# The Influence of Joint Laxity on the Development of Grasp on a Pencil

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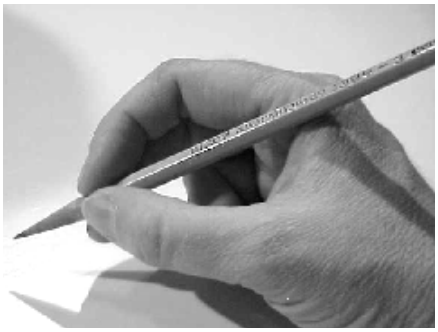
**Introduction:** The development of grasp patterns for graphomotor control in neurotypical development continues through age five to six. Tool use among children typically begins in the preschool years with the introduction of crayons, pencils, markers, and other graphomotor tools. There are many articles on the development of grasp, but the influence of joint laxity on grasp development is important for clinicians to understand. Joint laxity is common in the general population, and also is occasionally due to congenital disorders or injury. This article will look at joint laxity in the thumb interphalangeal joint, the thumb metacarpal phalangeal joint and the index distal interphalangeal joint. Atypical grasps on pencils appears to a recent phenomenon, and may be attributed to earlier tool use in children in the past 20 years due to an emphasis on educational readiness skills.

**Article:** In 1990, Bergmann found that in a study of 447 adults, 80 percent had a manipulative, tripod grasp pattern on pencils. Why then, is there is a prevalence of children who have non-manipulative grasp patterns on writing instruments? A generation ago, children entered kindergarten with some basic readiness skills, but there was not a significant emphasis on providing extensive readiness for kindergarten. The kindergarten curriculum was more developmental and provided a rich environment for students to develop fine motor skills. In current times when the kindergarten curriculum is more advanced and academic, fine motor skills need more emphasis during the preschool years, and there is an emphasis on tool use with preschoolers. It is important to understand the development of grasp in the preschool years and to recognize the influence of joint laxity on atypical grasp patterns.

The optimal grasp pattern for good manipulative skills has good separation between the two sides of the hand with the thumb, index and third fingers providing dynamic movement to control the tool, and the 4th and 5th fingers providing stability of the hand. Movement of the pencil requires the ability to isolate and grade individual finger and thumb movements (Case-Smith 1995). Separation between the two sides of the hand for

manipulative skills occurs around age four. Mary Benbow describes a grasp on a pencil using three components, radial manipulation, ulnar stabilization and finger excursion or "translation", (Benbow, M., 1990). These skills are reported to be associated with kinesthetic and tactile input (Benbow 1995). The child learns to use the thumb, index and third fingers within a tripod grasp, to manipulate objects (radial manipulation). Ulnar stabilization is the ability to stabilize the hand with the 4th and 5th fingers, while the thumb, index and third fingers manipulate objects. Finger excursion while using a writing instrument occurs around age 5 – 6, if a child uses a tripod grasp pattern. It involves dynamically moving the thumb, index and third fingers as a group to move forwards and backwards in the vertical plane, and sideways in the horizontal plane. To achieve finger excursion, a child must flex/extend the thumb, index and 3rd finger IP joints. Finger excursion is important to fluidity, and speed, and allows a child to write with less fatigue. The protocol of a functional grasp pattern as described by Benbow (1990, 1995) appear as follows:



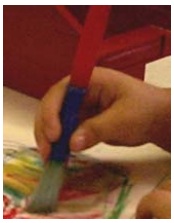
- 4th, 5th fingers tucked in palm (ulnar stabilization)
- Pencil should rest on the lateral (radial) edge of the index MCP joint
- Wrist slightly elevated to 30 degrees
- Prehension between index and thumb with support from medial edge of 3rd finger (radial manipulation)
- Rounding of the thumb web space
- Flexion of the thumb interphalangeal joint and the index and third PIP and DIP joints
- Wrist stability
- Forearm stability

McCleskey (2002, 2008) describes eight types of grasp patterns predominant in children and adults. The grasp patterns can further be described by Benbow's paradigm, as manipulative or non-manipulative.

Lateral grasp - a grasp pattern where the child uses the side of the thumb instead of the tip of the thumb to hold a pencil.

Pincer grasp - using the thumb and index finger for prehension, without assistance from the 3rd finger

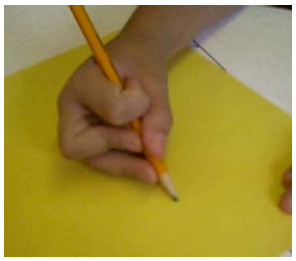
Modified Tripod grasp - using the correct fingers to hold a pencil (thumb, index and 3rd finger, but keeping the 3rd finger on top of the pencil). This grasp is normal in three year olds.



Hyperextension of the index finger - occurs when the distal joint in the index finger hyperextends or bends backwards. Usually the thumb is too far down on the pencil, and the hyperextension improves if the tip of the thumb is brought up even with the tip of the index finger. The hyperextension of the DIP in this picture appears significant, with stress to the joint and blanching of the skin due to pressure. Many students will complain of pain to the DIP joint with sustained writing when hyperextension is significant. Moving the thumb upwards on the shaft to be even with the index finger will reduce the hyperextension and reduce stress to the joint.

Multi-finger grasp - this grasp pattern is used to categorize any grasp pattern that uses more than the thumb, index and 3rd fingers to hold a pencil. There are numerous varieties of this grasp pattern, but all are considered non-manipulative grasp patterns.





Closed thumb web space - a child may have a correct grasp, but a closed web space. This is normal for young children who have short fingers, but by age 5, a child needs to make a circle with their thumb and index finger. A closed thumb web space does not allow a manipulative grasp, and the child should be encouraged to abduct the thumb to open the web space.

Hyperextension of the thumb interphalangeal joint (joint towards tip of thumb)) - usually caused by joint laxity. The thumb locks into extension, allowing no flexion. This prevents a manipulative grasp and often the child substitutes other grasp patterns in order to achieve stability.


There are also pencil grasps which may deviate from the above categories, that are non-manipulative. An example would be the grip shown below – it could be a tripod grasp

with three fingers on the pencil, but the hooking of the index finger would make this a non-manipulative grasp, with stress to the index PIP and MCP joints due to rotation.

Many grasp patterns may incorporate several grasp patterns. In the example below, the child is using a multi-grasp, with hooking of the index finger. Most importantly, the thumb IP joint is locked into extension. With locked extension of the IP joint or hyperextension (when there is joint laxity), a grasp cannot be manipulative. Optimal manipulation requires the ability to flex and extend the thumb IP joint. In the grasp pattern below, the child may attempt some manipulation of the pencil by moving the 4$^{th}$ finger to attempt dynamic control.

While many students may complain of fatigue during writing, few complain of pain during writing. When students do complain of pain, therapists should ask the student to localize the pain. The therapist should evaluate the dynamic control within grasp patterns, to determine if there is stress to a joint, joint laxity or a hand injury acquired through injury or congenital problems.

**Developmental Characteristics of Grasp Patterns:**

Fine motor skills are as important for kindergarten readiness as learning to say the ABC's and count. By understanding the development of grasp patterns, therapists, preschool teachers, parents and kindergarten teachers can prepare a child for writing. The developmental characteristics of grasp development are as follows:

- Forearm/wrist stability - developmentally comes about age 4 during coloring, with refinement around age 5.
- Tripod grasp - the child experiments with many grasp patterns prior to age 4. By age 3.5 to 4, therapists should be encouraging a tripod grasp on a pencil for all students. This is the window of opportunity where a child develops a kinesthetic awareness of a grasp on a pencil through practicing coloring and drawing.

Learning a correct grasp later is much more difficult than learning a correct grasp initially.

- Radial manipulation/ulnar stabilization – begins to develop around age 4 1/2, and becomes more refined around age 5 to 5 1/2. Manipulative grasp continues to develop, with additional increase in coordination for several years as finger excursion matures.
- Finger excursion – the ability to point and bend the IP joint of the thumb for dynamic control during writing or coloring may begin around age 5, but seems to refine around age 6 with coordination. Some children do not develop good finger excursion if they have a non-manipulative grasp.

**Chart of the development of dynamic control of graphomotor tools**

3.0 – 3.11 years

- Begins to show hand dominance, but hand switching continues
- Often begins to hold pencil with tripod grasp, but static posture (thumb and index, 3rd finger)
- Initiates coloring with shoulder movements to control graphomotor tools

4.0 – 4.11 years

- Begins to have some manipulative skills within a tripod grasp on a writing instrument
- Biomechanically begins to have an open web space on a tripod grasp due to increasing length of fingers/thumb due to growth.
- Initiates coloring with wrist extension/flexion to control graphomotor tools

5.0 – 5.11 years

- Preferred hand used more consistent
- Tripod grasp becomes more dynamic, more manipulative
- Initiates coloring with isolated finger movement (radial manipulation) to control graphomotor tools

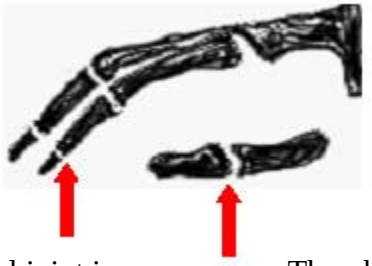
6.0 years

- Initiates coloring with finger excursion – dynamic control of the pencil with co-contraction of thumb IP flexion

**Reasons Why Poor Grasp Patterns Develop:**

As a child develops hand coordination, the intrinsic musculature in the hand strengthens. Children who enjoy drawing and coloring tend to develop strength in the hands and have good stability when holding a pencil. The reason for the development of a poor grasp pattern is often due to the child enjoying writing and coloring at an early age before the hand develops the coordination and proprioceptive awareness of a manipulative grasp. Other children who have little interest in fine motor skills, often are delayed in grasp development. Schneck (1991) found that children with immature grasping patterns and

poor handwriting had decreased kinesthetic awareness. Decreased kinesthetic finger awareness may contribute to a need for stability within grasp patterns. To hold a writing instrument, young children resort to stabilizing the pencil in many ways. If a child closes the web space tight and uses a lateral grasp pattern, more stability is given to the pencil. The child, who uses the 4th or 5th finger to help with prehension, achieves more stability with using the pencil. Squeezing the pencil with a variety of tight grasp patterns gives more stability. Unfortunately, stability does not produce fluidity. When radial manipulation and ulnar stabilization develop, a child is more able to stabilize the pencil with a tripod grasp due to better coordination. A young child can first be taught a tripod grasp, and then as development occurs, a child can learn to manipulate the pencil within the tripod grasp using radial manipulation and ulnar stabilization. Some children seek the proprioceptive feeling of stability by squeezing the pencil too hard. The child who has some hypotonia will usually compensate for weakness by using a more stabilizing grasp pattern. Children with joint laxity in finger joints also tend to use more stabilizing grasp patterns. Summers (2001) looked at the grasps of 55 7 y/o children to determine if joint laxity in the distal IP joint of the index and the IP joint and MCP of the thumb, influenced the development of grasps that deviated from the dynamic tripod. Laxity occurred in 71 % in at least 1 joint. The most common joint affected for joint laxity was the IP joint of the thumb with the index DIP joint being the second most commonly affected joint. The most common compensation for joint laxity in the thumb IP was the lateral grasp. Pencil grips incorporating thumb opposition were used more frequently when there was not joint laxity.



Distal interphalangeal joint in index finger (DIP joint)

Thumb interphalangeal joint

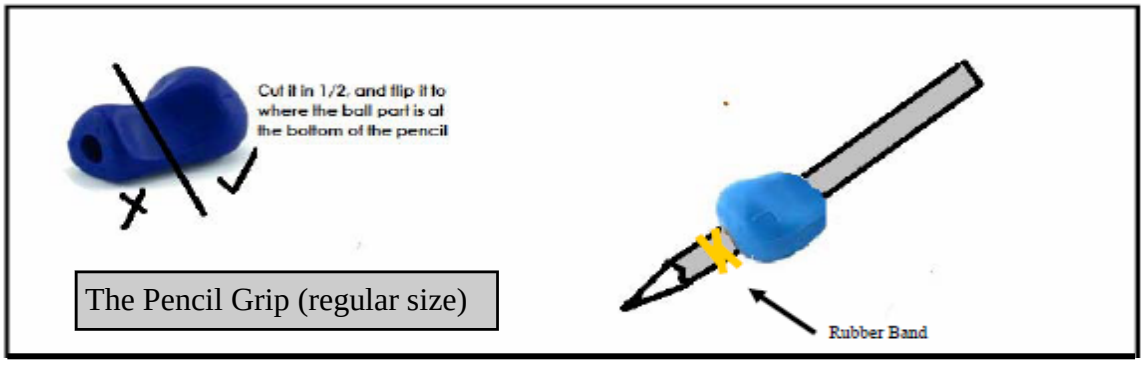
Stability through hyperextension of the thumb interphalangeal joint with locked extension should always be evaluated, and worked on through intervention. Stability with non-manipulative or poor-manipulative grasp patterns may help a young child hold a pencil to achieve the desire outcome of drawing or coloring. However, early stability may produce a habitual non-manipulative grasp pattern, even when the child develops more mature coordination skills.

The first thing to observe within any grasp pattern, is whether the student has joint laxity of the thumb IP joint, and see if it possibly may contribute to a non-manipulative grasp pattern. A young child will usually seek stability in a grasp pattern, which usually gets kinesthetically locked in (a bad habit), and the first and foremost treatment goal would be to teach the child how to co-contract and flex and extend the thumb IP joint during manipulative activities. With young children, it is important to start with using a tripod

grasp with some thumb flexion with tongs activities or writing tools. Once a therapist begins to observe the thumb IP joint of students when evaluating grasp patterns, the therapist will develop a keen sense of how often manipulation skills are affected when a student locks the thumb IP joint into extension.

Benbow 1995, Ziviani, 1982—observed that when joint stability in the thumb is insufficient to control mobility, a lateral grasp is an effective adaptation. A lateral grasp allows finger excursion in the vertical plane, but decreased excursion in the horizontal plane. Do we teach a lateral grip to allow students more mobility, or do we teach students with joint laxity in the thumb IP joint to compensate by developing the coordination to bend and extend the thumb IP joint, regardless of the joint laxity?

A good protocol is not to compensate for joint laxity by allowing maximum thumb flexion by teaching a lateral grasp as suggested by Benbow and Zivianni (Benbow 1995, Zivianni 1982), but to teach the child to flex and bend the thumb IP joint during manipulation of a pencil. Students can learn to co-contract this joint. In fact, often by passively allowing thumb IP flexion), students often can achieve a manipulative grip quickly. To get passive stability, McCleskey (2002, 2008) has developed a TIP grip protocol, to position the thumb in passive flexion, to prevent students from locking the thumb into extension or hyperextension. This allows the student to develop a more manipulative grasp. With practice, the student learns to co-contract and to develop the coordination to actively flex/extend this joint, and can usually progress off the grip. In treatment planning, the primary goal, is to use activities that train active co-contraction. The "TIP" grip, is basically a commercially available grip, called "The Pencil Grip". The Pencil Grip is cut in 1/2, flipped upside down, and placed on a pencil, with a rubber band approximately 1/4 in below the grip, and 1 inch above the pencil tip. Instead of calling this adapted version "the pencil grip flipped upside down, positioned on a pencil with a rubber band below the grip", The Handwriting Clinic calls this adapted version a TIP grip, for "Thumb IP joint", to biomechanically describe the positioning of the adapted The Pencil Grip.

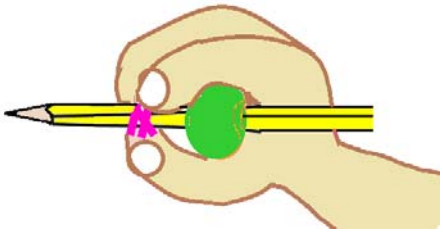



The Pencil Grip (regular size)

**Instructions for use of the TIP grip:**

Take the The Pencil Grip, and cut in half. Then position the more rounded end on a pencil with the rounded end towards the pencil tip. Discard the more triangular end, as it

is not used on the pencil. This would be upside down from the way The Pencil Grip is usually placed on a pencil, according to the manufacturers instructions. Place a rubber band 1/4 inch below the "TIP grip". When encouraging a student to hold a pencil or crayon adapted with the TIP grip, it is important that the student place the tip of the thumb on the rubber band, forming a tripod grasp. The pencil shaft should rest touching the index MCP joint, and the TIP grip should be positioned completely within the web space of the hand.



## VIDEO:

www.TheHandwritingClinic.com has a video of how to adapt The Pencil Grip to use as a therapeutic intervention for grasp development and promotion of co-contraction of the thumb IP joint.

The Pencil Grip company sells two sizes of The Pencil Grip - Jumbo or Regular. When using the adapted TIP grip on writing tools, students that are six and above usually use the jumbo size TIP grip on writing tools, and progress to the smaller TIP grip. The jumbo size tends to work best initially, as students age six and above tend to have longer fingers and a larger web space. Students then progress to the smaller TIP grip, then to a rubber band on the pencil only, and finally no rubber band on the pencil. Students that are younger than six, are still developing a manipulative grasp, and usually the protocol is for students to stay on the TIP grip through age 5 1/2 or 6. Young three and four year old children may have a static tripod grasp with the thumb nicely positioned in some flexion, but it is not until approximately age 5 or above, when students begin to dynamically control the tripod grip with isolated finger movement and active thumb flexion/extension of the thumb IP joint.

The hand develops in preschoolers through age 6, to develop fine motor readiness for graphomotor skills. For this reason, students in preschool - kindergarten are appropriate to work through fine motor development activities - ex. tongs, tweezers and coloring labs in order to develop radial manipulation/ulnar stabilization and finger excursion. Students who use fine motor lab activities such as tweezers and tongs, often achieve stability through locking the thumb IP joint into extension or hyperextension - particularly when they have joint laxity in this joint. For this reason, the TIP grip protocol suggests that young children should have their thumb IP joint passively flexed in order to develop co-contraction and the ability to flex/extend the IP joint during manipulation. A good way to work on developing manipulation within a tripod grasp, is to encourage tongs activities in preschool - kindergarten, using a tripod grasp. To additionally encourage thumb IP joint flexion, tongs may be adapted with the TIP grip. Below are pictures of how to adapt tongs using the TIP grip.

Students in preschool through K\kindergarten should participate in fine motor labs, to encourage radial manipulation and ulnar stabilization. The First Strokes® Sea Animal Grasp Kit is a complete kit for teaching coloring, tongs, and scissors labs encouraging a tripod grasp. It contains printable tongs labs and 196 blocks to encourage a tripod grasp on tongs. The therapist or instructor focuses on treatment planning to use ulnar stabilization and radial manipulation, by having the student place the 4th and 5th fingers into their palm and holding the tongs with a tripod grasp, with particular attention to flexing the thumb IP joint. The kit comes with a TIP grip for the tongs, or for a puncher to work on thumb IP joint flexion. It also contains printable coloring labs to encourage children to use thumb push ups/finger excursion when coloring, to promote isolated finger movement and the skill to change directions when coloring. Scissors skills to cut forward, curved and angled lines also promote separation of the two sides of the hand, for ulnar stabilization and radial manipulation. More information on the Sea Animal Kit can be found in the catalog at www.FirstStrokesHandwriting.com.

Creative therapists can develop therapeutic activities that will use tongs, graphomotor tools and scissors skills to promote good radial manipulation, and ulnar stabilization as children develop through the preschool years, and finger excursion with isolated finger movement through the kindergarten year. Older children, students with special needs, and even patients that are recovering from hand or neurological injuries may additionally benefit from using tongs, scissors and coloring labs. Graphomotor skills, refined fine motor skills requiring isolated finger movement, and separation of the two sides of the hand for stability and manipulation, are all occupational performance skills needed within activities of daily living. Using Mary Benbows paradigm of radial manipulation, ulnar stabilization, and finger excursion within therapeutic activities may promote increased tool use for graphomotor skills for a variety of treatment populations. Being cognizant of the effect of joint laxity and its possible effect of atypical stabilization within grasp

patterns, may help a therapist improve the development of therapeutic activities within treatment goals. Research tends to indicate that speed or legibility of handwriting does not appear to be influenced by grasp patterns. However, more research is needed to determine the effect of joint laxity, on stress to joints due to years of practicing atypical grasp, since the prevalence of atypical grasp patterns in school aged children appears to be a recent development since the 1990's. In the meantime, working with preschoolers and kindergarteners on typical grasp development, may empower the child with fine motor skills that may prevent pain in the future from atypical grasp patterns.

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NOTE: FULL CREDIT IS GIVEN TO THE PENCIL GRIP COMPANY FOR DEVELOPING AND NAMING THE PENCIL GRIP. THE TERM “TIP GRIP” REFERS TO THE ANATOMICAL POSITION OF THE GRIP ON THE THUMB IP JOINT, WHEN THE PENCIL GRIP IS ADAPTED FOR A THERAPEUTIC INTERVENTION.