



**Substantial Skeletal Muscle Loss Occurs After Surgery<sup>(14)</sup>**

The most muscle atrophy is seen during the initial 2 weeks post-op<sup>(3)</sup>

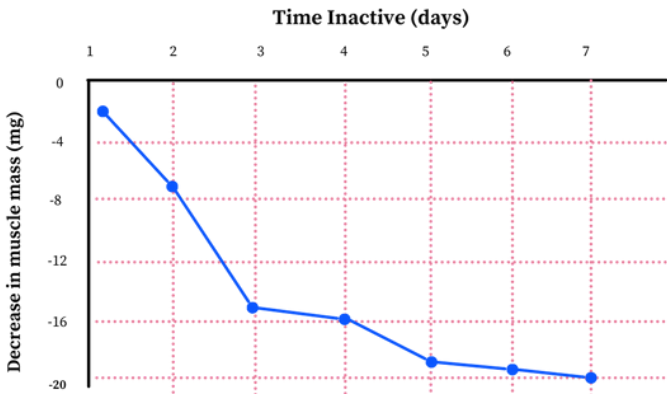
**Decreased mobilization leads to further muscle atrophy:**  
0.5% /day in young  
1.0% /day in elderly<sup>(18-21)</sup>

This catabolic state requires elevated (~80%) demands for essential amino acids [EAA].<sup>(22)</sup>

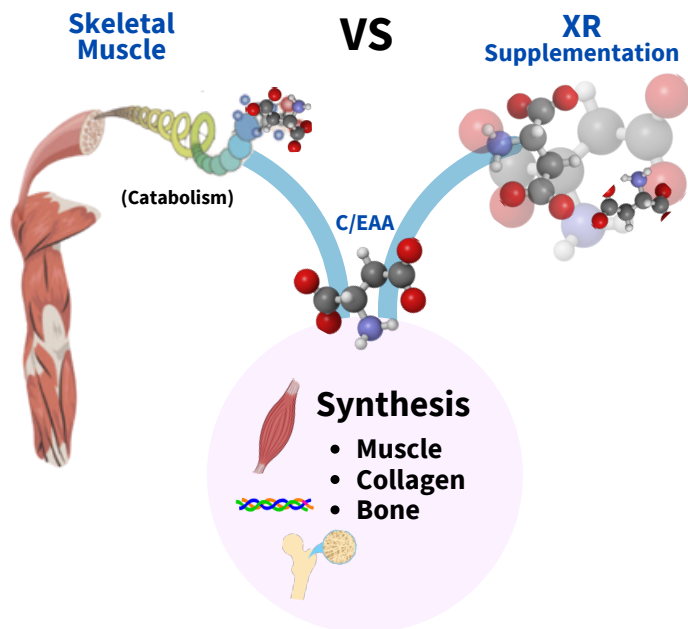
**EAs serve as the necessary building blocks for collagen, bone and Muscle Protein Synthesis (MPS).**<sup>(23)</sup>

Without adequate nutritional support, the body harvests its only reserve (skeletal muscle) to provide these critical substrates for tissue healing.<sup>(22-24,40)</sup>

XR™ is a targeted amino acid supplement formulated with clinically studied ingredients at optimal effective doses in preserving skeletal muscle during the catabolic state of surgery.



Kortebein, J Gerontol A Biol Sci Med Sci. 2008



# XR Basic Science/ Clinical Studies

## Essential Amino Acids (EAA)

EAA: ↑Muscle Protein Synthesis (MPS) via mTOR pathway <sup>(1,2)</sup>

EAA: ↑ # satellite (stem) muscle cell, ↓TNF- $\alpha$  (anti-inflammatory) <sup>(3,4,25)</sup>

Leucine: anabolic stimuli MPS via mTOR pathway <sup>(26,27)</sup>

## Conditionally Essential Amino Acids (CEAA)

Glutamine: Anti-catabolic ↓ proteolysis, ↑collagen synthesis <sup>(23)</sup>

(HMB)  $\beta$ -Hydroxy  $\beta$ -methylbutyric: <sup>(28)</sup>  
Anti-Catabolic, ↓ proteolysis

Arginine / Citrulline : <sup>(29-34)</sup>  
↑endothelial NO production/↑collagen synthesis,  
↑IGF-1, /↑ osteoblast activity / ↑ Fracture healing

Cystine /Theanine: Antioxidant, anti-catabolic <sup>(35-39)</sup>

## Clinical Applications

## Results

TKA (\*2020 Ranawat Award)<sup>(1,2)</sup>  
(1 wk pre- 2wks post-op)

↑Quad Volume  
↑Strength ↑Albumin ↓Pain

TKA  
(1wk pre-2/6wks post-op) <sup>(3,4)</sup>

Preserve Muscle  
↑Functional Recovery

Hip Fracture<sup>(5,6,44,45)</sup>

↑Albumin ↑Hemoglobin  
↓Infection ↑Strength  
↑Functional Recovery

ACL<sup>(7)</sup>

↑Quad Volume ↑Strength

Trauma (Fracture fixation)<sup>(10)</sup>  
2 wks post

Improved fracture union rates  
Decreased complications  
Preserved Muscle

TKA(5 days pre-28d post) <sup>(8,9)</sup>

↑Quad Volume ↑Strength

Collagen Deposition <sup>(12,13)</sup>

67% ↑Collagen Synthesis

Surgical Stress Suppression <sup>(11)</sup>  
5-10 days periop

↓CRP ↓IL-6

Diabetic foot ulcer <sup>(15)</sup>

Shortened healing period  
↓Use of antibiotics

(NASA) Countermeasure to  
Microgravity <sup>(18)</sup>

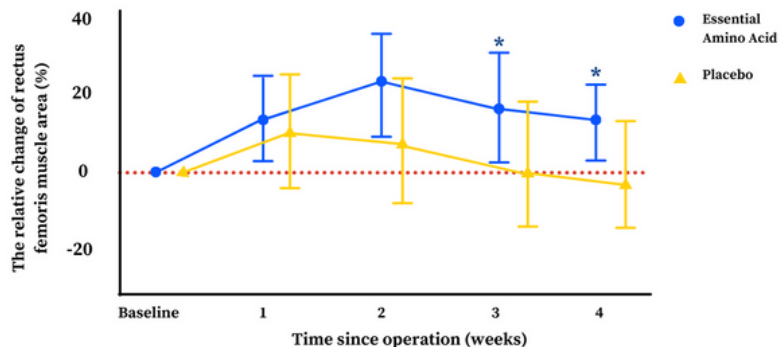
Preserve Muscle Mass  
Mitigation of strength loss

Sarcopenia/ muscle wasting <sup>(16,17)</sup>

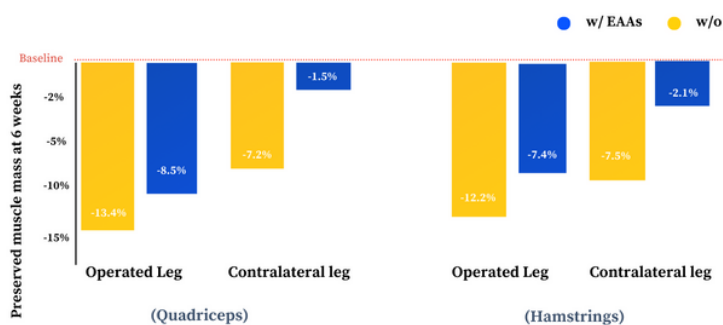
↑Lean body mass  
↑Ablumin ↓Cortisol

Spine<sup>(41-43)</sup>

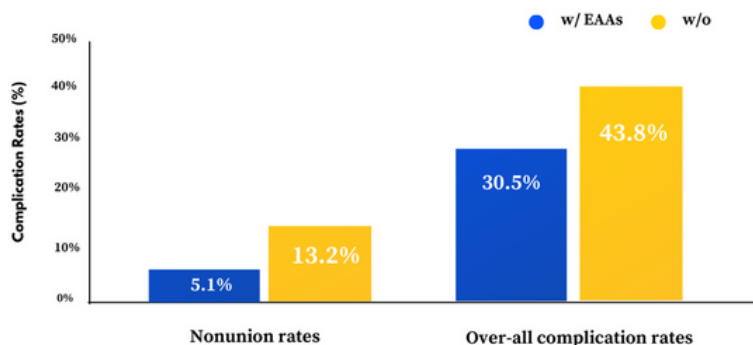
↑Strength  
↑Wound healing ↓Infection  
↑Fusion  
↑IGF-1 ↑ Albumin



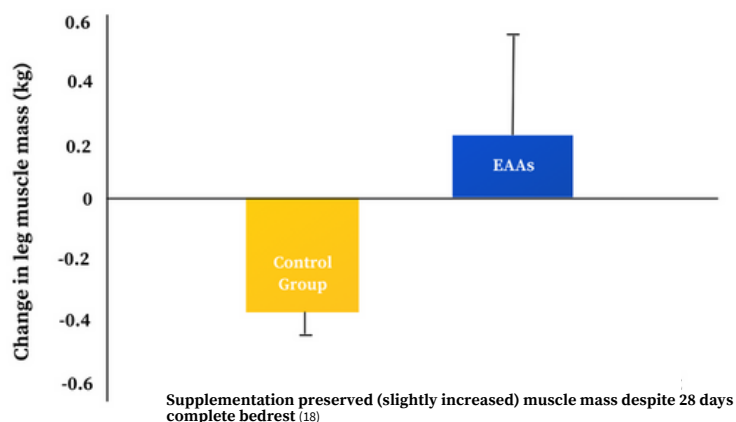
Patients who received EAAs 1 wk pre-op and 2 wks post-op had less muscle atrophy and early functional recovery after TKA <sup>(2)</sup>



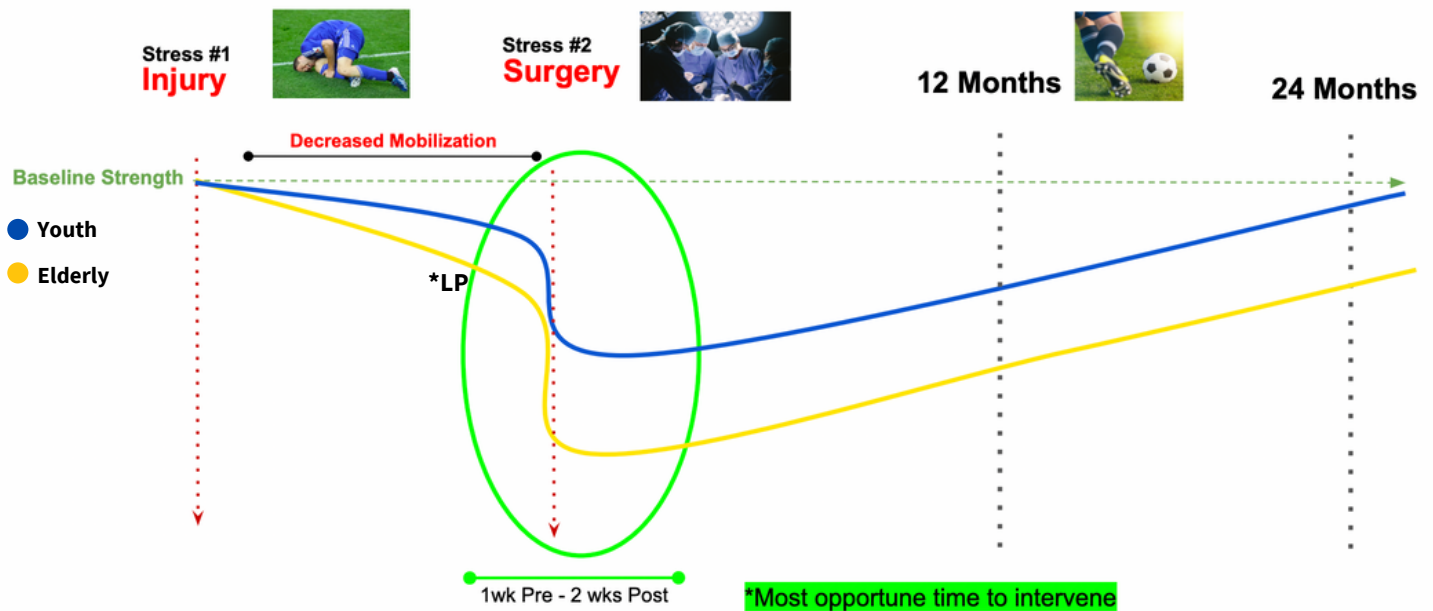
EAA group had significantly less decrease in mean muscle volume compared with the placebo group <sup>(3)</sup>



2wks of CEAA post op reduced complications and muscle wasting after fracture fixation<sup>(10)</sup>



Supplementation preserved (slightly increased) muscle mass despite 28 days complete bedrest <sup>(18)</sup>



### \*Loading Phase ( 1 week Pre-op)

Consumption of EAA for 1 week prior to surgery increases satellite (muscle stem) cells.<sup>(25)</sup>

Preservation of muscle mass in the early post op period is predictive of muscle volume and strength at two years post-op.<sup>(2)</sup>

Skeletal muscle mass is both protective and predictive of post op complications and rate of functional recovery.<sup>(1-4,6,8-10)</sup>



**THERAPEUTIC  
MUSCULOSKELETAL  
RECOVERY  
SUPPLEMENT**

**Augmenting the Biology:**

*Optimizing the body to heal itself*

**Utilizing targeted amino acid supplementation provides essential substrates for tissue repair during recovery with evidence-backed benefits in mitigating muscle loss, reducing complications, and improving overall outcomes.**

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