition, frailty was often mistaken for senile weakness and physical disability. However, due to increased elderly population and multiple studies, we now have a better understanding of frailty. Moreover, one of the primary definition and phenotype of frailty was described by Fried et al. [1] in 2001, and has been regarded as a standard definition and characterization of frailty in elderly population. This defined frailty with 5 criteria - exhaustion, weakness, slowness, physical inactivity and weight loss. Based on these criteria and the progression of osteoporosis, co-relation among these two should be relevant.

Understanding Frailty

Even if most of the researchers agree on the model provided by Fried et al, there have been numerous attempts at defining frailty using other methods and criteria [2,3]. Frailty is a wide concept, and no two frail individuals are similar. Many people recognize frailty but, quantification and analysis may prove difficult. With numerous descriptive terms like pre-frail, frail, etc the proper classification of frailty may be seriously hindered.

With the increase in elderly population, incidence of frailty is also increasing. UN recent data suggests projections of elderly population to 2 billion by 2050, with 426 million above 80 age group [4]. Looking at this trend, it seems a safe bet to expect the increase in frail population in the future.

With numerous health implications such as functional decline, loss of independence, deterioration in health status, increased risk of hospitalization [5] resulting in death, frailty syndrome warrants the most concern for caretakers among elderly . Since it is mainly considered an irreversible state [6], prevention or taking care of frailty once set seems more feasible than actually trying to nurse the patient from `frailty` or `pre-frail` to `fit` state.Multiple factors are responsible for development of frailty syndrome in the elderly. Malnutrition [7], osteoporosis and/or sarcopenia [8], smoking, alcohol consumption, lack of education and awareness, lack of physical activity [9], and many more. Prevention and caretaking are the only two socially and economically feasible options available at this stage.

Understanding Osteoporosis and Sarcopenia

Changes in musculoskeletal health in accordance with age are a well-established concept. Muscle mass and strength decline is commonly referred as sarcopenia [10] and bone mineral density and bone strength reduction is called osteoporosis [11]. Multiple factors such as reduced dietary protein intake, low Vitamin D levels, resistance of muscle protein synthesis to anabolic stimuli, menopause (in women) , lack of physical activity, obesity, all contribute to development of osteoporosis and sarcopenia [12,13]. Both phenomena contribute to higher risk of fall and fractures which later contribute to disability, dependence and decrease quality of life [14].

From the previous studies, sarcopenia is broadly used to describe the observed age-related decrease in muscle mass. It is associated with diminished physical ability, exhaustion, predisposition to fall injuries and proneness to incidental liability thus associating it with frailty. Sarcopenia is considered to have multifactorial etiologies. Commonly associated etiology is old age, when multiple disease burden associated pain and lack of ambulation likely contributes to sarcopenia and as a consequence, frailty [15]. Malnutrition also plays a vital role, with appetite reducing up to 25% in elderly population [16]. Along with contributing lack of Vitamin D and reduced protein intake, sarcopenia is more likely to occur [17,18]. Another theory that has wide acceptance is hormone theory. Studies have proven that testosterone level is associated with muscle mass [18] and women experience a

sharp fall in muscle strength after the age of 55 often attributed to estrogen concentration decline [19,20].

Osteoporosis, on the other hand has long been associated with old age and frailty. It is often described as micro architectural deterioration of bone tissue, low bone mass and increase in bone fragility and chances of fracture [21]. One of the indicators of osteoporosis is Bone Mineral Density or BMD. Although, by definition BMD should be bone related, it is however integrally related to decreased muscle, increased adiposity and frailty [22]. However, in multiple studies, BMD is described as the precursor to osteoporosis and prevention of osteoporosis is targeted towards improvement of BMD. Osteoporosis is not always single-handedly responsible for frailty, reduced dietary intake of protein however; osteoporosis with sarcopenia is a perfect recipe for frailty (Figure 1).

Tackling Osteoporosis and Sarcopenia

Osteoporosis once set is virtually impossible to reverse to the original condition. However, preservation of functionality along with bone composition should be the focus of health personnel in patients with osteoporosis. Multiple modalities of prevention of osteoporosis have been proposed. Most prominent among them are: Lifestyle modification, healthy lifestyle from a young age, Hormone replacement therapy (female targeted), exercise regimens, drugs and supplement therapy and prevention of falls. Each modality comes with their own pros and cons and a blanket protocol may not be sufficient for an individual or racial group. Moreover, HRT (Hormone Replacement Therapy) may come with its own set of complications including CHD and other cognitive function disorders that may complicate matters further. Other proposed management protocols are not mainstream or too experimental to be of significant clinical use. Multiple studies have been done to address the optimal type of intervention with the aim of taking care of patient with osteoporosis (Table 1).

Table 1 outlines some of the representative studies done for prevention of osteoporosis and increase in BMD approximately for the past 15 years. These studies mainly focus on the lifestyle modification and various exercise regimens for prevention of osteoporosis. The result gist shows that these studies may have succeeded in preventing/managing osteoporosis and increasing/ maintaining BMD.

Sarcopenia prevention, on the other hand relies exclusively on dietary supplementation and balanced nutrition. Since most components are responsible for development of sarcopenia are dietary in nature (protein, calcium, vitamin D), correction of these deficiencies may go a long way in preventing sarcopenia (Table 2).

In addition to above studies linking different nutritional and endocrine causes to sarcopenia, exercise also plays a role in preventing sarcopenia [23]. Sedentary lifestyle is one of the main causes of sarcopenia and exercise plays a vital role in preventing sarcopenia. Some studies [24-26] have gone on to record that exercise is the most effective way of tackling sarcopenia (Table 2).

Path Forward After Onset of Osteoporosis and/or Sarcopenia

Frailty due to onset of osteoporosis and/or sarcopenia is a debilitating condition that severely reduced the quality of life of an individual. Severe limitation in skeletal muscle strength with recurrent fractures, primarily of large joints (eg. Hip joint) may impair mobility, reduce day to day activities and hamper the physical and psychological wellbeing. Once osteoporosis has onset and shown its effects(i.e.fractures), then it becomes vital for the individual to immediately undergo surgery to prevent long term complications. There are currently no consensual guidelines to improve the motility after hip joint surgery, however, all clinical protocols agree on early mobilization to prevent deep vein thrombosis.

More important than surgery, is the prevention. Since most fractures occur in frail population due to fall injuries, their prevention makes more sense. Home based exercises and other activities have shown to play a vital role in preventing fall injuries

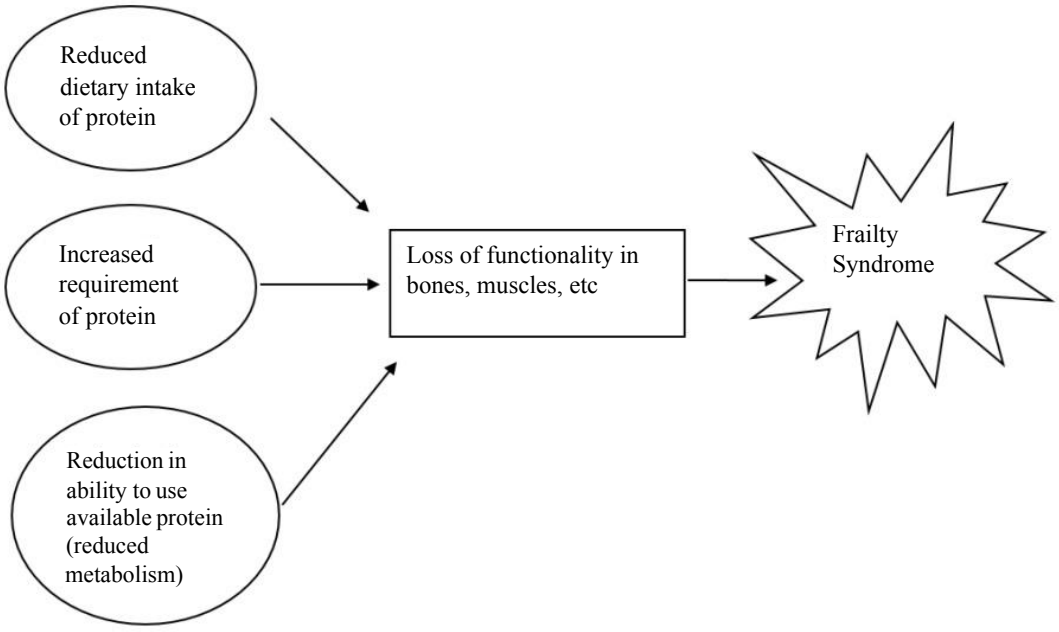

Figure 1: Pathogenesis of Frailty (protein hypothesis). Image based upon conclusions of study by O` Connell [47].

Table 1: Some representative studies for prevention and management of osteoporosis.

Study	Year	No. of cases	Modalities	Result	Limitation
Bernard PL, et al. [35]	2018	338	PBM-HE	Improved	Boot straping method utilized, no control population
Man-Ying Wang, et al. [36]	2016	20	Hatha Yoga	Improved	Not RCT, small sample size, no significant variance among subjects
Yoo EJ, et al. [37]	2010	28	3 month walking exercise program	Improved	Effects on balance not addressed, small sample size
Stone TM, et al. [38]	2018	28	12 weeks yoga or cardio-kickboxing	BMD not deteriorated	Small sample size, no control group, limited timeframe of study
Gába A, et al. [39]	2016	104	10 weeks of self-regulated brisk walking	Modest effect on BMD	Short study duration
Silverman NE, et al. [40]	2009	86	Aerobic exercise with weight loss program	Significant increase in BMD	Non-RCT, DXA (Dual Energy X-ray absorptiometry) use during weight loss may incur a biased result
Yamazaki S, et al. [41]	2004	50	Daily outdoor walking, minimum 1 hour with minimum 8000 steps, over 12 months	No significant changes in BMD, however, NTX (N-terminal telopeptide) value could be used as an indicator	Subjects not randomly divided, very modest change in BMD
Wu J, et al. [42]	2006	136	Isoflavones(75 mg/day) combined with walking(1 hr/3 times a week) vsisoflavonesvs walking vs placebo	Combination of isoflavones+ walking shows significant improvement in BMD	Japanese study population, so controlled intake of soy products could not be done, shorter duration of study

Table 2: Some representative studies for prevention and management of sarcopenia.

Study	Year	No. of cases	Modalities	Result	Limitation
ShikanyJ.M, et al. [43]	2014	5925	Diet quality index vs frailty status	Diet quality was inversely proportionate with frailty	Study limited to community dwelling white men. No significant racial variance
Roth SM, et al. [44]	2004	302	Association with vitamin D receptor(VDR) with fat free mass in cohort study	VDR translation site is closely associated with sarcopenia	Older Caucasian males were the only subjects
Scott D, et al. [45]	2010	686	Association between Vitamin D vs sarcopenia and low physical activity	Baseline Vitamin D level was a positive indicator for muscle strength	Less follow up, short period, other endocrine functions were not considered
RondanelliM, et al. [46]	2016	130	Nutritional supplementation along with moderate exercise to tackle age related skeletal muscle weakness	In comparison with placebo group, nutritional supplementation and exercise helps in generalized wellbeing and boosts strength	Blood Vitamin D assay was not done.

[27]. This method, however applies to people requiring very little or no care at home. In hospital or care facilities, however, it is a different matter altogether. Difference in interventions and level of dependency play a vital role [28]. Exercise, alongwith Vitamin D supplementation may be beneficial in these cases.

There are a very few specific interventions once osteoporosis and sarcopenia have set in. Most researchers agree on exercise and nutritional supplementation. High protein intake is recommended by some landmark studies [29]. On a similar note, ESCEO guideline proposes optimized recommended nutrient intakes for calcium (1000 mg/d), vitamin D (800 IU/d) andprotein (1.0–1.2 g/kg BW/d) for the general management of patientswith osteoporosis [30]. Further, supplementation with branched-chain amino acid including but not limited to lucine has also been advocated [31]. Some home diet derived nutrients are also said to be beneficial [32-48].

Conclusion

Ageing is the inevitable part of life. By that logic, age related changes in the musculoskeletal system are also inevitable. Changes such as reduction in muscle mass, strength, power, BMD, bone strength tends to cause an increase in fracture, tendency of fall injury, and hamper the quality of life. However, the degree of changes and the quality of changes seem to be controllable. Due to multiple factors such as dietary habits, smoking, exercise, genetics, etc frailty affect some portions of populations more than the other.

Osteoporosis and/or sarcopenia are both very vital contributing factors for frailty. Even if we follow the age old doctrine of "prevention is better than cure", osteoporosis and sarcopenia have multifactorial and multi faceted origin and effects, thus making it very difficult to prevent and manage. The only conclusion we can draw from this study alongwith conjunction with the above mentioned studies is that healthy lifestyle from mid-age combined with proper nutrition and exercise is the only reasonable way to prevent frailty. A multi-disciplinary approach including physicians, nurses, dietician, nutritionists, family members and caretakers is the only feasible way.

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