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Methodological Article

The handstand: A four stage training model

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ABSTRACT

The handstand is considered as one of the most important fundamental skills in gymnastic, however currently available gymnastics textbooks and scientific literature fails to provide a systematic and practical approach to training this skill to a beginner with an advanced and progressional focus. The aim of this article is to provide coaches with a progressional model to teaching the handstand to beginner gymnast based on theoretical and contemporary skill training methods available in scientific and textbook literature. This was achieved through an examination of relevant research studies available through Medline, modern gymnastic textbooks/coaching manuals, and the author's personal knowledge and experience. The model presented suggests 4 stages of development/progression of the handstand, with a unique approach to refining the gymnast's proprioceptive and kinesthetic awareness for maintaining balance. It is also hypothesized that through improved proprioceptive and kinesthetic awareness the gymnast will be able to master dynamic handstand control much more effectively allowing for the improved learning of advanced gymnastics elements.

Key Words: Handstand training, progressional learning, balance, skill learning

INTRODUCTION

The handstand is often cited in gymnastics literature and by coaches as one of the most, if not the most important, skill to master for beginners and for higher-level gymnastics. The handstand is performed on five out of six apparatus used in both male and female artistic gymnastics, with the only exception being the vault. However, even on vault the gymnast should ideally pass through a handstand position at some point during the performance of any of the FIG Code of Points recognized vaults. The ideal technical execution of the handstand is vitally important for the optimized progression into more advanced skills (e.g. press to handstand, all vaults, swing to handstand, clear hip to handstand etc), which highlights the importance of mastering this skill early on. Even though the correct technical execution of the handstand is common knowledge amongst gymnastics coaches, the best progressions to teaching and developing the handstand are not as clear.

Currently available (personally to the author) scientific literature relevant to the training of the handstand has explored the strategies for maintaining balance in a handstand (1,2) the effects of vision on postural control (3,4,5), and the transfer of postural ability between stances (from standing to a handstand and vise versa) (6). Commonly available contemporary gymnastics textbooks often provide a relatively similar and simple approach to teaching the handstand, which is usually simple enough to successfully apply to recreational classes, but often not advanced or refined enough for the technical requirements of competitive gymnastics. Probably the best analysis of the handstand can be found in Gerald S. George's Biomechanics of Women's Gymnastics wherein he describes how to the correct body-line and the amplication on balance in the handstand. However he fails to describe a progressional approach to achieving the described features of the perfect handstand. Most full progressional approaches/methodologies are passed on between coaches at training workshops/clinics rather then literature or other media. Unfortunately this approach is effective in educating only the select few attendees of the methodology of the presenter. The aim of this article is to analyze the available literature and popular training methods on developing a handstand and in turn provide coaches with a progressional skeletal framework based on scientific and popular methods in order to teach a perfect handstand to a beginner gymnast.

METHODOLOGY

Some have suggested that the best way to learn the handstand is through a step-by-step approach (8), in coaching terms this is known as a progressional approach. The benefits of such an approach for young children are supported by the systems theory of motor development (7). The steps taken when teaching a motor skill can vary and it should be made clear that there isn't necessarily a single

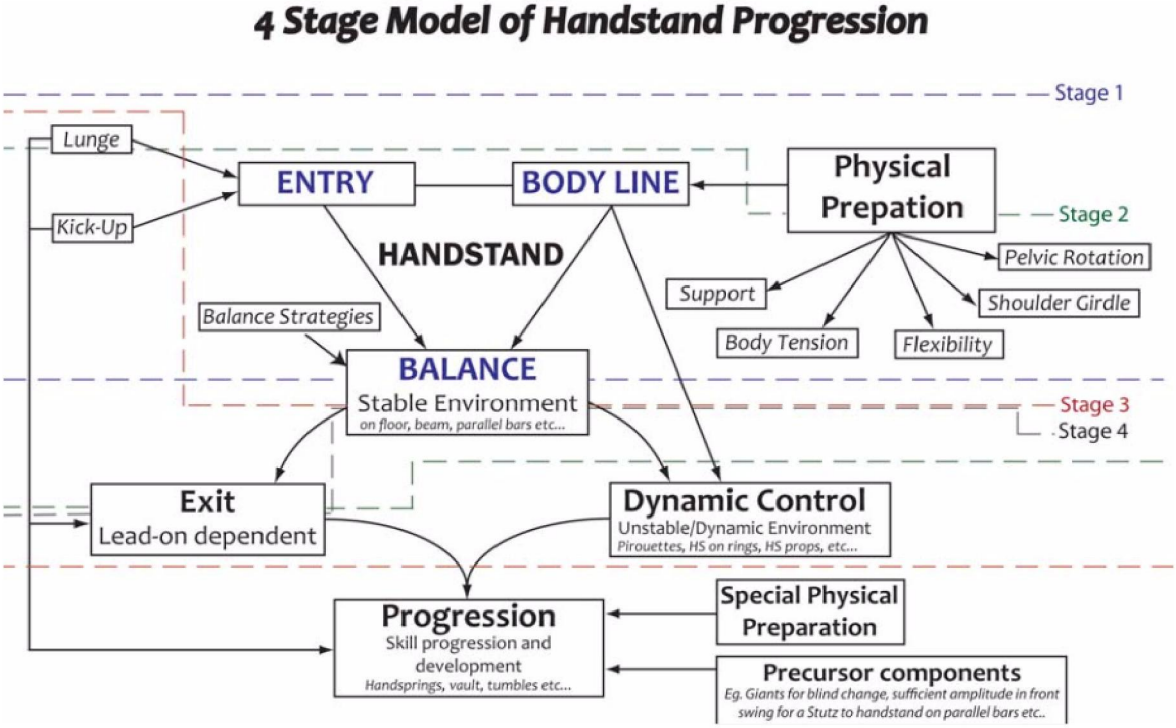


Figure 1 - *A diagrammatic representation of the four stage model for developing the handstand. Each stage is represented by the enclosed content between the corresponding colored lines.*

'best way' (8). What works for one child may or may not work for another. Hence, coaches that know a broad range of progressions, drills, and techniques are better equipped to cater for the individual strength's and weaknesses of gymnasts. However, it would be fair to say that there are various degrees of effectiveness between methods (12). The method presented in this article only considers the training and development of stages 1 and 2 out of the 4 stages of the model (Figure 1). Stages overlap to ensure continued progression, but each stage focuses on certain key aspects of the handstand development.

Stage 1 - In the first stage of learning the handstand, focus is directed to developing the gymnast's physical ability to be able to assume and maintain a straight *body line* (shape) (8), and the *entry* into the handstand (lunge/kick-up). The gymnast is introduced to the balance strategies and encouraged to practice them however at this stage balance is not a priority. represent

Stage 2 – In stage 2 *balance*, entry and *body-line* (the fundamental components of the 'handstand') are of equal important and the aim is to refine and develop mastery of each component. Alternative entries should be introduced, such as the press to handstand, tuck to handstand, handstand push-ups etc. Specific physical conditioning is overall reduced in volume, with a greater emphasis being placed on strengthening weaker areas and conditioning through more advanced compound exercises in preparation for advanced progressions. The exit out of the handstand is also introduced at this point. At this stage only the more basic exit forms should be introduces (e.g. step down, single leg Courbet action, front limber etc). Exit strategies will not be covered in this article as it is beyond the scope of this article's aims.

Stage 3 – During third stage, focus shifts from static balancing of the handstand to developing dynamic control of the handstand (pirouettes, on rings handstand trainers, single rails etc), as well as learning the more advanced handstand exits (the courbet, front walkover, front limber to stand, etc). Basic static balancing should continues to be trained regularly and on various stable surfaces. At this stage the gymnast should also start work on developing a more aggressive lunge entry into the handstand in preparation for handsprings and handstand propping onto higher surfaces.
Precursor components
eg. Giants for blind change, sufficient amplitude in front swing for a Stutz to handstand on parallel bars etc..

Stage 4 – By this stage of training the gymnast should have mastered the handstand statically and to have reached a proficient level of dynamical control. S/he is now ready to start learning more advanced skills such as going in, and out of the handstand (turns on the single rail, blind changes, complex turns like healy's, diamidov's, miller on beam etc). Specific physical preparation (drills, conditioning etc.) plays a critical role for the development of these advanced progressions, and thus such skills are often not solely only dependant on mastery of the handstand. Static handstand training is still trained and should always be a part of any training program at any level. Basics (learned during stages 1-3) can and should be revisited regularly.

Preparation of Stage 1

The first stage of teaching the handstand is based on preparing the body and mind of the performer to be able to recognize and assume the correct body position/shape. The key muscle groups and their related function with the

execution of handstand are described in Table 1 and Figure 2.

TABLE 1 - Agonist muscle groups and their actions associated with maintaining the correct handstand posture

Joint action/ Movement pattern	Muscle Groups	Related function in the performance of the handstand
Planter flexion	Gastrocnemius, Flexor digitorum longus, Flexor hallucis longus, Peroneus (fibularis) longus and brevis, Plantaris, Soleus, and Tibialis posterior	Toe point
Knee extension	Rectus femoris, Vastus medialis, Vastus lereralis, Vastus intermedius.	Maintaining straight legs, as well leg thrust from the lunge
Posterior pelvic tilt	Rectus abdominis (predominantly), Internal and External oblique abdominals, Transversus abdominis.	Flattening out of the lower back
Extended hips, with slight external hip rotation	Gluteus maximus, medius, and minimus	Open hips when combined with posterior pelvic tilt, and the kick-up.
Shoulder girdle abduction	Serratus anterior, Pectoralis minior	Round back.
Shoulder girdle elevation	Rhomboids, Trapezius, Levator Scapulae	Push through the shoulders, so there are no gaps between arms, shoulders and ears.
Slight cervical extension	Rectus Capitis posterior major and minor, Obliquus capitis superior, Spinalis capitis.	The slight tilt of the head so the gymnast can peek over his/her eye brows to spot the anchor point in-between the hands.
Wrist and finger flexion	Flexor carpi radialis, Palmaris longus, Flexor carpi ulnaris, Flexor digitorum superfacialis, Flexor digitorum profundus, Flexor pollicis longus	Employed during balance through the 'wrist strategy' (1,4,2)

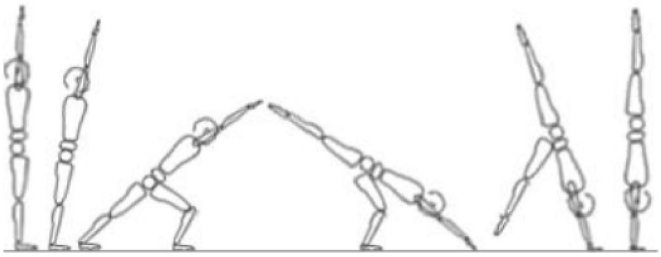


Figure 2 — *Diagrammatic representation of the lunge entry into a handstand. Coaches should not ice the fall prior to the lunge step and the fingers reaching for the floor*

There are 5 key areas of conditioning to the handstand development: the support, body shape (including tension), shoulder girdle, pelvic rotation, and flexibility (this is usually not a problem for young children and will therefore not be discussed in this article, but it is acknowledged that this could be a limitation). Figure 3 (page 4) illustrates the recommended exercises for each area of physical preparation during stage 1. Volume and constant shaping are the most critical training protocol parameters. Ideally the gymnast should aim to be able to sustain static positions for up to 15-30sec (30 preferably) before advancing to harder variations of the exercises, and to ensure a smoother transition into the next stage. Dynamic exercises like the press to pike stand should be done for multiple sets (at least 2-5 reps per set), with 5-10 repetitions per set. Once again volume is more important during the learning process, rather than intensity. Many of the exercises can be incorporated in pre-team and beginner gymnasts' regular conditioning program to ensure regular practice. Once proficiency is developed All exercises should be done with closed and open eyes when applicable and safe. Sets can be alternated so that 1 set is done with closed eyes 1 is with eyes open. This is believed to greatly improve the gymnast's proprioception and kinesthetic awareness.

Even though the kick-up and lunge thrust also require strengthening this is easily achieved at the beginning through the teaching process and does not require additional specific conditioning until stage 3. This article does not consider in detail the coming down, or exit from the handstand, because it is highly depended on the lead-on from the handstand (e.g. front limber, back walkover exit, cartwheel, basic step=down etc) and this aspect of the handstand training is not within the scope of the article. However, it is advised that at the beginning the gymnasts is taught to where the second leg (lunge leg) is the first to come down, with the gymnast passing through a scale balance and finishing in starting position. The reason the lunge entry is discussed in more detail even though there are many entry options is because:

1- It is the simplest technique to teach and master for a beginner.

2- It has developmental purposes.

3- It is usually the required technique in junior compulsory floor routines

4- It is a fundamental entry action for more advanced skills (aerials, handsprings etc). Progression from Stage 1 to Stage 2 is very much dependant on the gymnast's ability to demonstrate that he/she understands and is able to adopt the required body line.

Preparation of Stage 2

The second stage of the training model focuses on refining the gymnast's ability to balance, and maintain the correct body line. The two are closely related, however body line can be taught with the absence of balance. On the other hand balance is harder to obtain without proper alignment. The recommended training exercises during this stage are shown in figure 4 (page 5). These are but a few of the many possible exercises that can be used to refine and develop the handstand body line, and balance.. However the recommended exercises are selected based on their ease of application, spotting requirement, and skill transfer to other skills. Most of these exercises are

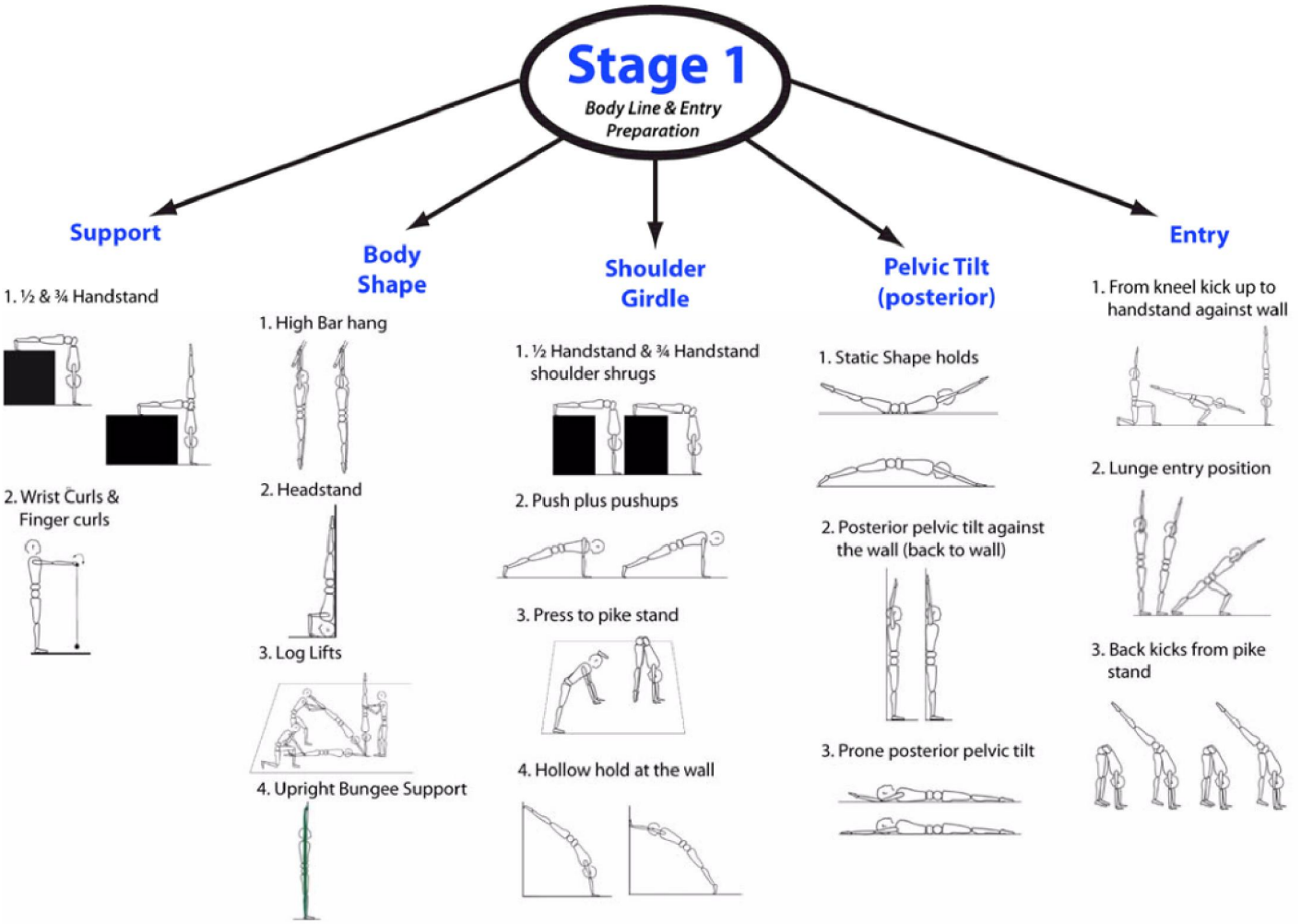


Figure 3 - *Illustrations of the recommended exercises for each specific area of physical preparation during stage 1 of the handstand development.*

preparatory basic movement patterns for more advanced handstand training and skills which will be required in stage 3 and 4 of the handstand development.

Consistency and regular practice is even more crucially vital at this stage than in stage 1. At this stage improvements come slower, and thus it is important to ensure that the volume and intensity is balanced, and varied throughout the training process. Its advised that coaches implement a handstand training program into their regular training/physical preparation, in order to provide the required constancy in training required to keep making gains and fast improvements.

Complex exercises such as the log falls and lifts should not be overdone. These exercises should be sufficiently demanding that low reps with multiple sets will be the training protocol of choice. Between 3-6 reps with 3-4 sets several times a week is the recommended volume. Holds at this stage should be done for approximately 30 seconds. Holds longer then 30sec is counter productive for the goals of gymnastics training. It is much more effective to do more sets with less time (due to increased intensity) than fewer sets for longer times. Form/technique is the best

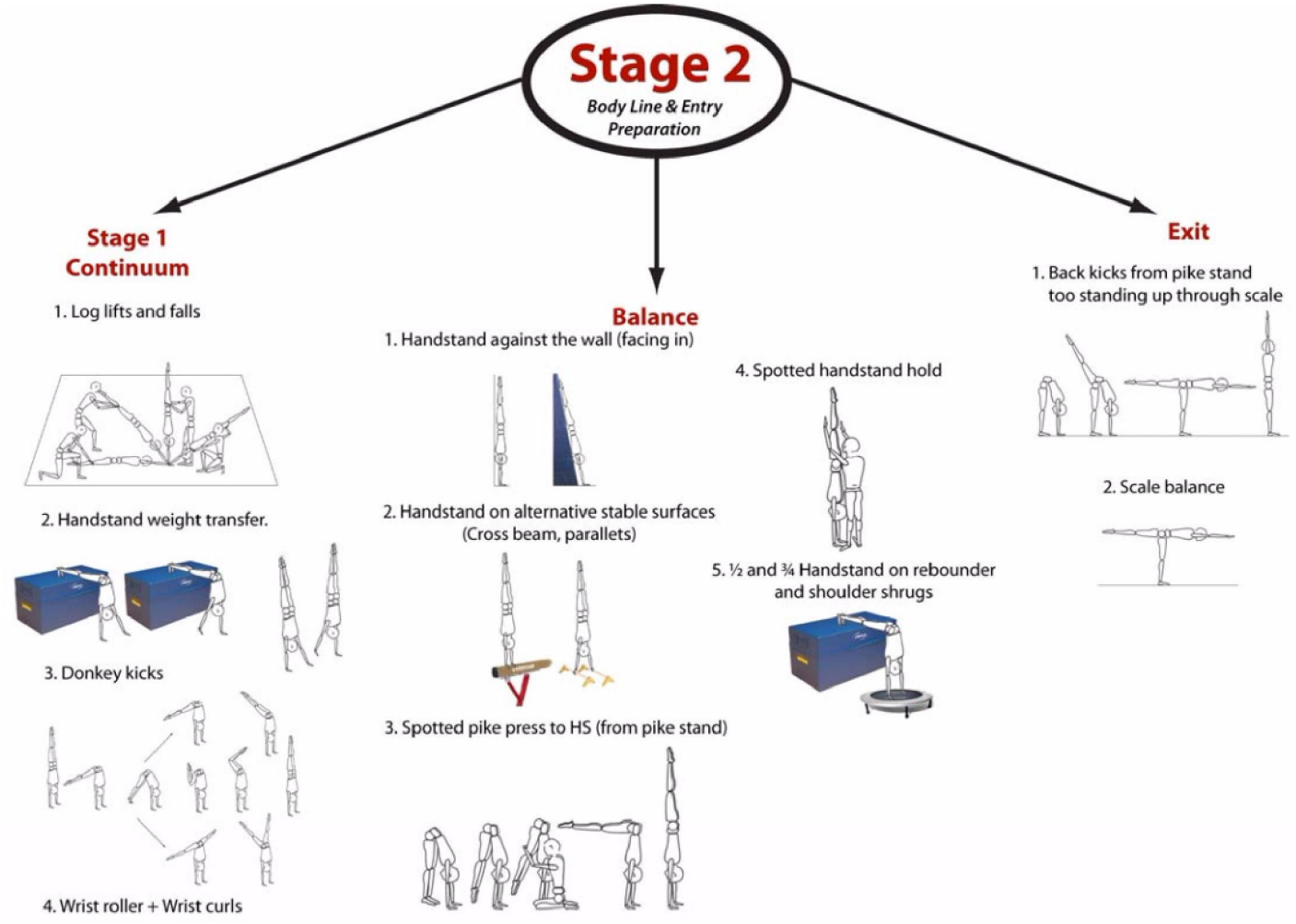
Figure 4 – *(next page) lustrations of the recommended exercises for each specific area of preparation and refinement during stage 2 of the handstand development (next page)*

gauge for when an exercise should stop. If the gymnast cannot maintain form, or the coach is doing as much or more work than the gymnast than the exercises should be stopped.

DISCUSSION

The four stage model presented in this article aims to provide a logical analysis of past and current methods presented in respected gymnastics literature and the author's personal experience teaching the handstand to a 5-6 year child (selected from a recreational/pre-school class to start competitive gymnastics after at least 2 x 9 week term classes). There is no direct research available that compares or suggests an ideal teaching styles/method

movement is a product of the cooperation of many subsystems in the body
– strength, balance, coordination etc
– motivation, attention etc (13).
When motor skills work as a system, separate abilities blend together, each cooperating with others to produce more effective ways of exploring and controlling the environment. This is particularly applicable to young children who tend to learn motor skills through progressional learning (12). With each stage the abilities developed will blend together to produce more effective results, as opposed to just learning the desired skill as whole (7). Each new progression must endeavor to provide:
(1) Central nervous system development
(2) Movement capabilities of the body
(3) Goals the child has in mind and that



he/she can accomplish
(4) Environmental supports for the skill

The 4 stage model presented in this article is based on the biomechanical and motor development applications of the dynamical systems theory, which is an area of applied mathematics used to describe the behavior of complex dynamical systems. The application of this theory to biomechanics and motor learning is that mastery of motor skills involves acquiring. increasingly complex systems of action. The individual represents the system, and

If progressions do not consider these elements to development, the pathway is less effective and the child will start to explore and select new, self selected motor patterns (7, 12), which may not be desirable from a gymnastics point of view. We often see the manifestations of this with kids developing poor habits (technical) early

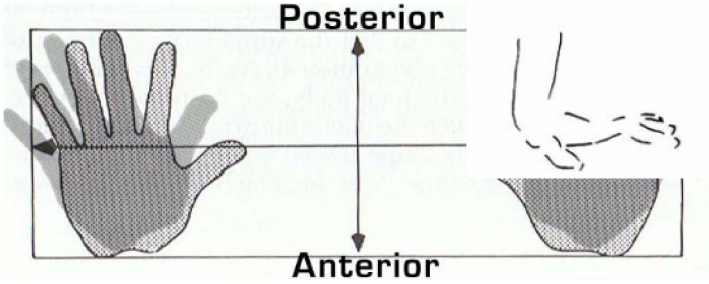
on, due to either accelerated progressions (rushing thought progressions), inappropriate progressions, or inadequate motivation for acquiring the skill. It must also be acknowledged that the coach's feedback and teaching style is also of vital importance to the speed of progression and the efficacy of any one method (12).

The development of the handstand can be compared to the learning process a baby goes through from learning how to crawl, to standing with help, to standing independently, especially because there are similarities between the upright stance and the handstand. Handstand is considered to be a much more demanding and difficult postural stance compared to our daily erect upright stance because the handstand has:

1. Smaller base of support (surface) (5).
2. Increased distance between the center of gravity (CoG) and the support surface (5)
3. The handstand requires unusual muscle activity from the upper limbs for a beginner (or anyone who has not trained hand balancing/inverted hand support). (5).
4. The function of the upper limbs muscles is more precise and less fatigue resistant than the lower limb function (5).
5. The anterior-posterior (forward and backward) deviations are greater (5).
6. The body configuration for the handstand requires specific postural control from four joints (wrists, elbows, shoulders, and hips) as opposed to three for bipedal stance (ankle, knees and hips) (5).

Balance requires a coordinated response by the central nervous system to information obtained through proprioceptive, visual, and vestibular feedback systems (2,3,5). Essentially, balance dependants on the gymnast maintaining his/her body weight over the base of support (hands), which is greatly regulated by the processed feedback from these sensory systems (8). Balance in the handstand is maintained through similar strategies as upright stance (2,3,5). In upright stance postural sway is managed through what is known as the ankle, knee and hip strategies (2). Depending on the circumstances: the greater the imbalance the more strategies are employed to try and restore balance (5). Balance in a handstand is controlled in much the same way, but through the wrists, elbows, shoulders, hip strategies (5). George (1980) coined the terms 'counter-balancing' and 'on-line balance' (Figure 5) to describe the most acceptable balancing methods in gymnastics (8). Counter-balancing requires the use of the wrists, shoulders, hips (sometimes in extreme cases elbows) to control large body sway motion, such as imbalances common on high bar and rings where the base of support is extremely small (8).

On-line balancing requires only the use of the wrists to control the constant small body oscillations during the handstand. This gives the illusion of perfect balance, and is the desired technique to master for modern gymnastics.



On-line balancing is particularly important for maintaining balance on the floor, beam, pommel, parallel bars while in a handstand (8). Body shape is a vital factor in achieving and maintaining balance. A close examination of the technically correct handstand highlights four key body configurations that aid the balance and integrity of the handstand position. These factors must be mastered for the performer to master the perfect body line, and optimize balance during the handstand (especially during on-line balancing):

Entry/Hand placement

A balanced handstand begins with the entry (14). When the gymnast reaches for the floor, s/he should do so with the fingers and not the 'heel' or the flat of the hand (14). By reaching with the fingers the gymnast is able to get his/her weight over the fingertips in the handstand thereby

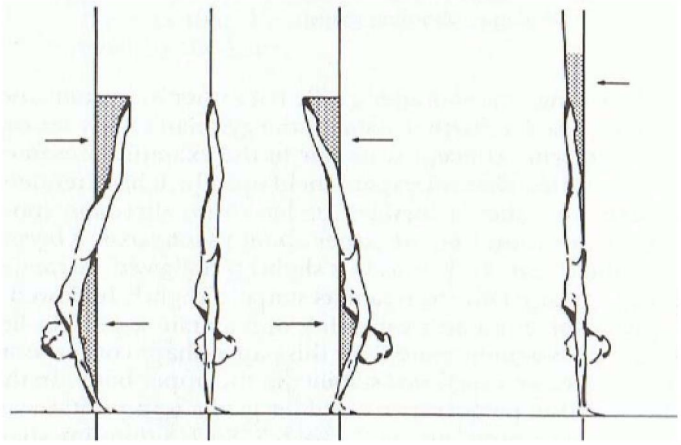


Figure 3 - *Diagrammatic representation of the counterbalancing technique (left) and on-line balancing as described by George (1980).*

finishing with his/her weight more towards the fingers and not the heel/palm. This is similar to the weight distribution though the ankles during the upright stance (14). In the handstand the fingers should be slightly flexed at the distal interphalangeal joint and proximal interphalangeal joint, with the fingers spread out as shown in Figure 6 and 7. This allows the gymnast to exert more pressure on the floor to counter balance during the posterior body tilt (falling over). When the gymnast is in the handstand it is important that the gymnast maintain his weight over his fingers and not on the palm since the anterior tilt (coming back down) is not easily counterbalanced without serious technical form errors (e.g. bending of the elbows, shoulder extension, hip flexion etc.).

Figure 4 & 7 - *The recommended hand placement positions during a handstand. (George, 1980) (above). The fingers should be slightly flexed at the distal interphalangeal joint and proximal interphalangeal joint (below)*

This method of entry also ensures that the arm-trunk angle (aka shoulder angle) is as close to 180deg as possible (coaches often refer to this as an open shoulder angle), thus allowing the body to pivot over the hands during the kick up and finishing in a position so that the rest of the body is directly over the hands. This has critical biomechanical advantages and technical carry over in the performance of skills like front handsprings, flysprings, handstand blocks etc. Sometimes lack of flexibility in the shoulder joint restricts this 'open shoulder angle' position, which effects the overall final position of the handstand, usually requiring the gymnast to adopt a less than perfect body alignment to achieve balance. Aside from improving the active and passive flexibility, often the gymnasts has his/ her hands turned inward which further exacerbates shoulder flexibility deficiencies and hinders the effective control of postural sway through the wrists. Simply by encouraging and educating the gymnast to slightly turn-out their hands so that the index finger points either directly forward or about 30deg off the vertical (posterior direction) there can be substantial improvements in position (Figure 6)

Hollow shape

Rounding the back or hollowing (aka chest in) is an important body configurational requirement that provides a stabilizing effect during the handstand. George (1980) compared this effect to the rounding of a plain piece of paper in order to balance it its side. (Figure 8). Hollowing (aka dishing) the gymnast essentially widens the base of support in the direction of the line of force (which should be posteriorly directed). This stabilizing effect is also important for a majority of handstand related skills (8).

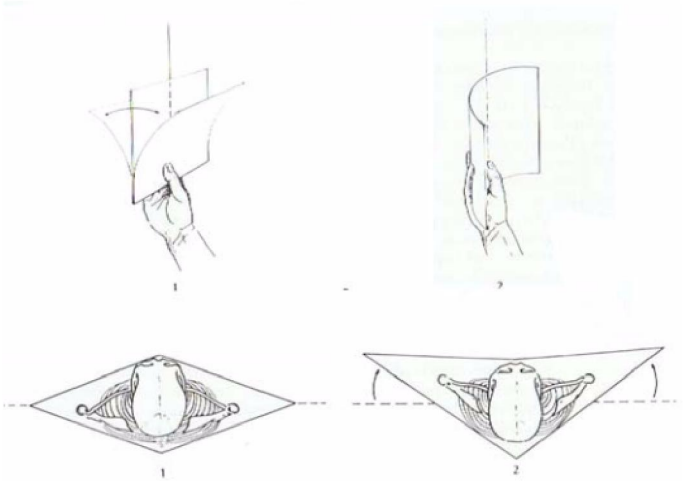


Figure 8 - *By abducting the shoulders and in essence hollowing, the gymnasts adopts a stronger more stable base of support. This is represented by the stabilizing effect of concaving a piece of paper to balance it on its side. Image taken from George (1980). Biomechanics of Women's Gymnastics*

Vision

Vision has been shown to play a very important role in the balance control of the handstand (3,4,5). A study by Gautier et al. (2007) concluded that vision can accounts for as much as 50% of the handstand regulation in comparison to other balance systems (proprioceptive and vestibular) (5). Vision plays a much more significant role in the handstand than in the upright stance because of the closer proximity of the visual target (floor) to the eyes during the handstand compared to upright stance (5). The gymnast should fixate his gaze about 5cm in front of the wrists in the space between the hands (3). This visual anchoring point is called the 'cliff edge', which has been show to help improve stability (5,15). Research shows that the ideal head position to optimize balance during the handstand is a slightly dorsiflexed position, known in gymnastics terms as a 'neutral' head position (4). This head position allows the gymnast to spot the closes visual target (the floor) without breaking his/her body line (8). Having a completely inline head is thus disadvantageous and not the recommended technique, even through it may have a greater aesthetic appeal.

Proprioception

In the upright stance the proprioceptive input has been shown to significantly affect postural sway (16). Based on this evidence it is hypothesized that the proprioceptive input from the wrists, arms, shoulders also play a significant role in balancing the handstand. To the author's best knowledge, the role of proprioceptive input on handstand balance has not yet been studied. The model presented in this article assumes this hypothesis to be true and considers balance training with open and closed eyes to be a highly effective training method for improving balance. The purpose behind visual sensory depravation is to force the gymnast's to rely on his/her kinesthetic awareness and proprioceptive inputs to try and maintain the handstand, without reply on vision and the sensory feedback it provides. Developing the gymnast proprioceptive feedback will allow the gymnast to identify and correct postural sway much more effectively. Developing greater proprioceptive and kinesthetic awareness is important in acquiring greater control during dynamic handstand work during the following stages of the training model.

CONCLUSIONS

The handstand is considered by most coaches as the corner stone to mastering the majority of the other skill on all apparatus. It thus stands to reason that a fair amount of time should be dedicated to the training of this skill at all levels of gymnastics. The handstand training method presented in this article divides the training of the handstand into 4 stages, which have common overlap in order to have a constant progression. The focus in this article is to define the first 2 stages of the handstand model, which help the gymnast learn body shaping and static balance.

The handstand is dependant on: entry, body shape, and balance. The entry is dependent on the overall skill, however at this stage a lunge entry is the most beneficial method to learning. The body shape is learned through

specific physical preparation involving a variety of exercise to strengthen the movement patterns involved in performing the handstand. The final stage to be trained is balance as it is largely dependent on the correct performance of the entry and body shape.

Essentially balance is a coordinate responses involving feedback from proprioceptive, visual, and vestibular feedback systems. In stage two of the model balance becomes a main focus. In order to optimize the learning of balance all 3 systems are trained, using correct body positioning, anchoring points, and visual depravation training.

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