Aadhar

Trunk stability product for Ataxia Patient in sitting posture

Master of Design

by

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22M2229

Project Guide

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Approval

This is to certify that Industrial Design Project II (P2) entitled "Aadhar- Trunk stability product for Ataxia Patients" by Kulkarni Vedang Uday is approved in partial fulfillment of the Master's Degree of Industrial Design at IDC, Indian Institute of Technology, Bombay.

Signature of the Project Guide:

Signature of the Chairperson:

Signature of the Internal Examiner. 23/11/2023

Signature of the External Examiner:

Date:

Declaration

The written submission is a part of my report, "Trunk stability product for Ataxia Patients" is done as a Project - 2 and Design Exploration Seminar (DES) for post-graduation program at IDC, IIT Bombay, under the guidance of Prof. Purba Joshi.

Thereby declare that the thoughts, ideas, and words in this document are original, and appropriate references are cited wherever due. I understand that the violation of the above can cause disciplinary action by the institute.

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Abstract

This project introduces a specialized trunk stability product designed to enhance the seated posture and overall stability of individuals diagnosed with ataxia. Ataxia, a neurological disorder affecting coordination and balance, presents unique challenges that compromise daily activities, particularly those involving seated positions. The proposed trunk stability product aims to address these challenges by providing targeted support and promoting improved posture for ataxia patients.

The product employs innovative design principles, incorporating adjustable features to accommodate varying degrees of ataxia severity and individual preferences. Utilizing ergonomic considerations and feedback from individuals with ataxia, the product focuses on optimizing comfort and functionality during prolonged periods of sitting. The implementation of assistive technology and biofeedback mechanisms further augments the user experience, fostering a supportive environment for trunk stability.

This report outlines the comprehensive development process of the trunk stability product, from conceptualization to prototype testing. Through rigorous design iterations and collaboration with healthcare professionals, the product aims to fill a crucial gap in existing assistive devices for ataxia patients, particularly in addressing seated stability.

Preliminary testing and user feedback underscore the potential of the trunk stability product to significantly improve the quality of life for individuals with ataxia, fostering independence and promoting confidence in daily activities.

The trunk stability product signifies a step forward in the pursuit of tailored solutions for neurological disorders, highlighting the importance of addressing specific challenges associated with ataxia. As advancements in assistive technology continue to evolve, this product exemplifies a promising avenue for enhancing the well-being of individuals navigating the complexities of ataxia, particularly in the context of seated stability. As advancements in assistive technology continue to evolve, this product exemplifies a promising avenue for enhancing the well-being of individuals navigating the complexities of ataxia, particularly in the context of seated stability.

Keywords

Ataxia, Neurological disorder,Trunk stability, Seated posture
, Assistive technology, Rehabilitation, Balance impairment
, Coordination, Ergonomic design, Biofeedback, Mobility aid
, Independent living, Quality of life, User-centered design
, Prototype testing, Healthcare innovation, Functional improvement, Patient-centered care, Adaptive equipment
, Neuromuscular control

Content

Introduction

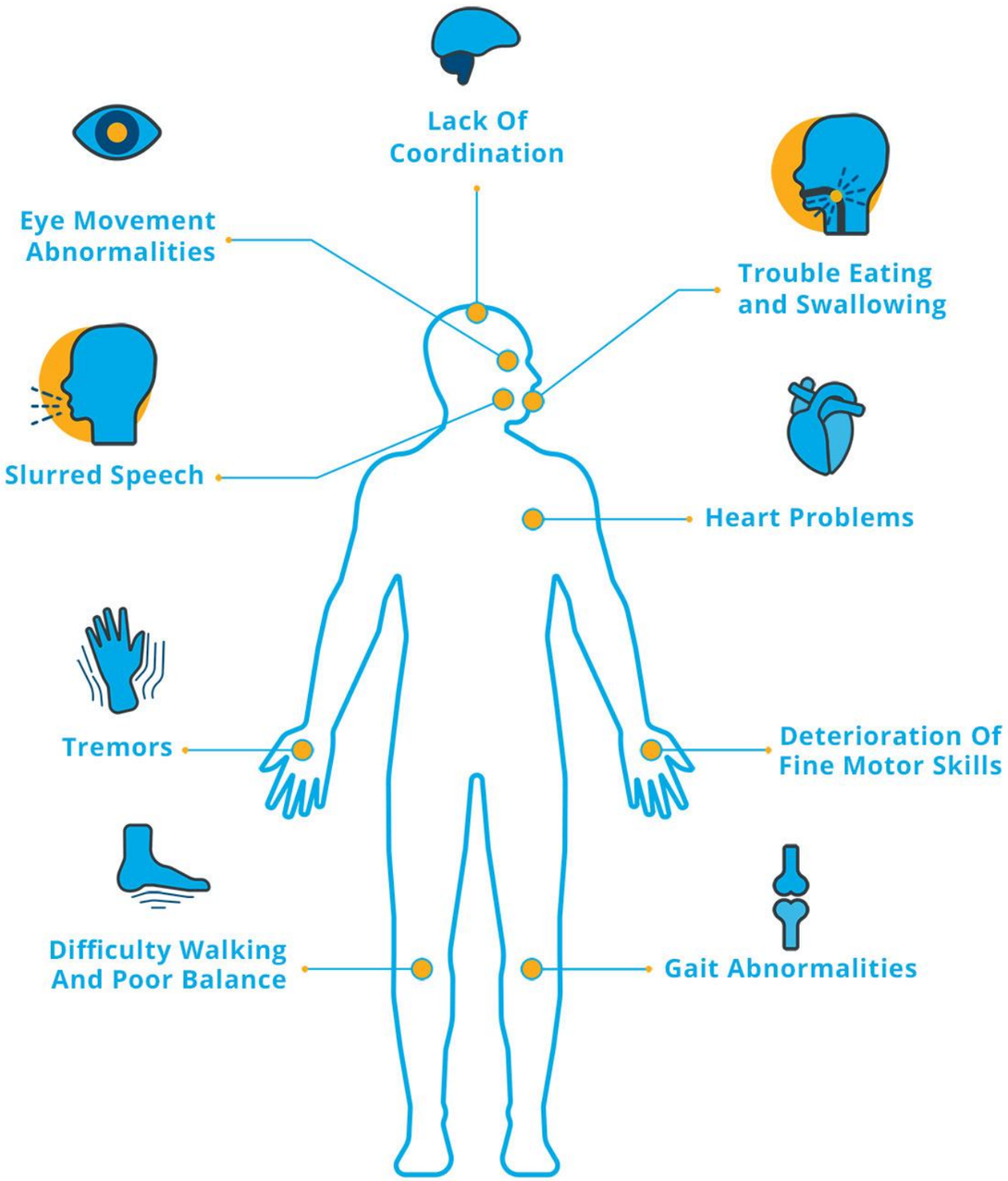
Ataxia is a neurological disorder characterized by a lack of coordination and unsteady movements. It is a condition that affects the cerebellum, the part of the brain responsible for controlling voluntary muscle movements and maintaining balance. Individuals with ataxia often experience difficulties with walking, speaking, and performing fine motor tasks, leading to a significant impact on their overall quality of life.

This project focuses on developing a trunk stability product specifically tailored for ataxia patients. Trunk stability is a crucial aspect of mobility and balance, and addressing this issue can substantially enhance the daily lives of individuals grappling with ataxia. The challenges posed by ataxia necessitate innovative solutions that can provide support, stability, and improved functionality for those affected.

The primary goal of this project is to design a product that aids in improving trunk stability among ataxia patients, enabling them to navigate their surroundings with greater ease and confidence. By addressing the unique needs of individuals with ataxia, we aim to contribute to the enhancement of their independence and overall well-being.

This report delves into the background of ataxia, outlining its causes, symptoms, and the impact it has on individuals. It also provides an overview of existing interventions and technologies designed for ataxia patients, highlighting the gaps and opportunities for innovation in the realm of trunk stability. The subsequent sections will detail the development process of the trunk stability product, including design considerations, testing methodologies, and potential applications.

Ultimately, through the implementation of this project, we aspire to make a meaningful difference in the lives of ataxia patients by offering a tailored solution to address their unique challenges and contribute to their overall rehabilitation and improved functionality.



Background Reseach

What is Ataxia

Definition: Ataxia is a neurological disorder characterized by a lack of coordination, unsteady movements, and difficulties with balance. It results from dysfunction in the cerebellum, a region of the brain responsible for coordinating voluntary muscle movements, maintaining balance, and regulating posture. Ataxia can manifest as a standalone condition or as a symptom of various underlying causes.

Types of Ataxia:

1. Hereditary Ataxias: Result from genetic mutations and are often progressive. Examples include Friedreich's ataxia, spinocerebellar ataxias (SCAs), and episodic ataxias.
2. Acquired Ataxias: Occur due to non-genetic factors such as head injuries, strokes, tumors, multiple sclerosis, or certain medications.
3. Idiopathic Ataxias: Cases where the cause of ataxia is unknown, making diagnosis challenging.

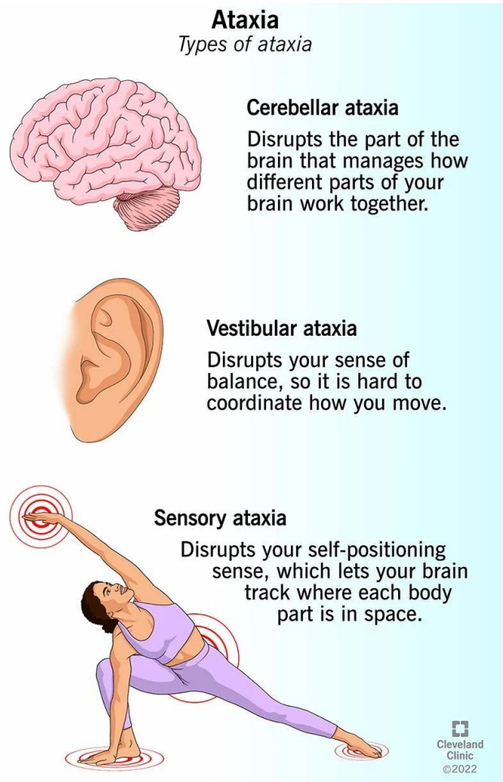
Causes of Ataxia in Detail:

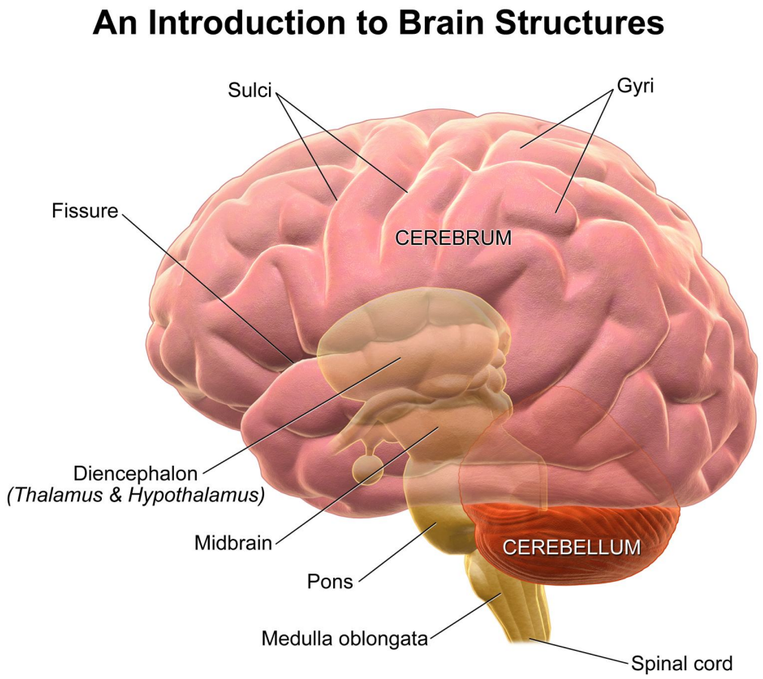
Ataxia can result from a variety of causes, ranging from genetic factors to acquired conditions. Understanding the underlying cause is crucial for proper diagnosis and the development of targeted treatment strategies. Here are some detailed explanations of the primary causes of ataxia:

1. Genetic Factors:
    - Hereditary Ataxias: Numerous genetic mutations can lead to hereditary ataxias, which are often characterized by a progressive decline in coordination and motor function. Examples include:
        - Friedreich's Ataxia: Caused by a mutation in the frataxin gene, leading to impaired coordination, muscle weakness, and cardiac issues.
        - Spinocerebellar Ataxias (SCAs): A group of dominant genetic disorders, each associated with a specific gene mutation, resulting in degeneration of the cerebellum.

2. Acquired Causes:
    - Head Injuries: Traumatic brain injuries, including concussions or severe head trauma, can damage the cerebellum or its connections, leading to ataxia.
    - Strokes: Interruption of blood flow to the brain can cause damage to the cerebellum, affecting coordination and balance.
    - Tumors: Brain tumors, particularly those located in or near the cerebellum, can disrupt normal function and cause ataxia.
    - Infections: Certain infections, such as encephalitis or meningitis, can lead to inflammation and damage in the brain, including the cerebellum.
    - Multiple Sclerosis: An autoimmune disease that can result in demyelination and damage to the nerves, including those in the cerebellum.
3. Idiopathic Ataxias:
    - Unknown Causes: In some cases, the specific cause of ataxia remains unidentified, leading to a diagnosis of idiopathic ataxia. This may be due to factors not yet understood or a combination of genetic and environmental influences.
4. Toxic Causes:
    - Alcohol Abuse: Chronic alcohol abuse can lead to cerebellar ataxia, characterized by a wide-based, unsteady gait and impaired coordination. The exact mechanisms are not fully understood but are related to alcohol-induced damage to the cerebellum.
5. Metabolic Disorders:
    - Vitamin Deficiencies: Deficiencies in vitamins crucial for nervous system function, such as vitamin E and B12, can lead to ataxia.
    - Hypothyroidism: Underactive thyroid function can contribute to ataxia symptoms.

Identifying the specific cause of ataxia is essential for determining the appropriate course of treatment and management. Genetic testing, imaging studies, and a thorough medical history are often employed to pinpoint the underlying cause and guide healthcare professionals in providing targeted care for individuals with ataxia.



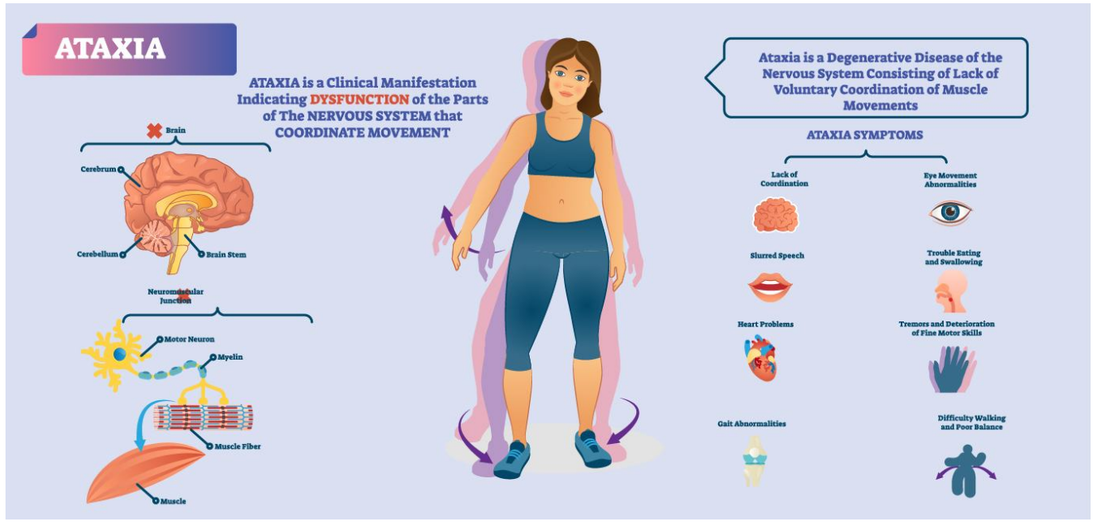


Symptoms of Ataxia

Ataxia is characterized by a range of symptoms that reflect the impaired coordination and balance associated with dysfunction in the cerebellum. The severity and progression of symptoms can vary depending on the underlying cause and type of ataxia. Here are detailed explanations of the key symptoms:

1. Gait Disturbances:
   - Unsteady Walk: Ataxic gait is characterized by an unsteady and unpredictable walk. Individuals may have difficulty maintaining a straight line and may exhibit a wide-based or staggering gait.
   - Poor Coordination: The coordination of leg movements is affected, leading to challenges in initiating and controlling steps.
2. Limb Incoordination:
   - Impaired Fine Motor Skills: Ataxia often results in difficulties with precise movements, affecting activities such as writing, buttoning clothes, or using utensils.
   - Tremors: Involuntary shaking or tremors may be present in the limbs, particularly when attempting to perform controlled movements.
3. Speech Impairment:
   - Slurred Speech: Ataxia can affect the muscles involved in speech, leading to slurred or irregular speech patterns.
   - Dysarthria: Difficulty in articulating words clearly, impacting the overall intelligibility of speech.
4. Eye Movement Abnormalities:
   - Jerky Eye Movements: Abnormalities in eye movements, known as nystagmus, may occur. This can result in rapid, involuntary eye movements that affect visual stability.
   - Difficulty Focusing: Maintaining a steady gaze or focusing on a specific point may be challenging.
5. Swallowing Difficulties:
   - Dysphagia: Impaired coordination of the muscles involved in swallowing can lead to difficulties in eating and drinking.
6. Postural Instability:
   - Balance Issues: Individuals with ataxia may have difficulty maintaining balance, particularly when standing or sitting. This can increase the risk of falls.
   - Swaying Movements: A tendency to sway from side to side when attempting to maintain an upright posture.
7. Coordination Challenges in Arms and Hands:
   - Impaired Handwriting: Writing and other fine motor tasks may be challenging due to lack of coordination in the hands.
8. Progressive Nature:
   - Worsening Symptoms: In many cases, ataxia is progressive, meaning that symptoms tend to worsen over time.
   - Loss of Independence: Progressive ataxia can lead to increased dependence on others for daily activities.
9. Fatigue:
   - Increased Fatigue: Individuals with ataxia may experience fatigue more quickly than those without the condition, particularly during activities that require coordination and physical effort.

It's important to note that the specific combination and severity of symptoms can vary widely among individuals with ataxia. The underlying cause, whether genetic, acquired, or idiopathic, plays a significant role in determining the progression and manifestation of symptoms. Early diagnosis and management can help mitigate the impact of ataxia on an individual's daily life.



Impact of Ataxia on Daily Life

Impact of Ataxia on Daily Life in Detail:
Ataxia, with its disruptive effects on coordination and balance, can have a profound impact on various aspects of an individual's daily life. The severity of these impacts often depends on the underlying cause, the progression of the condition, and the effectiveness of management strategies. Here is a detailed exploration of the impact of ataxia on daily life:

Mobility and Independence:

- Difficulty Walking: Ataxic gait makes walking challenging, affecting the ability to move independently.
- Risk of Falls: Balance issues increase the risk of falls, impacting the individual's confidence in navigating their surroundings.

Activities of Daily Living (ADLs):

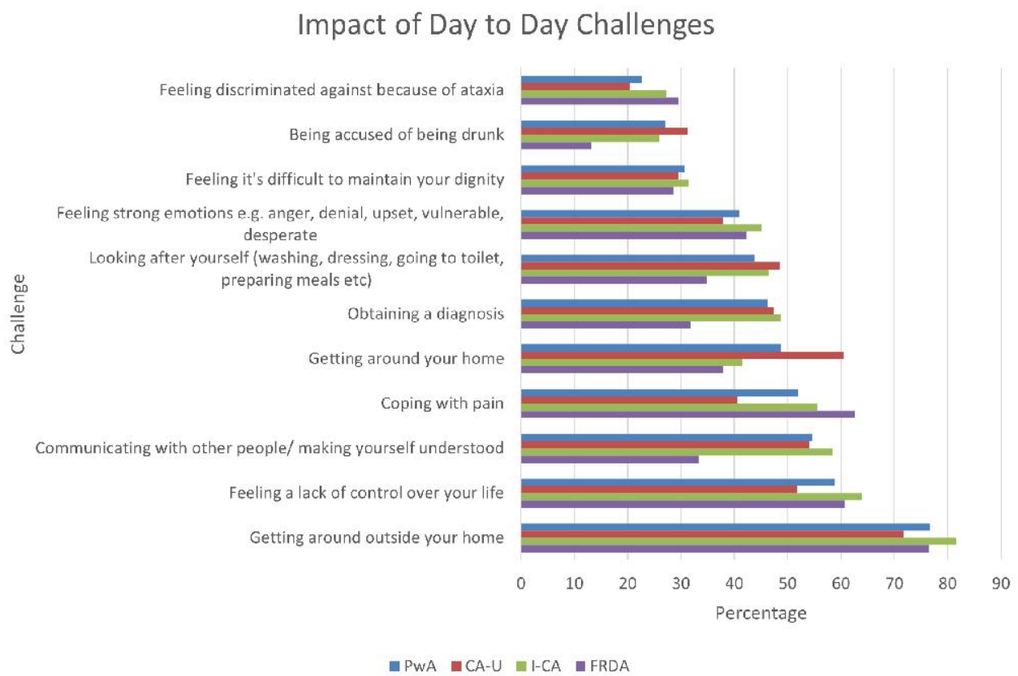
- Impaired Fine Motor Skills: Difficulties with precise movements impact basic tasks like dressing, grooming, and feeding.
- Writing and Communication: Handwriting may become illegible, and speech difficulties can affect communication.

Social and Emotional Well-being:

- Social Isolation: The visible symptoms of ataxia can lead to self-consciousness, potentially resulting in social withdrawal.
- Emotional Impact: Coping with the challenges of ataxia may lead to emotional stress, anxiety, and, in some cases, depression.

Occupational Challenges:

- Employment Implications: Ataxia can interfere with work-related tasks, potentially limiting employment opportunities.



- Productivity Challenges: Tasks that require coordination and dexterity may become more time-consuming or challenging.

Educational Impact:

- Learning Challenges: For individuals with ataxia onset during childhood, the condition can affect learning and academic performance.
- Adaptations Needed: Educational settings may need to make accommodations to address the challenges associated with ataxia.

Cognitive and Emotional Strain:

- Increased Mental Effort: Coordinating movements and maintaining balance may require heightened cognitive effort, leading to mental fatigue.
- Coping with Uncertainty: The progressive nature of some forms of ataxia introduces uncertainty about future abilities and independence.

Dependency on Caregivers:

- Assistance Required: As ataxia progresses, individuals may become increasingly dependent on caregivers for activities that were once performed independently.
- Impact on Caregivers: Caregivers may face increased responsibilities and emotional challenges in providing support.

Quality of Life:

- Restricted Participation: Ataxia can limit participation in recreational activities and hobbies, impacting overall quality of life.
- Loss of Independence: The cumulative effects of ataxia may lead to a gradual loss of independence, requiring increased support for daily living.

Adaptations and Assistive Devices:

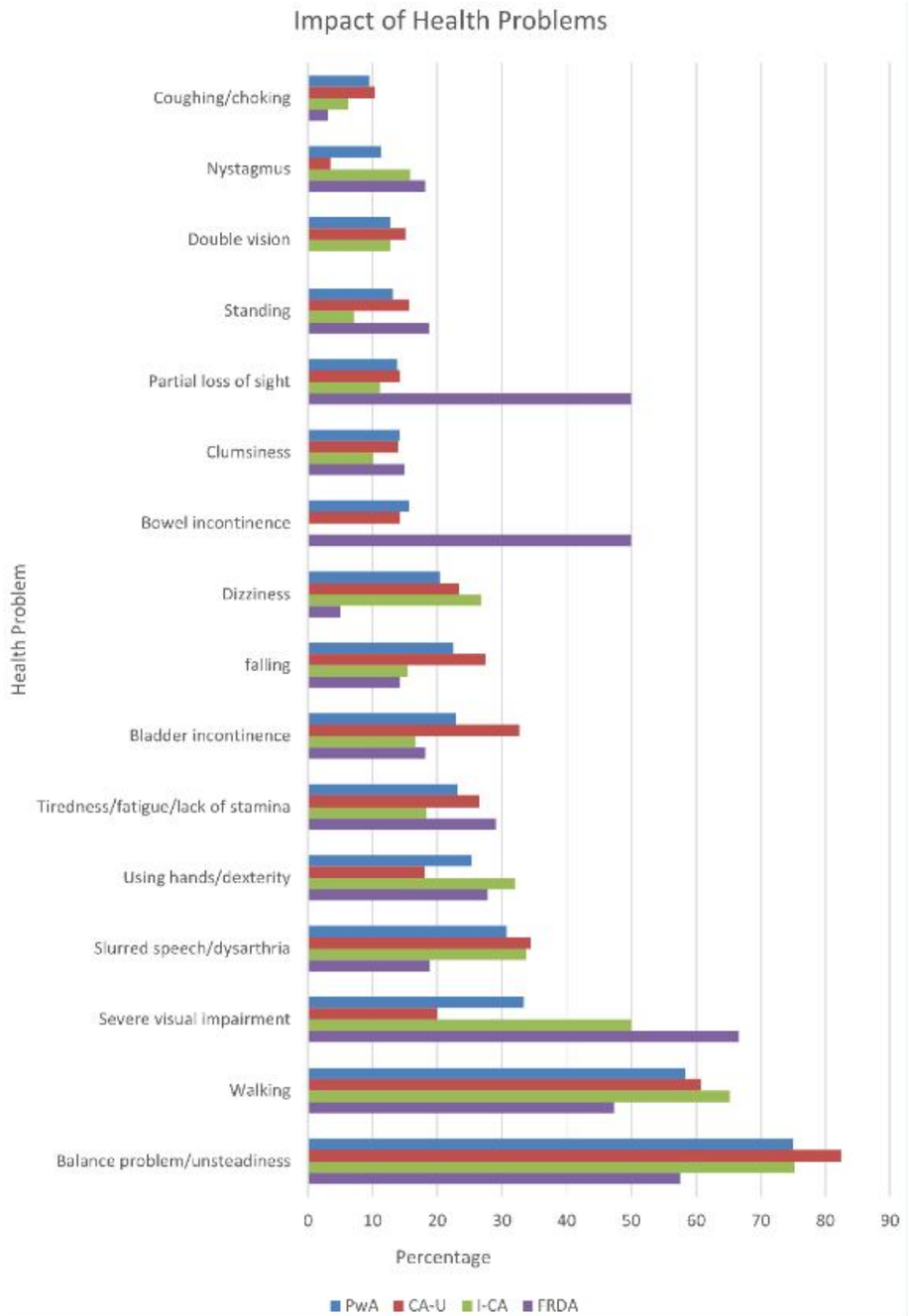
- Use of Mobility Aids: Individuals with ataxia may need to use assistive devices such as walkers or canes to enhance stability.
- Adaptive Equipment: Modifications to the home environment and the use of adaptive tools can help compensate for mobility and coordination challenges.

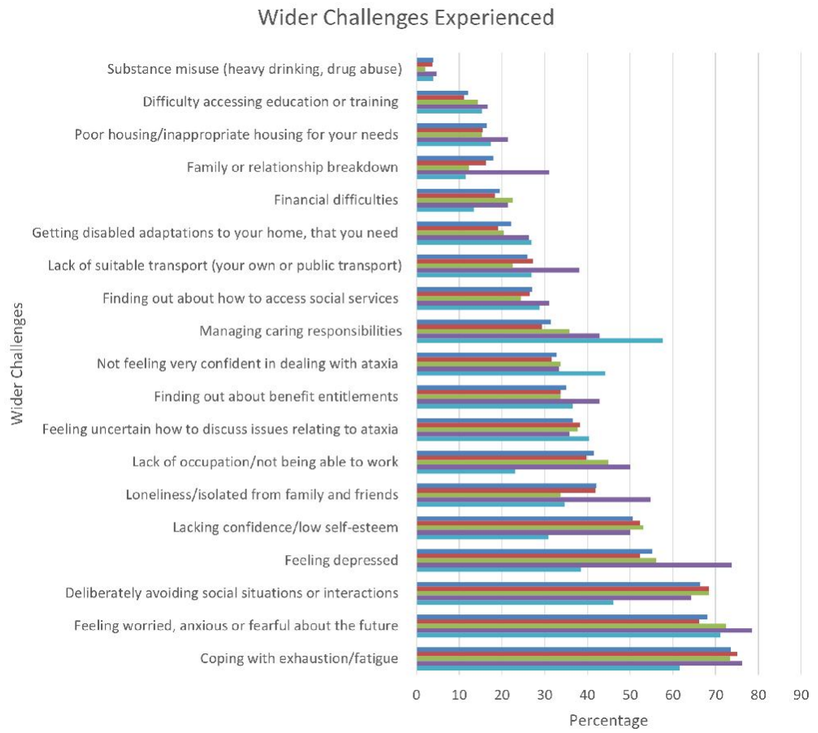
Financial Implications:

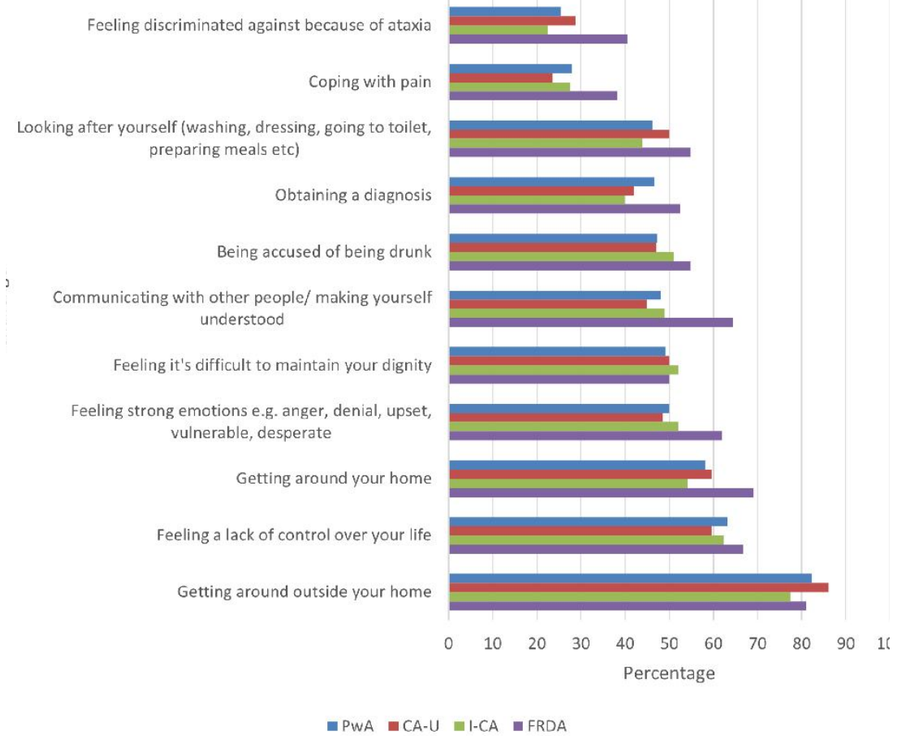
- Medical Costs: Managing ataxia often involves ongoing medical expenses for consultations, treatments, and assistive devices.
- Employment Changes: Career limitations or changes may have financial repercussions.

Understanding the multifaceted impact of ataxia is crucial for developing comprehensive support systems and interventions. A holistic approach that addresses physical, emotional, and social aspects can significantly improve the overall well-being of individuals living with ataxia.

Impact of Ataxia on Daily Life







Current Interventions in Ataxia:

Managing ataxia involves a multidisciplinary approach aimed at addressing symptoms, improving function, and enhancing the overall quality of life for individuals affected by the condition. While there is no cure for most types of ataxia, several interventions are commonly employed to mitigate the impact of symptoms. Here are detailed explanations of current interventions:

1. Physical Therapy:
    - Objective: Physical therapy plays a central role in ataxia management, focusing on improving coordination, balance, and muscle strength.
    - Exercise Programs: Tailored exercise programs help individuals practice movements that challenge and stimulate the cerebellum.
    - Gait Training: Specific exercises aim to improve walking patterns and reduce the risk of falls.
    - Adaptations: Therapists may recommend adaptive strategies and tools to compensate for coordination challenges.
2. Occupational Therapy:
    - Objective: Occupational therapists work to enhance independence in activities of daily living (ADLs) and address fine motor skill challenges.
    - Adaptive Tools: Recommending and teaching the use of adaptive tools to facilitate daily tasks.
    - Cognitive Strategies: Implementing strategies to cope with cognitive fatigue and improve task organization.
3. Speech Therapy:
    - Objective: Speech therapists address speech and swallowing difficulties associated with ataxia.
    - Articulation Exercises: Specific exercises target improving clarity of speech and articulation.
    - Swallowing Training: Techniques to enhance safe swallowing and reduce the risk of aspiration.
4. Medications:
    - Objective: While there is no cure, certain medications may help manage specific symptoms or address underlying causes.
    - Symptomatic Treatment: Medications such as those targeting tremors or muscle stiffness may provide symptomatic relief.
    - Disease-Modifying Agents: Some forms of ataxia caused by specific genetic mutations may benefit from experimental disease-modifying treatments.
5. Assistive Devices:
    - Mobility Aids: Walkers, canes, and wheelchairs may be recommended to enhance stability and prevent falls.
    - Adaptive Equipment: Tools and devices adapted for individuals with ataxia, such as utensils with larger handles or grips.

1. Orthopedic Interventions:
    - Orthopedic Support: Braces or orthopedic devices may be used to provide additional support for weakened or unstable joints.
2. Genetic Counseling:
    - Objective: In cases of hereditary ataxias, genetic counseling provides information about the condition, its inheritance patterns, and potential implications for family members.
    - Family Planning: Guidance on family planning options and genetic testing for at-risk family members.
3. Counseling and Psychological Support:
    - Objective: Emotional and psychological support is essential for individuals and their families.
    - Coping Strategies: Counseling helps individuals develop coping strategies to deal with the emotional impact of ataxia.
    - Support Groups: Joining support groups can provide a sense of community and shared experiences.
4. Research and Clinical Trials:
    - Objective: Participation in research studies and clinical trials may provide access to experimental treatments and contribute to advancing knowledge about ataxia.
5. Educational Support:
    - Individualized Education Plans (IEPs): For children with ataxia, IEPs in educational settings provide tailored support to address learning challenges.

It's important to note that the effectiveness of interventions can vary depending on the type and progression of ataxia. A personalized approach that considers the individual's unique symptoms and needs is crucial for optimizing the outcomes of these interventions. As research continues, new therapies and interventions may emerge, offering additional options for individuals living with ataxia.

Problem Statement

Trunk balance problems are common in individuals with ataxia.
The trunk refers to the central part of the body, including the spine and surrounding muscles, which plays a crucial role in maintaining stability during movement and activities of daily living.

Trunk balance problems in ataxia are:

- Impaired coordination during sitting or lying down
- Swaying and loss of balance
- Challenging transitional movements
- Instability while standing
- Difficulty walking

Objective

To design a product for cerebellar ataxia patient to resist the fall in the sitting posture and solve the trunk balance problem by maintain the stability in the body.

User study

- We have conducted interviews with **Swasthi Wagh, Swarashree Mahajan** and **Suhas Mahajan**.
- Conducted the interview in both online and in person.
- Gathered insights from the patients about the condition and personally visited and saw the tremors, imbalance and other issues faced by them.
- Also, we interviewed **Dr. Jui Dave** (Neuro physiotherapist) who gave us the insights and perception to understand the conditions in Ataxia with good extent and in medical terms.
- Saw different assistive devices used by patient for different activities.
- Understood various challenges faced by caretaker throughout the day.

Questionare for patient

Background Information:
- Can you briefly describe your diagnosis and how long you've been living with Ataxia?
- Have you undergone any medical treatments or therapies related to Ataxia?

Trunk Stability Experience:
- Can you tell me about your experiences with trunk stability or balance issues related to Ataxia?
- How does Ataxia affect your ability to sit and maintain trunk stability?

Daily Activities:
- What daily activities are most affected by your trunk stability issues?
- Can you describe specific situations or activities where you face the greatest challenges?

Assistive Devices:
- Have you used any assistive devices or products to improve trunk stability while sitting? If so, please describe them.
- What do you like or dislike about the assistive devices you've used?

Current Solutions:
- Are there any strategies or techniques you've developed on your own to cope with trunk stability issues while sitting?
- Do you receive any professional assistance, such as physical therapy, for trunk stability?

Product Preferences:
- What features would you consider important in a product designed to improve trunk stability while sitting?
- Are there specific design aspects that would make a product more appealing or practical for you?

Comfort and Functionality:
- How important is comfort when using a trunk stability product?
- What level of support or stability do you believe would be most beneficial for your needs?

Challenges and Frustrations:

- Can you share any specific challenges or frustrations you've encountered due to trunk instability?
- Are there any moments or situations where you feel particularly vulnerable or unsafe?

Safety Concerns:

- How concerned are you about potential falls or accidents related to trunk instability?
- What safety features or considerations would be crucial in a product for you?

Wishlist for a Solution:

- If you could describe your ideal trunk stability product, what would it look like, and how would it function?
- Are there any additional features or functionalities you wish such a product would have?

Feedback on Existing Products:

- Have you tried any existing products designed to improve trunk stability for individuals with Ataxia?
- If so, what were your impressions of these products?

Future Expectations:

- What improvements or changes would you like to see in products designed for individuals with Ataxia in the future?
- Do you have any advice for designers and developers working on such products?

Questionare for Doctor

Doctor's Expertise and Experience:

1. Could you please share your background and experience as a neurophysiotherapy specialist, especially in treating Ataxia patients with a focus on trunk stability and balance?
2. Over the course of your career, what key insights have you gained about the unique challenges and needs of Ataxia patients concerning trunk stability?

Assessment and Evaluation:

1. What methods or assessments do you typically use to evaluate the trunk stability and balance of Ataxia patients in a clinical setting?
2. In your experience, how does trunk stability impact the overall quality of life and daily activities of Ataxia patients?

Current Rehabilitation Approaches:

1. What are the primary rehabilitation techniques or exercises you recommend to Ataxia patients to improve trunk stability and balance?
2. Are there any assistive devices or products that you currently recommend or have seen success with in assisting Ataxia patients with trunk stability during rehabilitation?

Patient Feedback and Challenges:

1. Based on your interactions with Ataxia patients, what feedback or insights have you received regarding the challenges and frustrations they face in improving trunk stability?
2. Are there any safety concerns or considerations that Ataxia patients have when working on trunk stability during rehabilitation?

Relevance to Trunk Stability Product:

1. From your clinical perspective, what features or functionalities do you believe would be essential in a product designed to aid Ataxia patients in improving trunk stability?
2. Can you suggest any specific design considerations or aspects that would make a trunk stability product more effective and user-friendly for Ataxia patients?
3. Have you encountered cases where a technological solution or product significantly improved trunk stability for Ataxia patients, and what were the outcomes?

Future Trends and Needs:

1. Looking ahead, what do you foresee as potential advancements or trends in addressing trunk stability for Ataxia patients, and how can product designers align with these trends?
2. In your opinion, what are the critical unmet needs or areas where innovative solutions could greatly benefit Ataxia patients in terms of trunk stability?

Collaboration and Advice:

1. How do you envision collaboration between healthcare professionals and product designers to create effective trunk stability solutions for Ataxia patients?
2. Do you have any advice or recommendations for designers and developers working on trunk stability products aimed at assisting Ataxia patients in their daily lives?

Patient interview insights

1. Maintaining alignment between the eyesight and body direction is crucial, as any imbalance can result in instability.
2. Weakness in the body's core and lack of core stability lead to difficulties in controlling the body, requiring external support for stability.
3. Activities such as eating, writing, drinking water, and handling objects are challenging without support due to a lack of control over falling.
4. Bending beyond 10/15 degrees poses a risk of toppling or falling, making turning and writing difficult.
5. Patients often rely on external support, such as handrails, to prevent falls, as the brain signals instability even when the individual feels stable.
6. Back support is essential, even in the absence of hand support, but existing supports have limitations in bending and are heavy.
7. Lack of wearable devices and an aversion to risk in daily activities contribute to the need for external support.
8. Physiotherapy has limited impact on trunk balance, and some patients experience tremors in the trunk.
9. The gait resembles that of a pregnant woman leaning backward, and physiotherapists recommend forward bending, though it proves challenging.
10. The ideal solution involves an exoskeleton for correct posture, incorporating handles for support and braces to guide body posture.
11. Customized jackets, similar to those in foreign countries, could be beneficial for patients, allowing them to decide their comfortable posture.
12. Physiotherapy helps slow down the progressive nature of ataxia, emphasizing the importance of visual feedback.
13. Adaptive, stiff, and customizable trunk stabilizers are necessary, allowing for changes while permitting free movement.
14. Wearable products should facilitate daily tasks without restricting movement, enabling the patient to move beyond their range comfortably.
15. Doctors recommend weight reduction, as progressive ataxia makes it challenging for patients to lift their body weight.

Doctor interview insights

1. Trunk stability is evaluated through various measures such as assessing the range of motion, muscle strength, and challenging both anticipatory and reactive balance.
2. Consider designing a product that offers 3D stabilization for effective trunk support.
3. Envision an exoskeleton that is easy to wear and remove, catering to the specific needs of Ataxia patients who have a low threshold for adopting new products.
4. Prioritize user-friendliness in the product, ensuring it is accessible and easy for Ataxia patients to use.
5. The envisioned product should incorporate features such as static stability to maintain an upright position and dynamic stability to allow patients the freedom to bend.
6. Recognize the significance of visual feedback in aiding Ataxia patients to maintain stability and coordination.

Priority Matrix

Must have

- Static and Dynamic stability
- Resist and Dampen the fall

Should have

- Light weight
- Flexible
- Posture correction
- Exoskeleton

Could have

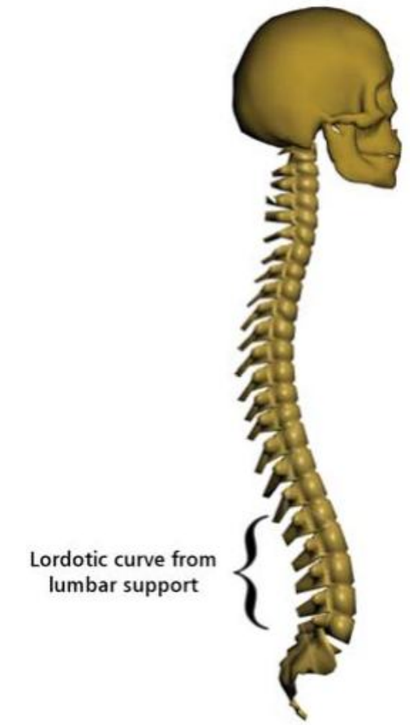
- Handle to hold
- Body motion sensors

Would have

360 degree freedom

Ergonomic data

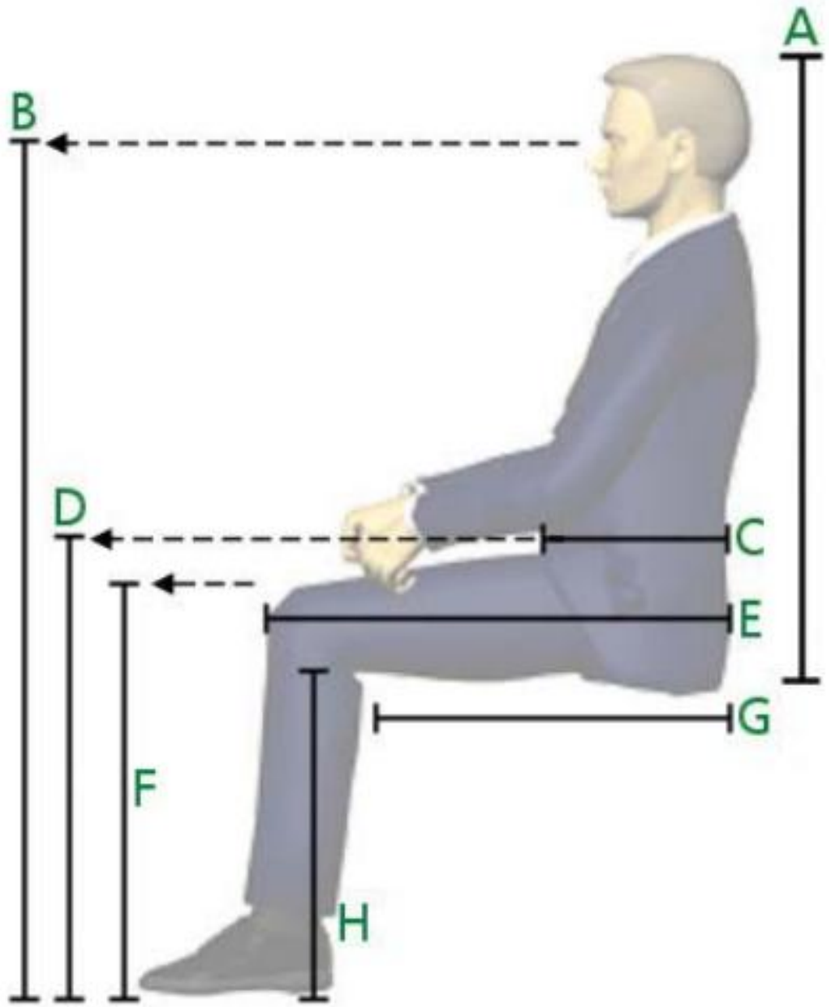
Dimension	Men				Women			
	5%	50%	95%	Mean	5%	50%	95%	Mean
Stature (cm)	1.60	1.74	1.85	1.73	1.54	1.64	1.74	1.64
Weight (Kg)	58.00	74.00	95.20	75.73	45.45	56.00	73.10	58.18
CMI (Kg/m)	20.00	24.00	30.00	24.66	17.00	21.00	26.00	21.3
Popliteal height (cm)	38.00	45.00	51.00	44.66	35.00	41.00	46.00	40.66
Buttock-popliteal distance (cm)	37.00	45.00	52.20	44.73	34.00	41.00	48.00	41
Hip width (cm)	38.00	45.00	57.20	46.73	37.45	44.00	54.00	45.15
Elbow height to the seat (cm)	20.00	24.00	30.00	24.66	19.00	24.00	28.00	23.66
Distance between the elbows (cm)	38.00	47.00	59.20	40.06	35.00	42.00	52.00	43



. Appropriate S-shaped curve of the spine.

Spine and Lumbar : Maintaining the neutral, or standing shape of the lumbar, or lower spinal area, is important for comfort and posture. Chairs can give appropriate and correct lumbar support. This seated lumbar support will help the spine maintain an S-shaped curve similar to the spine's shape when standing

Ergonomic data



Measurement	Letter	Female 5th – 95th%	Male 5th – 95th%	Overall Range 5th – 95th%
Sitting Height	A	31.3″ – 35.8″	33.6″ – 38.3″	31.3″ – 38.3″
Sitting Eye Height	B	42.6″ – 48.8″	46.3″ – 52.6″	42.6″ – 52.6″
Waist Depth	C	7.3″ – 10.7″	7.8″ – 11.4″	7.3″ – 11.4″
Thigh Clearance	D	21.0″ – 24.5″	23.0″ – 26.8″	21.0″ – 26.8″
Buttock-to-Knee	E	21.3″ – 25.2″	22.4″ – 26.3″	21.3 – 26.3″
Knee Height	F	19.8″ – 23.2″	21.4″ – 25.0″	19.8″ – 28.0″
Seat Length/Depth	G	16.9″ – 20.4″	17.7″ – 21.1″	16.9″ – 21.1″
Popliteal Height	H	15.0″ – 18.1″	16.7″ – 19.9″	15.0″ – 19.9″
Seat Width	Not Shown	14.5″ – 18.0″	13.9″ – 17.2″	13.9″ – 18.0″

Table 2. Values for 5th to 95th percentile males and females in the seated position used in designing seating. Use Figure 4 for visualization. Data from BIFMA Ergonomics Guidelines, 2002. All measurements are in inches.

Posture : Correct seated posture is a continual debate with ergonomic professionals. Some say that users need to have a 90-90-90 degree placement for the elbow, hip, and knee joints, respectively. Others feel that a variation in this placement is better, as long as it does not lead to slouching or hunching over. A good seated posture is one that is comfortable and does not put a lot of stress or strain on the user's buttocks, back, or arm muscles, and allows the user's feet to be on the fl oor.

Design Brief

To design a product for cerebellar ataxia patient to resist the fall in the sitting posture and solve the trunk balance problem by maintain the stability in the body. It should have the **dynamic stability** along with **flexible structure** and **light weight .**

Existing Product

Existing Product

Ideation

Why Why Method

Ideation

Six thinking Hats

What does your product do
What does your product not do

What will happen when there is stability in trump
What will happen when there is instability

why there is need of stability for ataxia patients
why there is not need of stability for non ataxia patient

where there is a need of product
where there is not need of product

when will patient use the product
when will patient not use the product

who is the user of product
who is not the user of product

How will patient use the product
How wil patient not use the product

where the product should be attached on body
where the product should not be attached

where do you feel stability needed
where do you feel stability not needed

when there is a need to use the product
when there is not a need to use the product

how product help to maintain balance
how product will fail to maintain balance

Why would someone buy the product you designed
why would someone not buy the product you designed

Insights

- Prioritize patient safety by implementing measures to prevent injuries.
- Develop a product that aids patients in preventing falls and maintaining control over their movements.
- The product is designed for use during sitting activities, ensuring versatility in various settings like home, office, or hotels.
- Ensure portability, allowing users to conveniently utilize the product anywhere, with no requirement for use while standing.
- Extend the usability of the product to cater to patients lacking trunk stability, enabling a broader range of individuals to benefit.
- Emphasize self-operability, enabling patients to independently wear, attach, and detach the product without external assistance.
- Minimize reliance on external support by providing versatile attachment options to the trunk, shoulders, legs, chairs, or a secure base.
- Incorporate dynamic stability features into the product for enhanced support during movements.
- Opt for elastic and robust materials to meet the product's requirements for durability and flexibility.
- Ensure the product's user-friendliness, including characteristics such as light weight, easy attachment and detachment, softness, elasticity, resistance to falls, portability, and foldability, promoting seamless integration with the body.

Ideation

Brainstroming

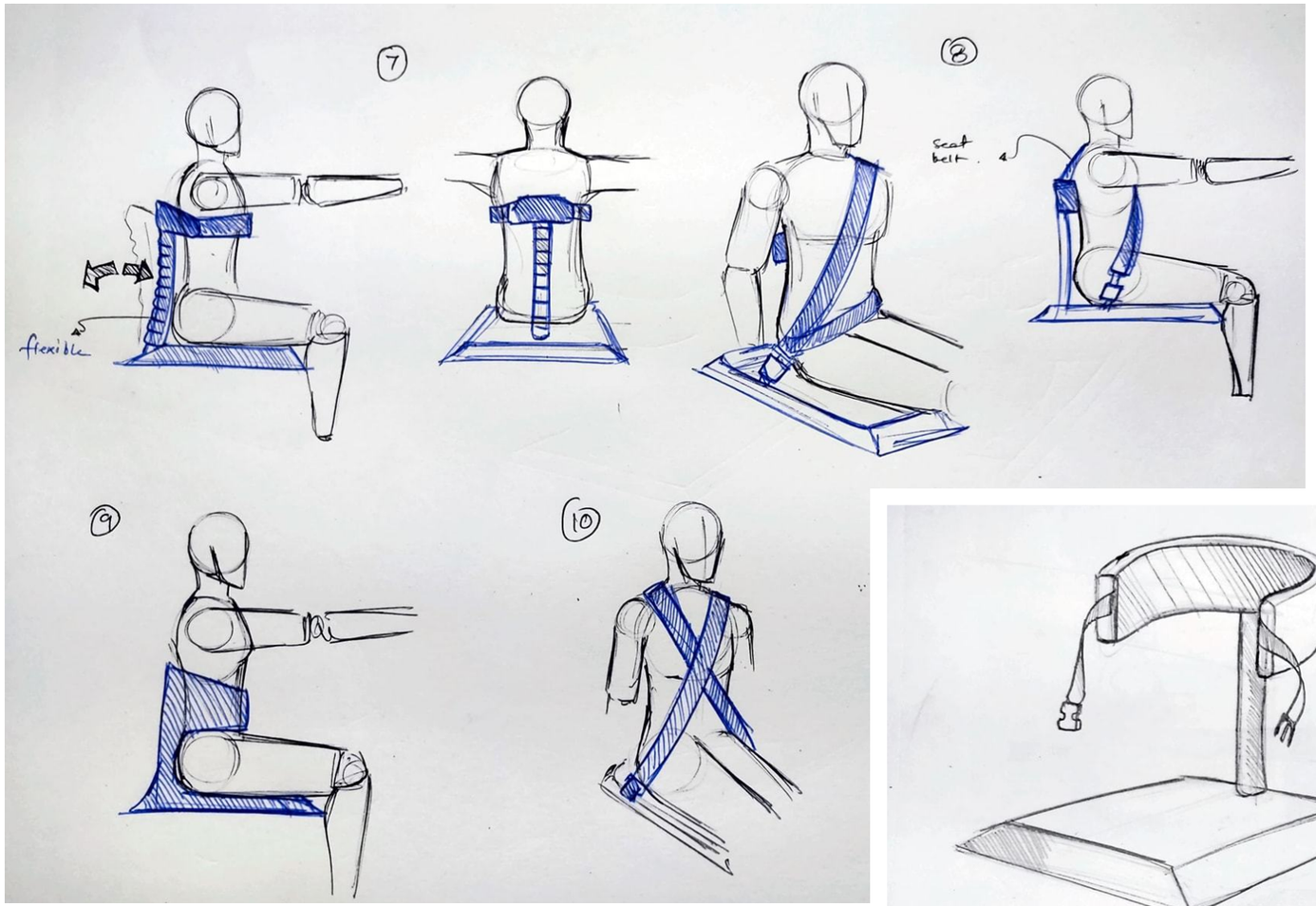
Questions for Brainstorming

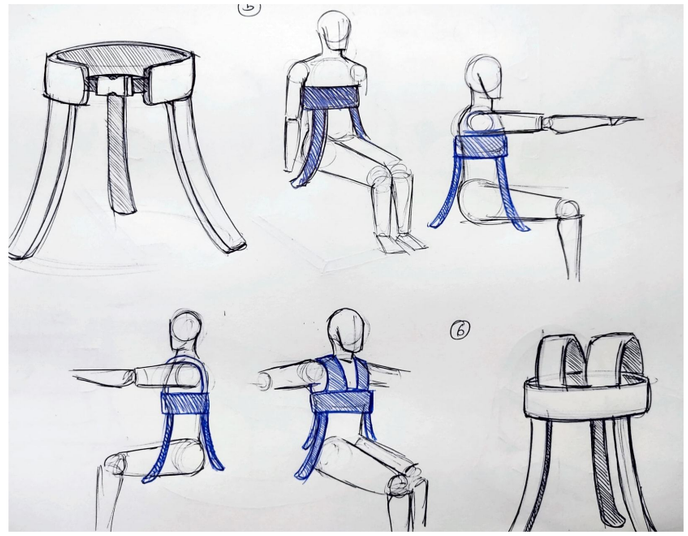
How to maintain trunk / upper body stable while sitting ?
How to avoid hurt by falling ?
How to resist the fall ?

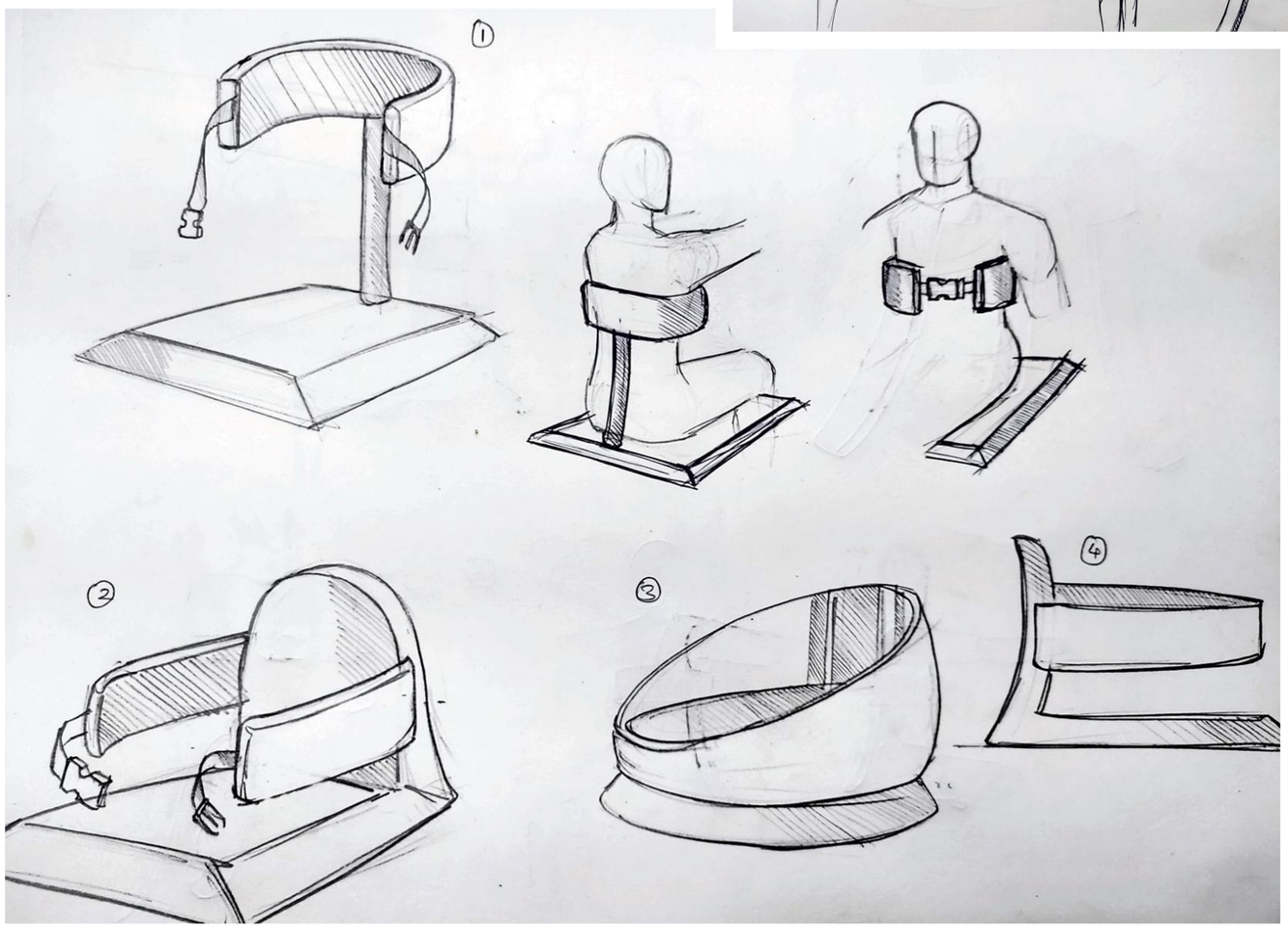
Ideas by Brainstorming

- Shifting of center of mass to back to avoid fall
- Product having gyroscope /gimble mechanism to balance the body
- Product having tensegrity and elasticity
- Spine guiding exoskeleton
- Weighted vest
- Balancing backpack
- Body and head armour
- Retracting clothes the regain position of body
- Product which works on the principle of newtonian fluid.
- Product working on the seatbelt mechanism
- Inflatory body jacket

Ideation sketches

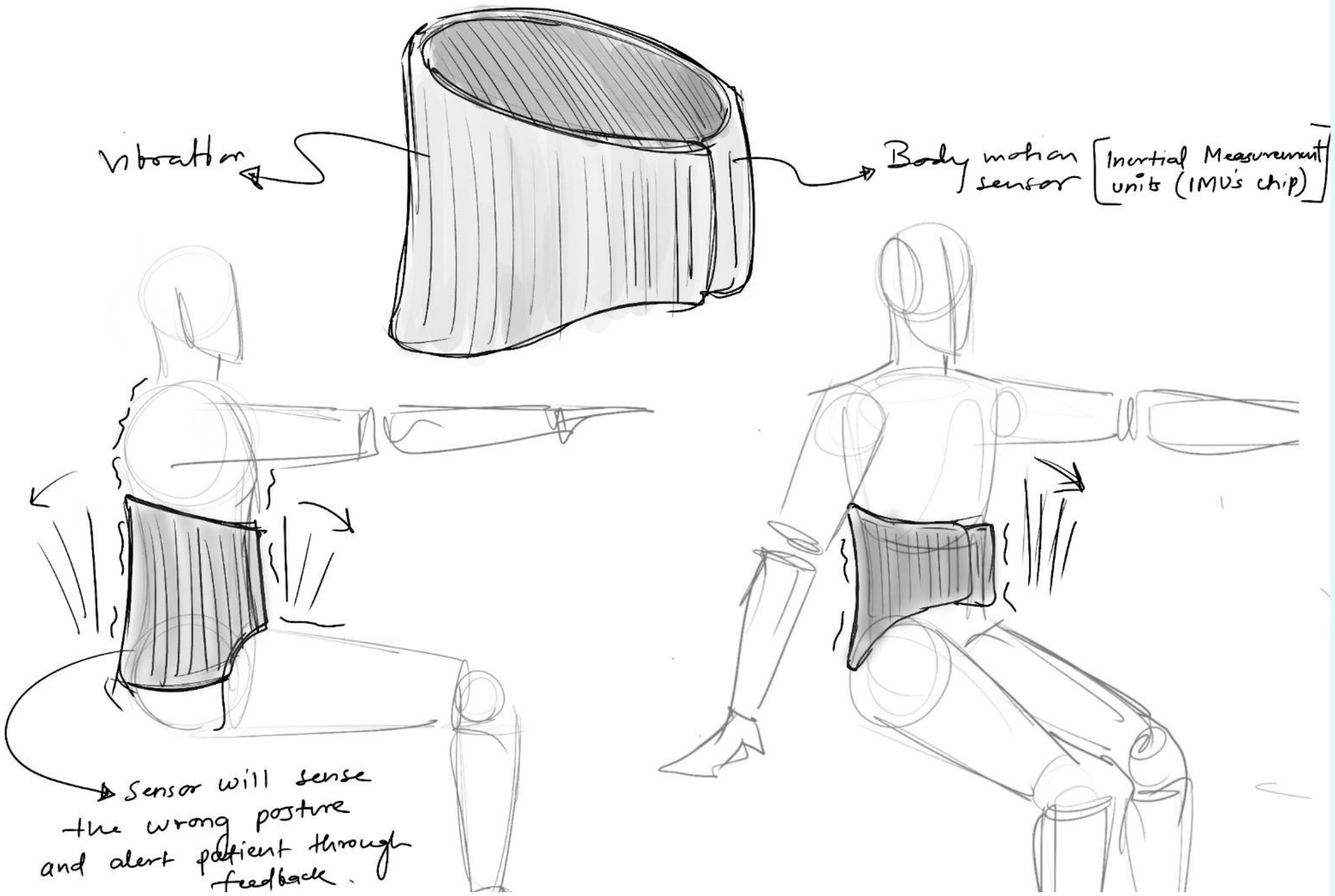






Ideation sketches

Concept 1



Pros

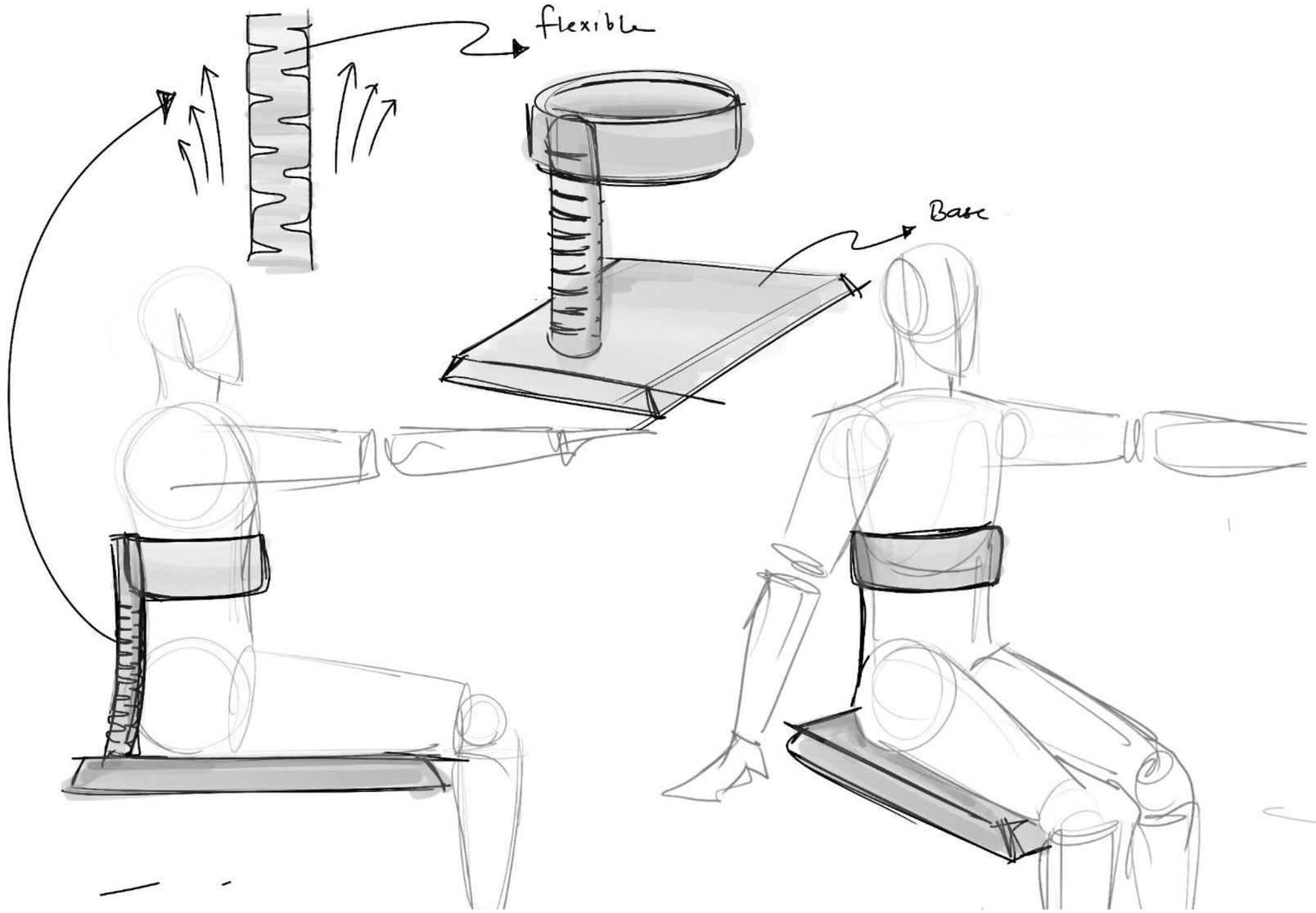
- Detects the body movements with the help of IMU chips and warns the patients to avoid the excess body movement with the help of vibrations
- Portable

Cons

- Only warns the patient about the excess body movement . Body fall is not avoided by this product

Ideation sketches

Concept 2



Pros

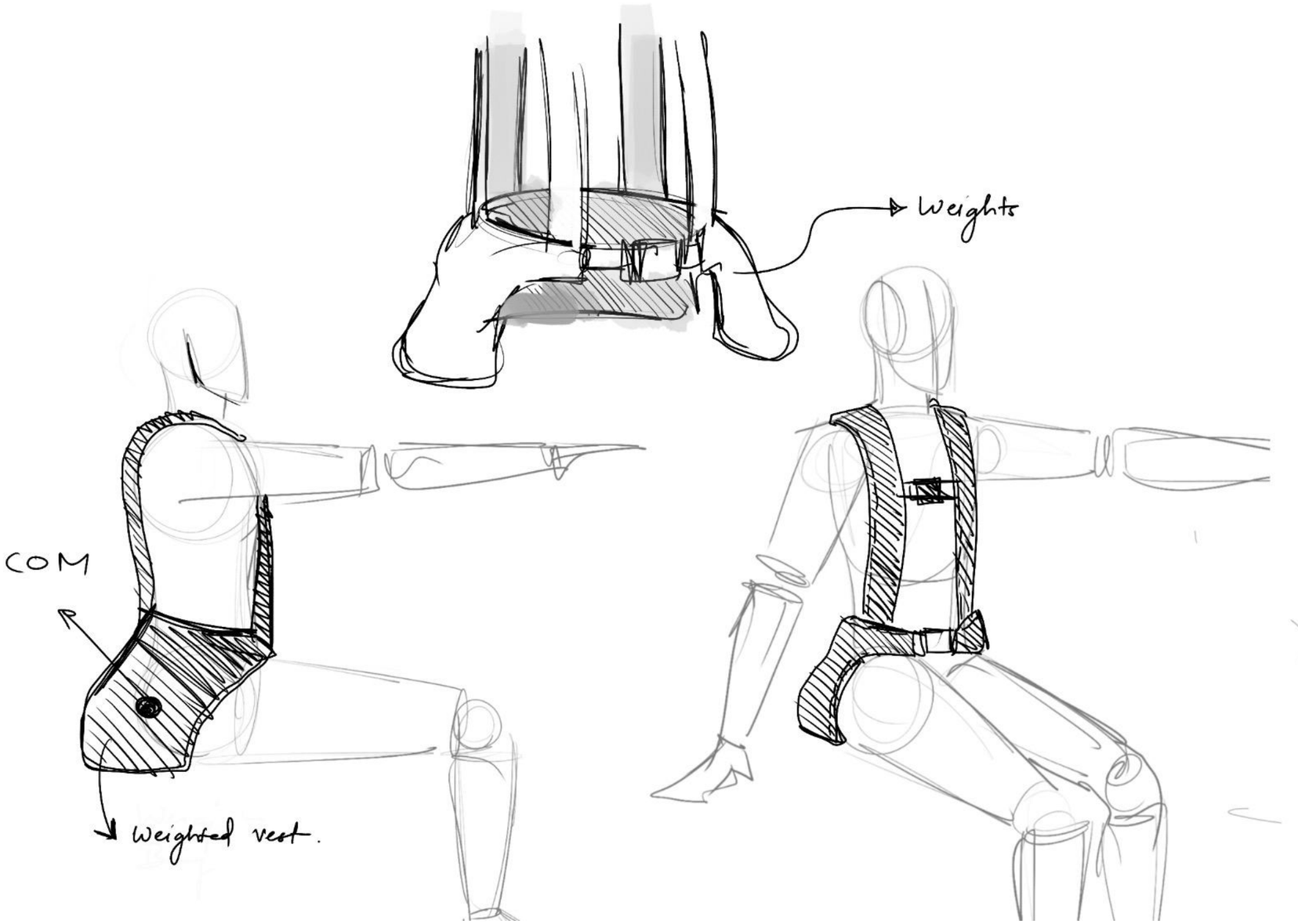
- Spinal structure with elastic structure.
- Dynamic stability for patients.

Cons

- Bulky structure
- non portable
- Only front and back bending

Ideation sketches

Concept 3



Pros

- With the help of weight the center of mass is transfered to back.
- Weighted vest gives support to back

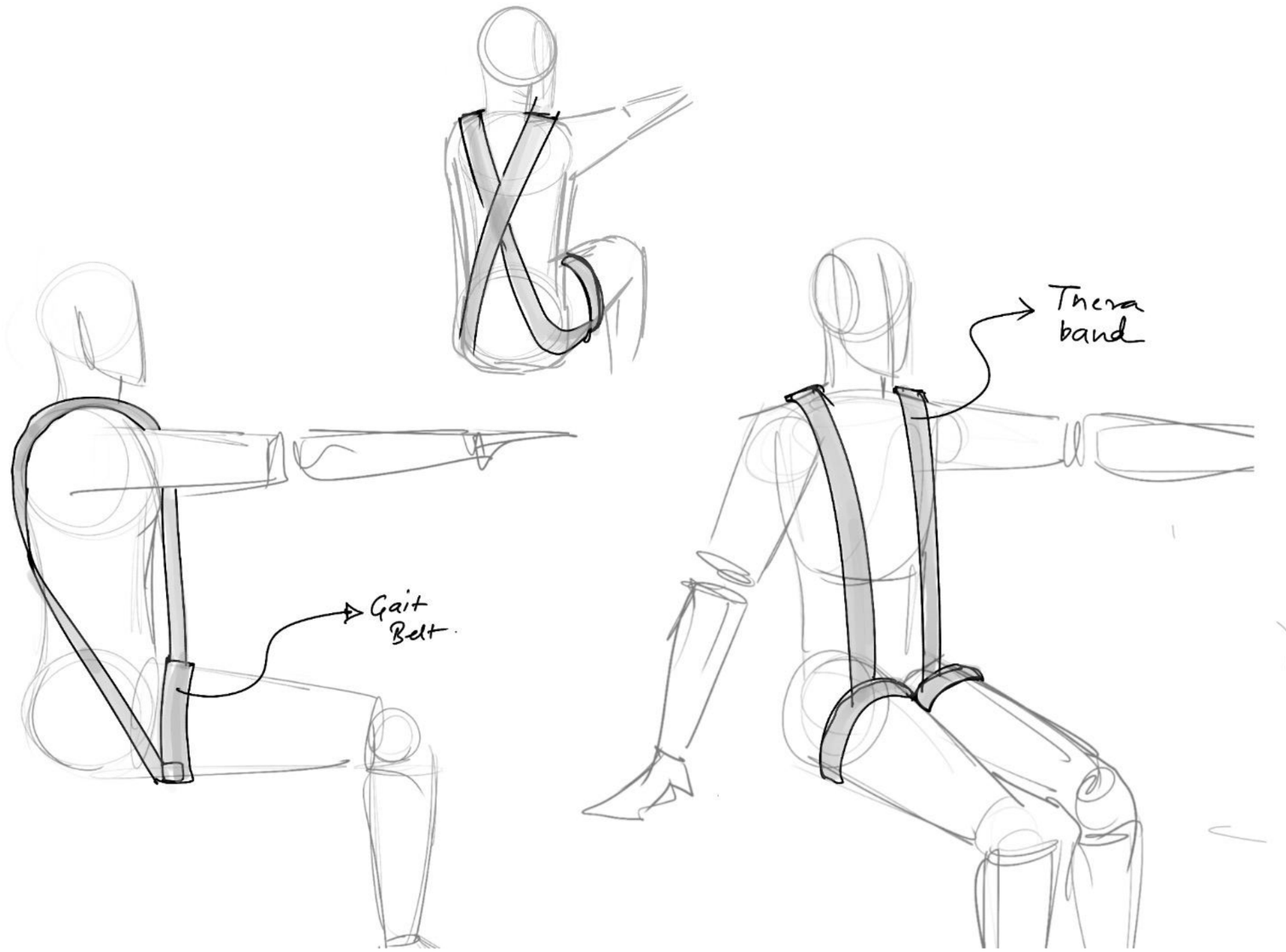
Cons

- Maximum support in back side.
- Weight vest is heavy and bulky

Mockup
Concept 3

Ideation sketches

Concept 4



Pros

- Thera band provides dynamic stability to the patient.
- Provides 360 degree freedom
- Portable

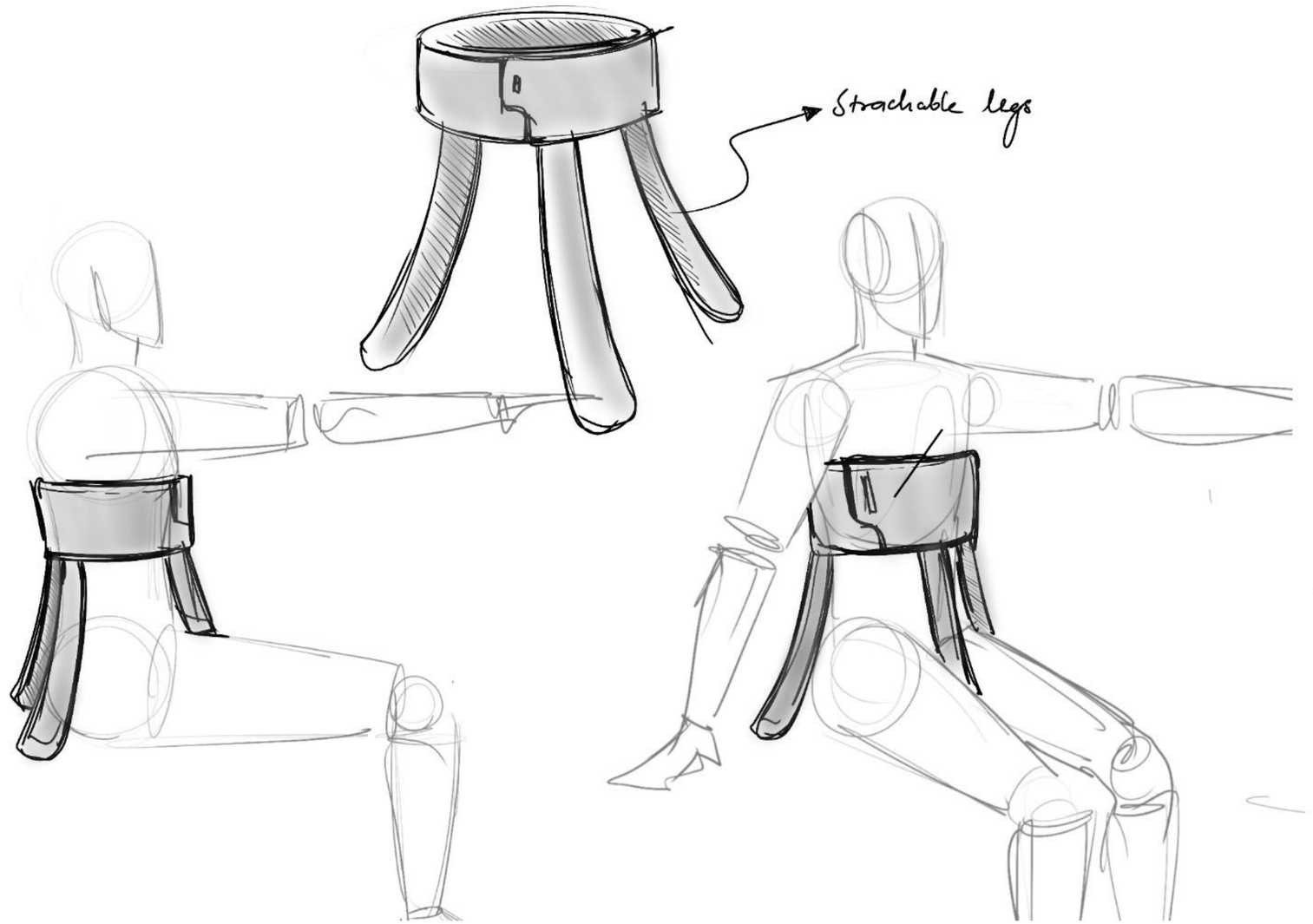
Cons

- Strain on the shoulder all the time

Mockups
Concept 4

Ideation sketches

Concept 5



Pros

- Provides dynamic stablity
- 360 degree freedom
- Easy attach and detach
- Elastic

Cons

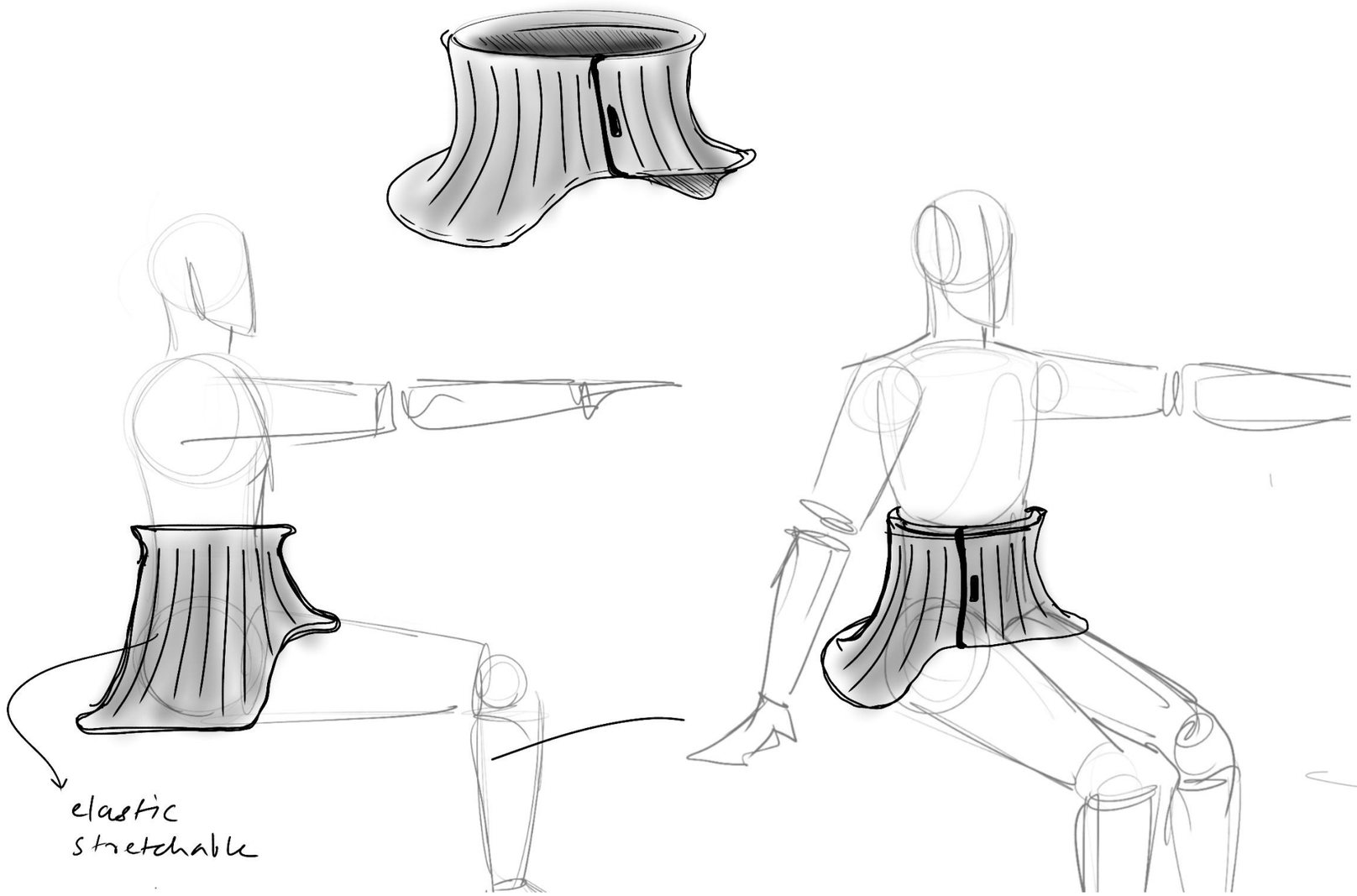
- Non portable
- Unstable legs
- Bulky product

Mockups

Concept 5

Ideation sketches

Concept 6



Pros

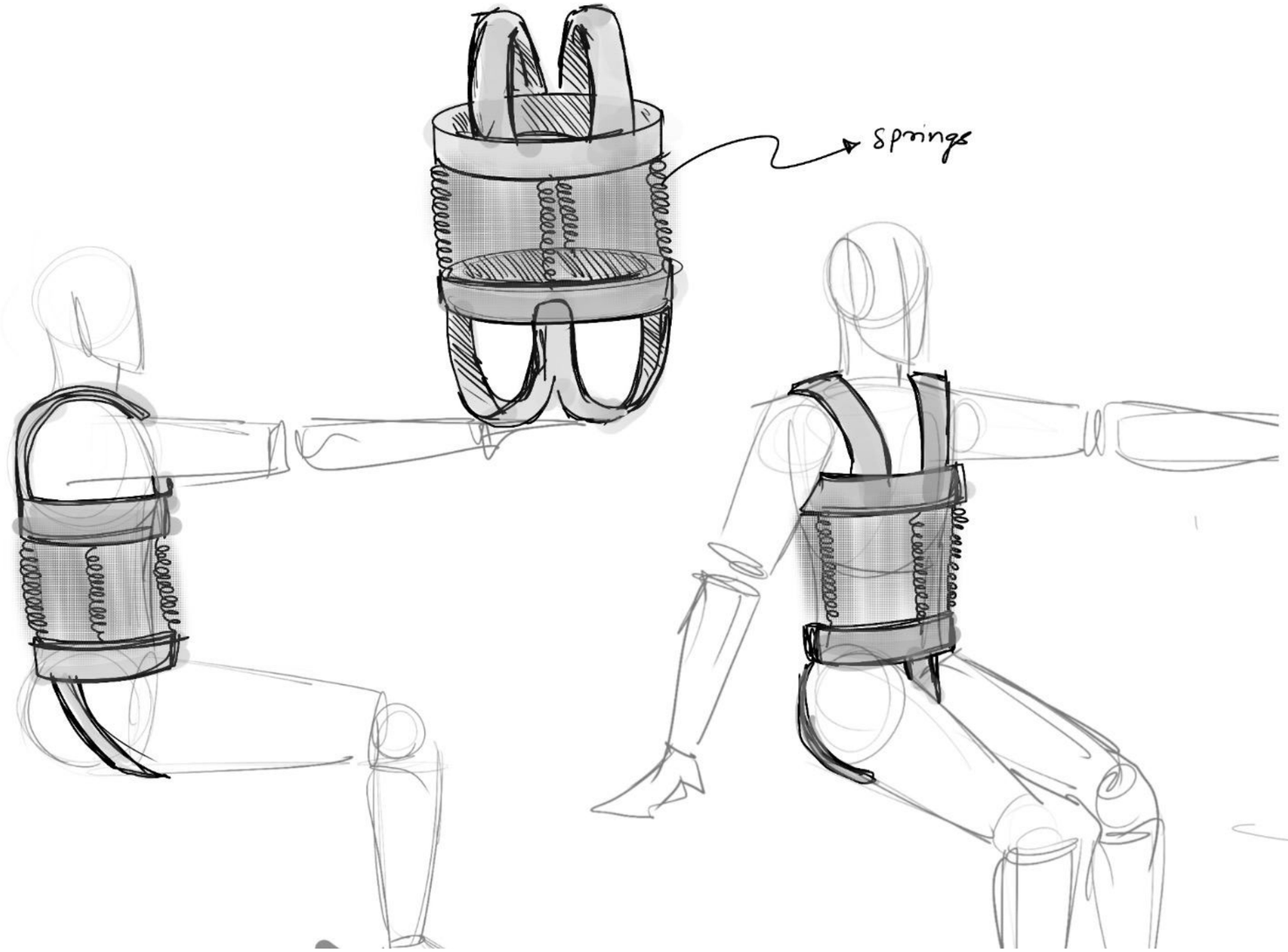
- Dynamic stability
- 360 degree freedom
- Elastic support
- Easy attach and detach

Cons

- Bulky product

Ideation sketches

Concept 7



Pros

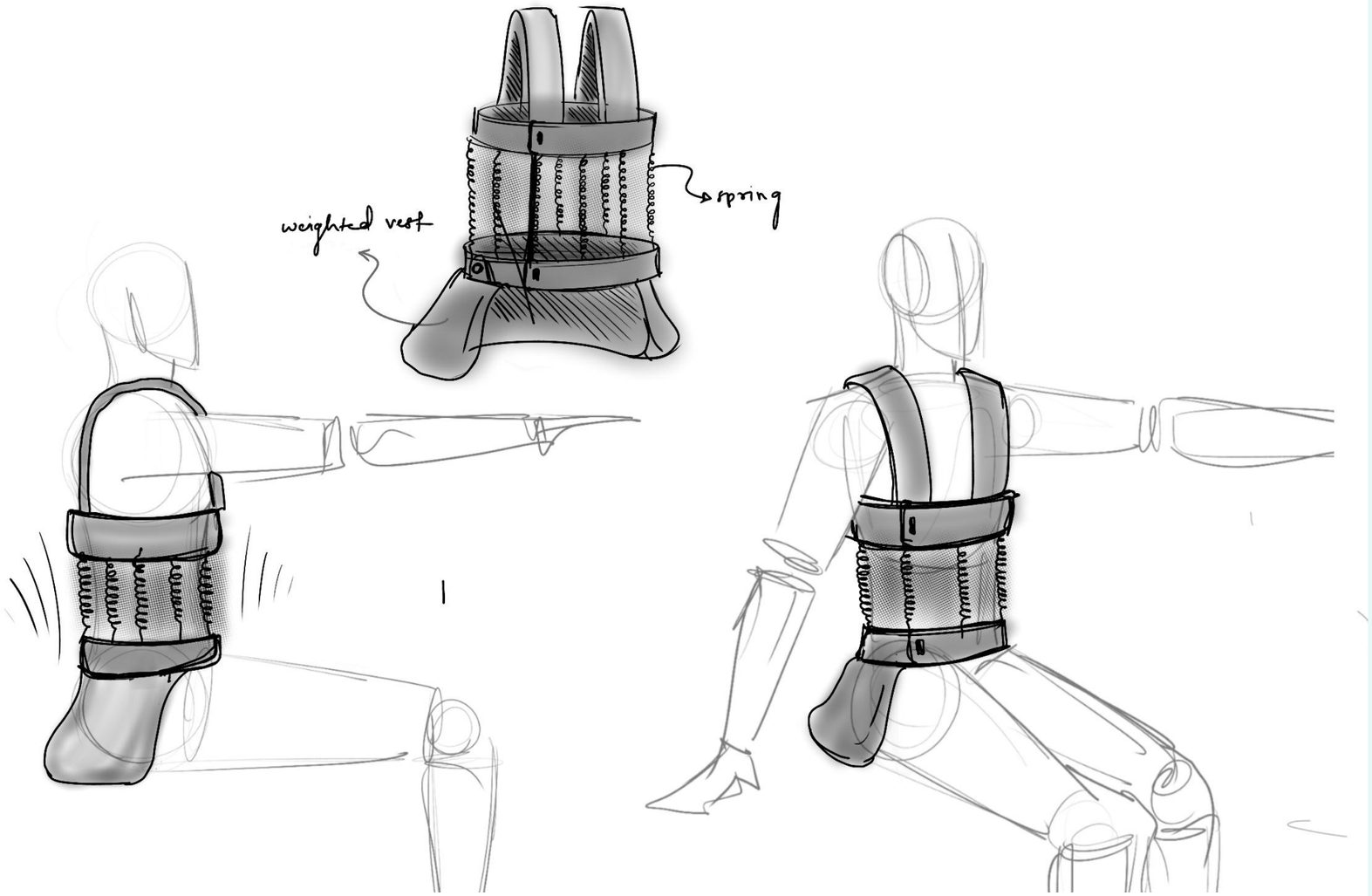
- Portable
- Elastic
- Dynamic stability
- 360 degree freedom

Cons

- Elastic belt/ spring should be in stressed position
- Stress on the shoulders
- Lower belt is not suitable for women

Ideation sketches

Concept 8



Pros

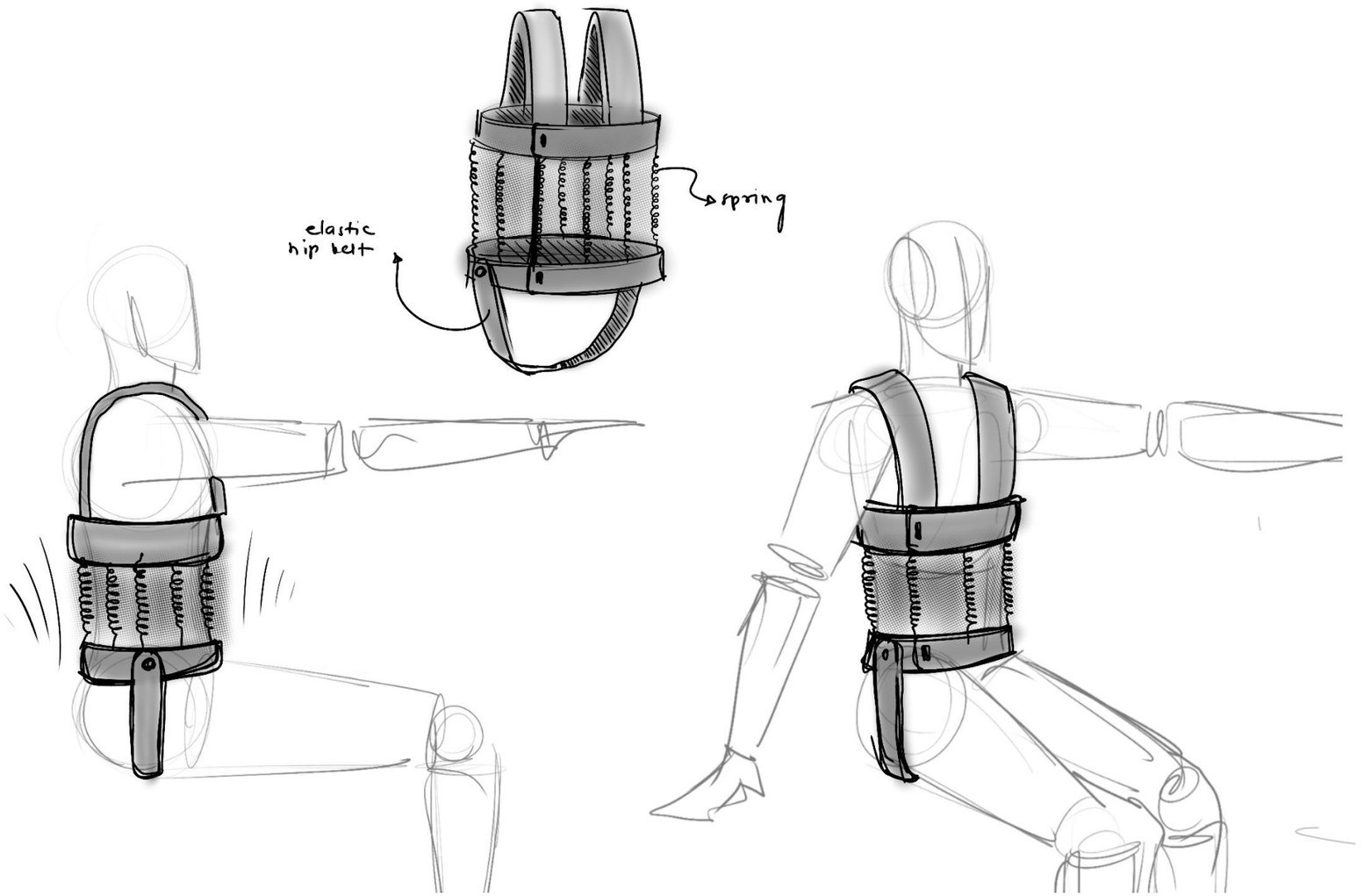
- Portable
- Elastic
- Dynamic stability
- 360 degree freedom

Cons

- Elastic belt/ spring should be in stressed position
- Stress on the shoulders
- Lower belt is not suitable for women

Ideation sketches

Concept 9



Pros

- Portable
- Elastic
- Dynamic stability
- 360 degree freedom
- Suitable for women

Cons

- Elastic belt/ spring should be in stressed position
- Stress on the shoulders
- Lowe belt attachment is difficult for patient to access

Mockups
Concept 9

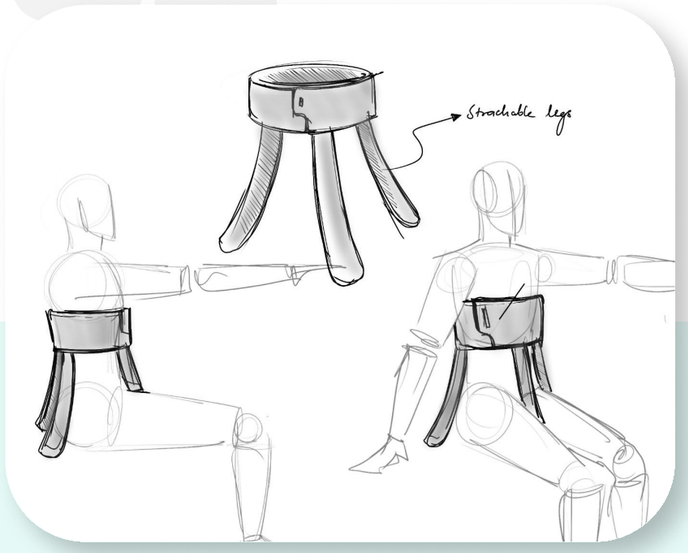




Interview Round 3 : Patient insights on Ideation

Selected Ideas

01



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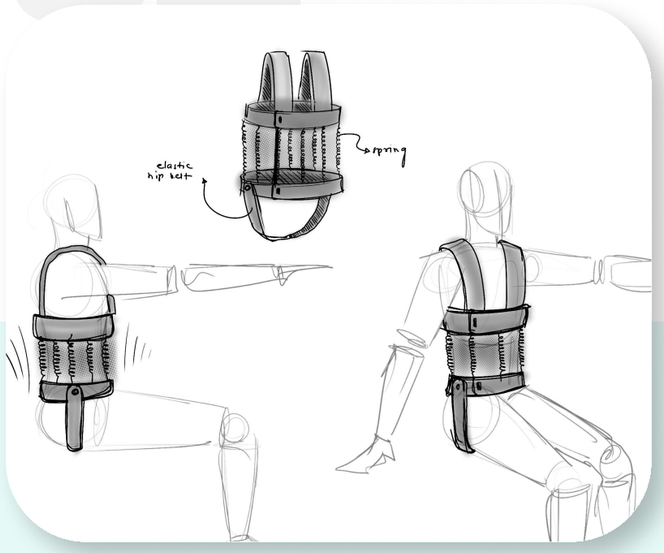

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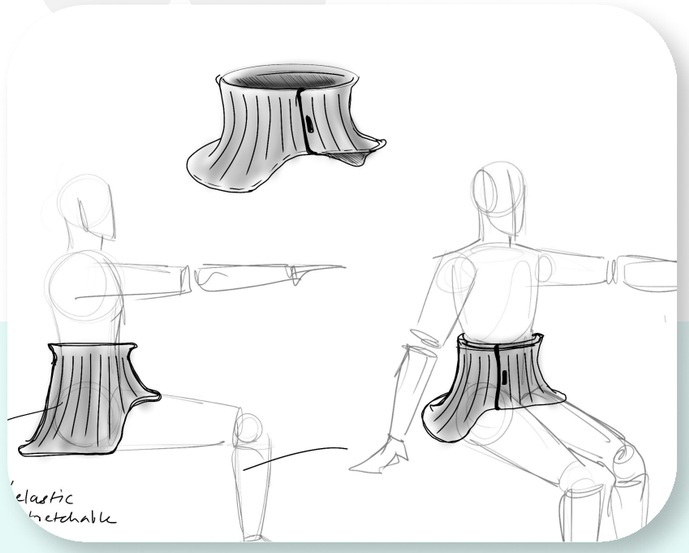


Prototypes 01

Pros

- Provides dynamic stablity
- 360 degree freedom
- Easy attach and detach
- Elastic

Cons

- Non portable
- Unstable legs
- Bulky product
- Need a strong stopper for the legs

Prototypes 01

Prototypes 02

Pros

- Portable
- Elastic
- Dynamic stability
- 360 degree freedom

Cons

- Elastic belt/ spring should be in stressed position
- Lower belt attachment is difficult for patient to access

Prototypes 03

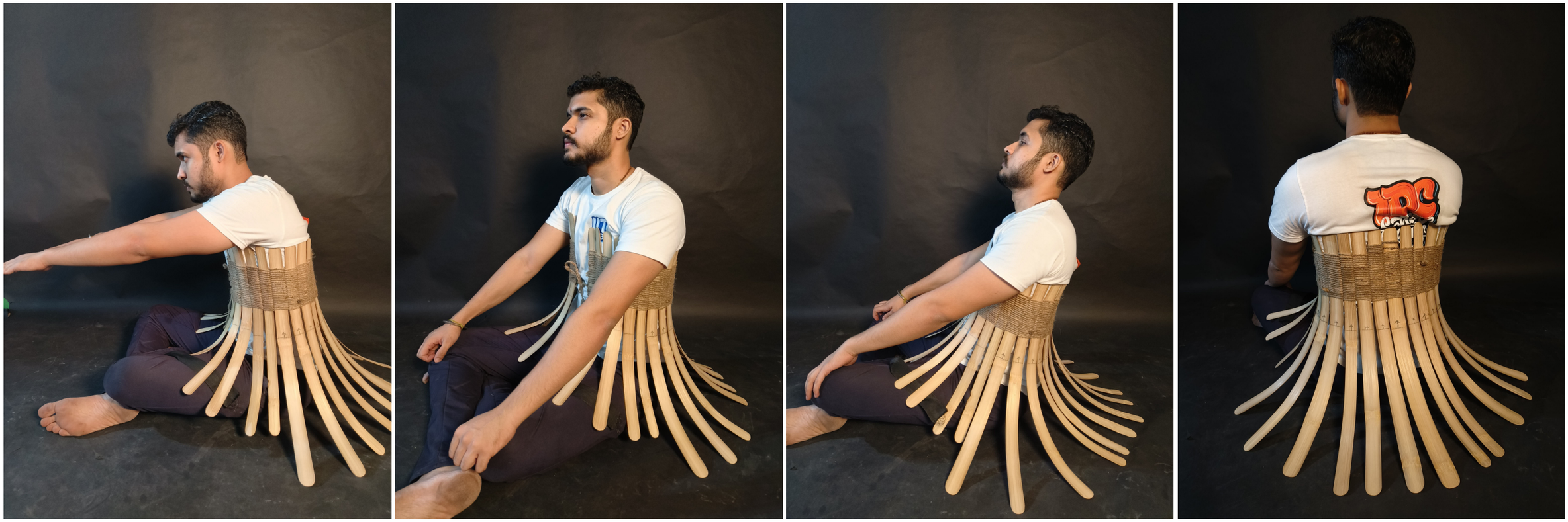
Pros

- Elastic
- Dynamic stability
- 360 degree freedom
- Easy Attach, Detach

Cons

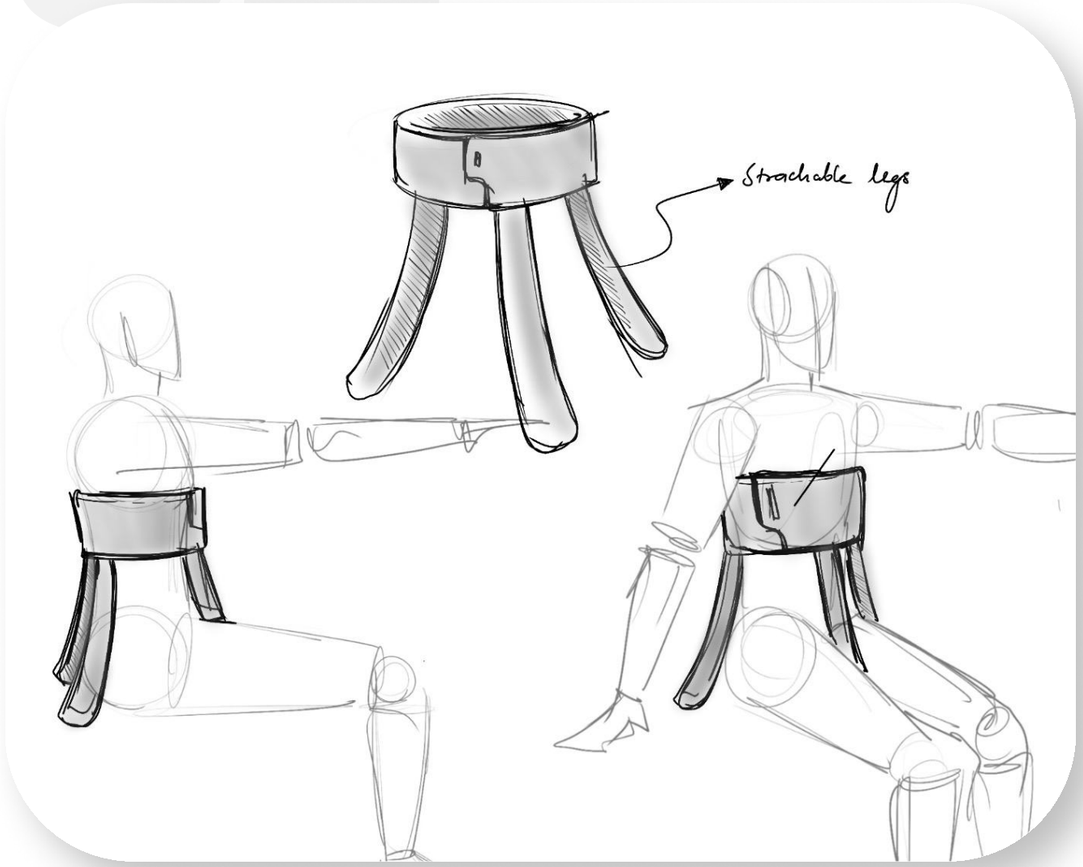
- Bulky
- Non portable
- Space consuming

Prototypes 03



Final concept

01



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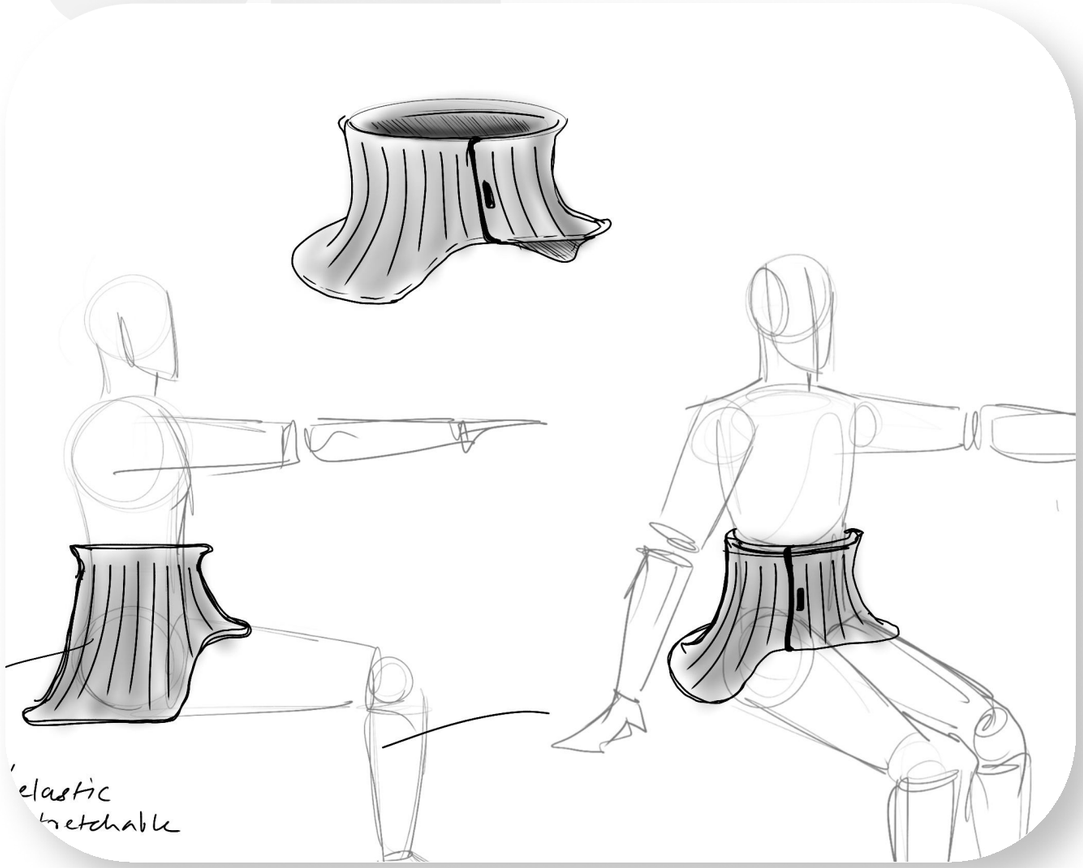
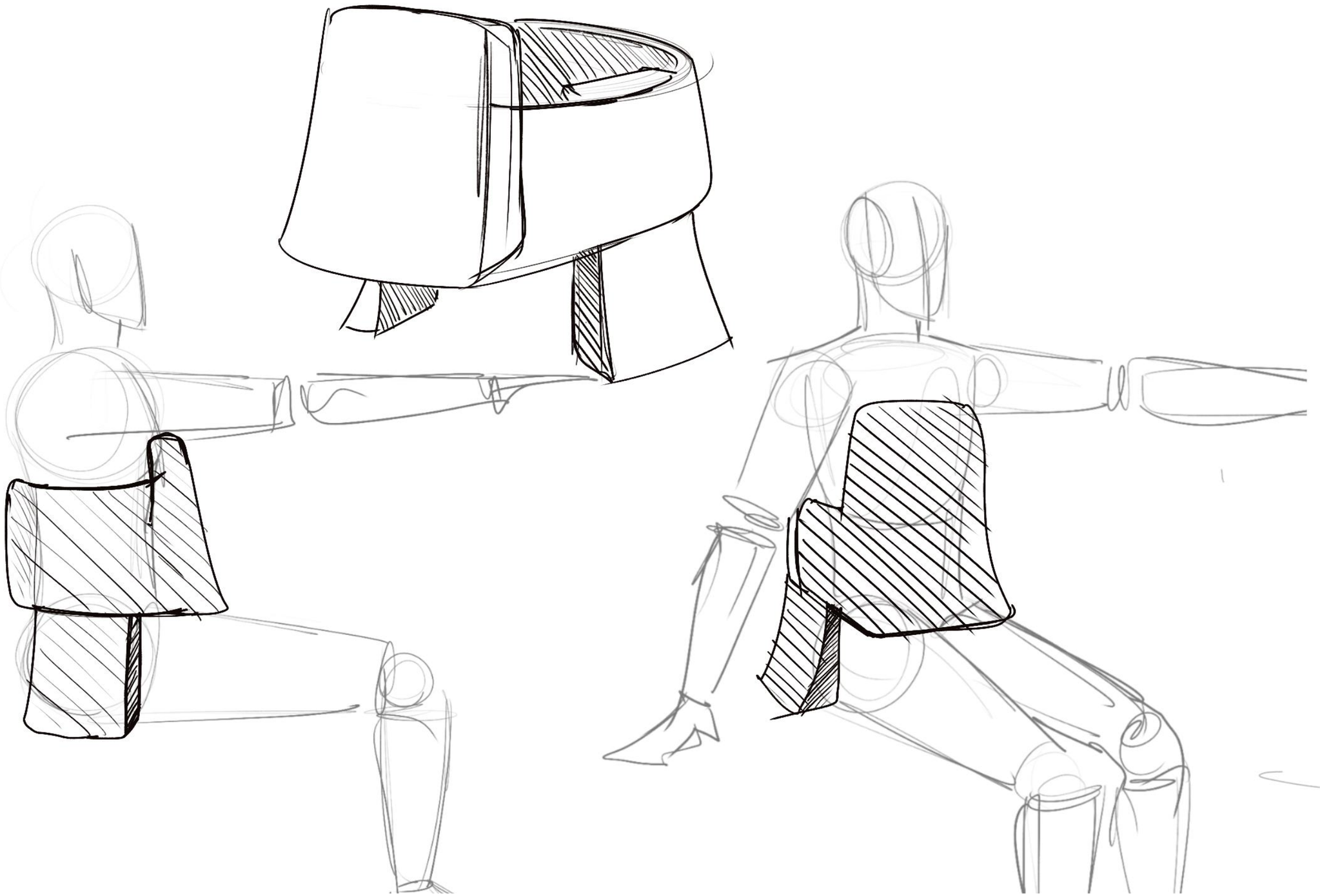


Final concept



Final Prototype

Pros

Cons

01

Final prototype

01

Final prototype

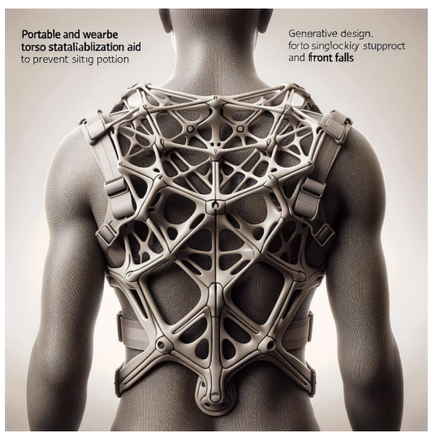
Final concept Renders

Final concept Renders

Future Scope

Explore

- Generative design
- Inflatable material
- Polyurithane
- Thermo Plastic Elastomer
- Exoskeleton



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Abhishek Khushwaha, Sukhadev Kumavat

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