T-GAP The Thumb Grasp and Pinch Assessment Administration and Scoring

Wendy Tomhave OTR/L
Occupational Therapist, Clinical Research
Shriners Healthcare for Children – Twin Cities

Kathleen Kollitz Jegapragasan, MD
Department of Orthopedic Surgery
Mayo Clinic, Rochester MN

Steven L. Moran, MD
Professor of Plastic Surgery and Orthopedic Surgery
Mayo Clinic, Rochester, MN
Agenda

• Background: Assessment of Thumb Hypoplasia
• T-GAP Standardization
• Administration
• Scoring
• Group photo and video scoring
• Questions
**Background: Normal thumb**

Congenital deficiency of the thumb greatly compromises hand function because the normal thumb contributes at least 40% of its usefulness. Vekris, Beris, Lykissas, Soucacos. Index finger pollicization in the treatment of the congenitally deficient thumb. *Ann Plast Surg. 2011*

The thumb is a specialized organ with unique functions that cannot be replicated by any other digit. Taghinia, Littler, Upton. Refinements in pollicization: a 30-year experience. *Plast Reconstr Surg 2012*
Background: Typically developing thumb

- Unique position of opposition at rest
- Saddle joint allows wide range of movement and rotation
**Background: Major developmental defects of the thumb**

- Constitute 16% of all birth deformities of the hand
- Frequently associated with partial or complete absence of the radius
- May present in isolation or as a component of a syndrome
- Bilateral involvement (62%)
- Absent or unstable thumb requires flexing or scissoring the fingers to stabilize an object
Our research focused on children who underwent index pollicization

- Absent or unstable CMC joint require thumb reconstruction
- Taking a mobile index finger to create an opposable thumb
Literature review: Outcomes to measure thumb function following index pollicization
Literature review: Outcome tools to measure dexterity

- Repetitive grasping of pegs or blocks
- Scores based on speed of performance
- Age matched normative data
- Allow any grasp pattern including no thumb use

9 Hole Peg Test

Functional Dexterity Test

Box and Blocks Test
Literature review: object handling assessments

• Several described; none were standardized
• Activities not age appropriate for young children
• All lacked a well-developed scale: Thumb use (Yes/No)
• Abnormal grasp patterns lacked standard terminology

Deviant grasp patterns

➢ Tricks moves
➢ Side to side pinch
➢ Modified manner
T-GAP: Thumb Grasp and Pinch Assessment
Hand Assessment Protocol 2005

• All patients with congenitally deficient thumbs were referred to OT for thumb function testing
• Included all standard outcome measures
• Object handling assessment (T-GAP)
• Became our standard of care for establishing baseline skills, progress and determining the effectiveness of surgeries and therapies
• Aided families in understanding their child's thumb function, concerns and progress over
A New, Direct Measure of Thumb Use in Children After Index Pollicization for Congenital Thumb Hypoplasia

Kathleen M. Kollitz, MD,* Wendy A. Tomhave, BA,† Ann E. Van Heest, MD,‡‡
Steven L. Moran, MD*†

**Purpose** After index pollicization for congenital thumb hypoplasia, time-based hand dexterity tests do not indicate whether the new thumb is being used by a child. The Thumb Grasp and Pinch assessment (T-GAP) is a new outcome measure that classifies grasp and pinch styles to quantify use of the new thumb. The goal of this study was to establish concurrent validity and construct validity in the T-GAP.

**Methods** Data from children treated with index finger pollicization for congenital thumb hypoplasia were retrospectively reviewed. Measures of strength, range of motion, and scores on the Box and Blocks Test (BBT), 9-Hole Peg Test (NHPT), Functional Dexterity Test (FDT), and Task 7 (Heavy Objects) from the Jebsen-Taylor Test (JTT7) were recorded. Patients also completed the T-GAP consisting of 9 age-appropriate tasks, during which grasp patterns were classified. Spearman correlation coefficients were calculated comparing the T-GAP score with scores on the BBT, NHPT, FDT, and JTT7.

**Results** We evaluated 21 thumbs in 21 children an average of 71.7 months after pollicization surgery (range, 9—175 months). The T-GAP score was significantly correlated with BBT, NHPT, FDT, and JTT7 (R = 0.69, −0.60,−0.59, and −0.60, respectively). The T-GAP score was significantly correlated with tripod pinch, key pinch, and grip strength (R = 0.77, 0.75, and 0.71, respectively) and with opposition and grasp span (R = 0.50 and 0.52, respectively). The T-GAP was the only functional measure correlated with parent and patient satisfaction with thumb function.

**Conclusions** Concurrent validity was supported by significant correlations between T-GAP score for all 4 dexterity measures. Construct validity was supported by significant correlations between strength and range of motion of the thumb and T-GAP score.

**Clinical relevance** This evaluation may help surgeons and therapists better understand results after pollicization and determine whether the new thumb is being incorporated into daily activities. (J Hand Surg Am. 2018;43(11):978—986. Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)

**Key words** Congenital thumb hypoplasia, dexterity measure, index pollicization, outcomes, thumb use.
Inter- and Intrarater Reliability of the Thumb Grasp and Pinch Assessment for Children Following Index Pollicization for Congenital Thumb Hypoplasia

Wendy A. Tomhave, BA,* Kathleen M. Kollitz, MD,† Steven L. Moran, MD*†

**Purpose** The Thumb Grasp and Pinch (T-GAP) assessment quantifies functional hand use in children with congenital thumb hypoplasia by categorizing grasp and thumb use patterns during assessment activities that encourage a variety of grasp and pinch styles. This study aims to demonstrate interrater and intrarater reliability results of the T-GAP.

**Methods** A retrospective review was performed of children who had undergone index finger pollicization for congenital thumb hypoplasia and subsequent evaluation with videotaping of the T-GAP assessment. Following a training period, 4 occupational therapists scored 11 T-GAP videos on 2 separate occasions, separated by at least 2 weeks. Intraclass correlation coefficients (ICCs), standard error of measurements, minimum detectable change (MDC), and Pearson correlation coefficients were calculated.

**Results** The T-GAP raw scores were 16 to 55, demonstrating a range of mild to severe hand grasp differences. The ICCs for the interrater reliability trials were 0.887 and 0.901. Intrarater ICCs were all above 0.88. The MDC for each trial was 8.1 and 6.7 points. Pearson correlation coefficients calculated for each rater and each pair of raters were above 0.8 in all cases.

**Conclusions** Interrater and intrarater reliability testing results for the T-GAP were excellent in all cases; this strongly suggests that results from T-GAP assessments are reliable. The high ICCs suggest that raters can classify and score children’s hand function consistently.

**Clinical relevance** This study, in conjunction with previous work, suggests that the T-GAP may be an ideal approach to assessing the outcomes of pollicization and provide a means of ongoing assessment of children’s grip and pinch function. (J Hand Surg Am. 2018; ■ (■):1.e1-e8. Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)

**Keywords** Assessment, dexterity, pollicization, reliability, thumb.
T-GAP Validation Summary

• Understanding typical and atypical grasp and thumb use patterns can potentially facilitate the choice of strategies:
  - in the therapeutic process
  - to determine the success of surgical treatment
  - to aid in future surgical decision making

• Additional validation studies are underway using the T-GAP with other patient populations:
  - Adult hand patients (Mayo Clinic)
  - Establishment of norms by age (Mayo Clinic)
  - Validity Studies (Oslo University Hospital, Norway)
T-GAP Thumb Grasp and Pinch assessment

- Standardized for children 18 months – 18 years
- Activities designed for three different age groups

Tip Pinch

18 months – Age 4

Ages 5 – 7

Ages 8 - 18
T-GAP Thumb Grasp and Pinch Assessment

• Includes nine activities to facilitate a variety of grasp styles and qualities

  - tip pinch
  - lateral key pinch
  - small grasp
  - medium grasp
  - large grasp
  - manipulation
  - resistance
  - school
  - activities of daily living
T-GAP 7 Point Hierarchical Scale

Grasp and Pinch Style Scoring

0   No Grasp, Passive Stabilization
1   Palmar Grasp, Finger Flexion; No Thumb Use
2   Ulnar Scissor Grasp; No Thumb Use
3   Radial Scissor Grasp; No thumb Use

4   Cylindrical Grasp; Thumb to Fingers
5   Lateral Key Pinch; Thumb to Index
6   Tip Pinch; Thumb to Finger Tip
7   Tripod Pinch; Thumb to Distal Index/Long
5-7 year old activities

• **Tip pinch** – put pennies into a bank
• **Lateral key pinch** – turn key to open padlock
• **Small grasp** – pull cap off marker
• **Medium grasp** – turn the end of a kaleidoscope
• **Large grasp** – open a jar of peanut butter
5-7 year old activities

• **Manipulation** – form a bowl out of play dough
• **Resistance** – pull back foam pull on sling shot
• **School** – color inside a circle
• **ADL** – tie shoelaces into a knot
**T-GAP Training**

**Review Test Kit Handouts:**
- Scoring and administration manual
- T-GAP administration and test kit items (3 age groups)
- T-GAP score forms (3 age groups)
- T-GAP activities chart by age and grasp style
- Two page scoring guide

**Review Grasp Style Examples**
- Group or individual rating of photo and video clips
T-GAP Scoring and interpretation

• 5-10 minutes to administer
• 9 activities are video recorded
• Scored subsequent viewing
• Final T-GAP score (range of 9-63 points)
• Higher score indicates a higher thumb opposition level
**T-GAP Rating**

- 10 minutes to score
- Identifies primary grasp style
- Multiple grasp styles
- Percentage of thumb use
- Monitor progress over time
- Compare pre- and post-operative function
Hierarchical scoring system based on principles of hand development

• Patterns of flexion to extension and abduction
• Ulnar to radial
• Palmar grips to distal grasp
• Refinement of intrinsic hand function
• Skillful distal finger control
• Complex rotation of objects within the hand
T-GAP Scoring

0  No Grasp or Pinch; Passive Stabilization of Hand
1  Palmar Grasp, Finger Flexion; No Thumb Use
2  Ulnar Scissor Grasp; No Thumb Use
3  Radial Scissor Grasp; No Thumb Use
4  Cylindrical Grasp; Thumb to Fingers
5  Lateral Key Pinch; Thumb to Index
6  Tip Pinch; Thumb to Finger Tip
7  Tripod Pinch; Thumb to Distal Index/Long
0 Points:
No grasp or pinch
Passive stabilization of hand
1 Point:
Palmar Grasp, Finger Flexion; No Thumb Use
All fingers flexed to palm
2 Points:
**Ulnar Scissor Grasp; No Thumb Use**
Scissors fingers between the small/ring finger
3 Points:
Radial Scissor Grasp; No Thumb Use
Scissors fingers between the index/long finger or long/ring finger
4 Points:
Cylindrical Grasp
Proximal grasp of all fingers to opposed thumb
5 Points:
Lateral Key Pinch
Thumb to side of index or index to side of thumb
6 Points:
 Tip Pinch
 Opposes thumb to side or tip of index finger
7 Points:
Tripod Pinch
Opposes thumb to distal index/long fingers
T-GAP Scoring for No Use of Thumb (0–3 points)

0 points = No grasp, passive stabilization
Passive stabilizing using fingertips or side of hand or task not observed

Variation Patterns on Right Side
(show alternate grasp patterns for each point value shown on the left)

1 point = Palmar Grasp, finger flexion
Finger flexion; all fingers to palm

Distal flexion of fingers=1 Point
Finger flexion without use of palm

2 points = Ulnar Scissor Grasp
Finger stabilization between small/ring. If 4 web spaces present (infrequently occurs), also between ring/long fingers

Scissors Multiple Fingers
Weaves objects and stabilizes between multiple fingers

3 points = Radial Scissor Grasp
Finger stabilization Between the index/long finger or long/ring finger

Distal Finger Scissoring
Distal pinch between non adjacent finger tips
T-GAP Scoring for Thumb Use (4–7 Points)

**Variations**

4 points = Cylindrical Grasp; thumb to all fingers
Opposed thumb with proximal grasp of all fingers

5 points = Lateral/Key Pinch
Opposes thumb to side of index finger

6 points = Tip Pinch
Opposes thumb to side or tip of index finger

7 Points = Radial Digital Grasp
Opposes thumb to index and long fingers

Distal cylindrical - 5 Points
Distal grasp of all fingers to opposed thumb

Lateral Cylinder – 5 Points
Encircling grasp of thumb and index finger

Tip to Non Index finger- 5 Points
Opposes thumb to tip of ring, long or small finger

Proximal Radial Digital Grasp – 6 Points
Supports objects proximally thumb/index/long fingers
Scoring Guidelines

• Score the most frequent pattern observed
• Two patterns equally used, score higher value
• Know what portion of the task you are scoring when you are videotaping
• Use the two-page scoring guide
• Variation patterns right side of page
### The Thumb Grasp and Pinch Assessment

**T-GAP Score form**

5 years – 7 years

<table>
<thead>
<tr>
<th>T-GAP Activity</th>
<th>LEFT (Score 0-7)</th>
<th>RIGHT (Score 0-7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick up 3 pennies one at a time and release into a piggy bank (tip pinch)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how penny is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn a key to open a 1-3/16” Master padlock (lateral key pinch)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how key is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull cap off a small diameter Crayola® marker (small grasp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how marker is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn end of kaleidoscope 3 times (medium grasp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how kaleidoscope is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twist cap from a 1 lb. peanut butter jar (large grasp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how jar is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form Play-Doh® into a bowl (manipulation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how Play-Doh is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull back foam pull on slingshot (resistance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how foam pull is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color inside a circle with a crayon (school)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how crayon is held</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tie shoelaces into a knot (ADL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score how laces are held</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Grasp and Pinch Style Scoring

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Grasp, Passive Stabilization</td>
</tr>
<tr>
<td>1</td>
<td>Palmar Grasp, Finger Flexion; No Thumb Use</td>
</tr>
<tr>
<td>2</td>
<td>Ulnar Scissor Grasp; No Thumb Use</td>
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<td>4</td>
<td>Cylindrical Grasp; Thumb to Fingers</td>
</tr>
<tr>
<td>5</td>
<td>Lateral Key Pinch; Thumb to Index</td>
</tr>
<tr>
<td>6</td>
<td>Tip Pinch; Thumb to Finger Tip</td>
</tr>
<tr>
<td>7</td>
<td>Tripod Pinch; Thumb to Distal Index/Long</td>
</tr>
</tbody>
</table>

### T-GAP Total Score

**Left Hand** _______/63
**Right Hand** _______/63

**Number of Grasp Styles: Points 1-7**

**Left Hand** _______
**Right Hand** _______

**Thumb Usage: Points 4-7**

**Left Hand** _______/9
**Right Hand** _______/9

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Shriners Healthcare for Children™ — Twin Cities
T-GAP test kit items and administration
**Videotaping and Set-up**

- Mobile tablet or handheld camera
- Tripod – tallest setting over child’s shoulder
- Record over child’s head or opposite shoulder to the hand you are evaluating
- Record each task in order as the admin and test kit form
- Have testing materials ready, off to the side
- Don’t allow too much time beyond what’s requested
- May need to switch hands to show tasks twice, using left and right hands
# T-GAP Administration and Test Kit Supplies

## Ages 18 Months - 4 Years

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Description</th>
<th>Score: How the item is held</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Film container and Cheerios</strong></td>
<td>Place the container and three Cheerios in front of the child. Ask the child to pick up each Cheerio and put it in the container.</td>
<td>How the Cheerio is held</td>
</tr>
<tr>
<td><strong>Metal tab zippered pencil pouch and markers</strong></td>
<td>Place two markers in the zippered pencil pouch. Ask the child to unzip the pouch and remove the markers.</td>
<td>How the zippered tab is held</td>
</tr>
<tr>
<td><strong>Large diameter Crayola® marker</strong></td>
<td>Ask the child to remove the cap from the marker then put the cap back on tightly and then remove the cap again.</td>
<td>How the marker is held</td>
</tr>
<tr>
<td><strong>Five Duplo® blocks stacked together</strong></td>
<td>Ask the child to pull the blocks apart and put them back together again.</td>
<td>How the blocks are held</td>
</tr>
<tr>
<td><strong>4-oz. bottle of bubbles with twist-off lid</strong></td>
<td>Ask the child to remove the lid and put the lid back on.</td>
<td>How the bottle is held</td>
</tr>
</tbody>
</table>
### T-GAP Administration and Test Kit Items
#### Ages 18 Months - 4 Years

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full-size container of Play-Doh®</strong></td>
<td>Demonstrate how to form the Play-Doh into a bowl. Form the dough into a ball and place it on the table. Ask the child to make a bowl. You can help start the shape if needed.</td>
</tr>
<tr>
<td><strong>Score</strong>: How the Play Doh® is held</td>
<td></td>
</tr>
<tr>
<td><strong>Medium-size fabric drawstring bag with rope laces</strong></td>
<td>Put Duplos® inside the bag and pull the drawstring to close the bag. Demonstrate how to use your hands to fully open the drawstring bag. Close the bag and ask the child to open the bag to see what is inside.</td>
</tr>
<tr>
<td><strong>Score</strong>: How the bag is held</td>
<td></td>
</tr>
<tr>
<td><strong>Box of 8 Crayola® crayons</strong></td>
<td>Place the box of crayons in front of the child. Ask the child to open the box and pull out his favorite color crayon. If you do not observe the grasp pattern, ask the child to pull out his second favorite color crayon.</td>
</tr>
<tr>
<td><strong>Score</strong>: How the crayon is held</td>
<td></td>
</tr>
<tr>
<td><strong>Child size sock</strong></td>
<td>Have the child sit in a chair or on the floor. Ask the child to remove one shoe and put the sock on.</td>
</tr>
<tr>
<td><strong>Score</strong>: How the sock is held open</td>
<td></td>
</tr>
</tbody>
</table>
### T-GAP Admin and Test Kit Supplies
#### Ages 5-7 Years

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sturdy medium size piggy bank and 3 pennies</td>
<td>Place the bank and three pennies in front of the child. Ask the child to pick up and put each penny into the piggy bank. Score: How the penny is held.</td>
</tr>
<tr>
<td>1 3/16” Master® padlock and vinyl-coated key</td>
<td>Demonstrate how to insert the key and turn it to open the padlock then demonstrate how to relock the padlock. Ask the child to unlock and lock the padlock two times. Score: How the key is held</td>
</tr>
<tr>
<td>Small diameter Crayola® marker</td>
<td>Place a marker in front of the child. Ask the child to pull off the cap then put the cap on tightly then pull the cap off again. Score: How the marker is held</td>
</tr>
<tr>
<td>Kaleidoscope standard size</td>
<td>Demonstrate how to use the kaleidoscope by holding it horizontally and looking through it while rotating the end. Ask the child to look through the kaleidoscope and turn the end three times. Score: How the kaleidoscope is held</td>
</tr>
<tr>
<td>Sealed 1 pound peanut butter jar</td>
<td>Place the peanut butter jar in front of the child and ask the child to take the cover off and put the cover back on. Score: How the jar is held</td>
</tr>
</tbody>
</table>
## T-GAP Administration and Test Kit Supplies
### Ages 5-7 Years

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Score: How the Item is Held</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full-size container of Play-Doh®</strong></td>
<td>Demonstrate how to form Play-Doh into a bowl, then form into a ball and place on the table. Ask the child to make a bowl. You can help start the shape if needed.</td>
<td></td>
</tr>
<tr>
<td><strong>Slingshot with foam pull</strong></td>
<td>Demonstrate how to hold the slingshot, grasp the round end of the pull and pull back with moderate force then release. Ask the child to do this sequence twice</td>
<td></td>
</tr>
<tr>
<td><strong>6” x 9” white drawing pad and a crayon</strong></td>
<td>Place a peanut butter jar on the paper and draw a circle around it with the crayon. Ask the child to color in the circle with the crayon.</td>
<td></td>
</tr>
<tr>
<td><strong>Child-size lace-up shoe with long, flat laces</strong></td>
<td>Place the shoe in front of the child and ask the child to tie a knot with the laces. You can show how to make a knot if needed.</td>
<td></td>
</tr>
</tbody>
</table>
**Plastic zip tie and 5 plastic beads**
Ask the child to thread the plastic beads onto the zip tie.

**Score**: How the bead is held

**Master® padlock and vinyl-coated key**
Demonstrate how to insert the key and turn it to open the padlock, then relock the padlock. Ask the child to unlock and lock the padlock two times.

**Score**: How the key is held

**Ballpoint pen with removable cover**
Ask the child to pull off the cap and put the cap back on tightly then pull the cap off again.

**Score**: How the pen is held

**6” x 9” sheet of drawing paper and a rubber band**
Make a large tube by rolling up the piece of paper and placing the rubber band around the middle. Ask the child to hold the tube and look through the end.

**Score**: How the paper tube is held

**Unopened 1-lb. peanut butter jar**
Ask the child to take the cover off and put the cover back on.

**Score**: How the jar is held
T-GAP Administration and Test Kit Supplies
Ages 8-18 Years

- **Handheld pencil sharpener and new no. 2 pencil**
  Ask child to sharpen the pencil. You must observe at least three rotations of the pencil in the sharpener.

  **Score:** How the pencil is held

- **Sling shot with foam pull**
  Demonstrate how to hold the slingshot upright, grasp the foam pull by the round end and pull back with moderate force, then release. Ask the child to demonstrate this sequence twice.

  **Score:** How the foam pull is held

- **6” x 9” drawing pad with a no. 2 sharpened pencil**
  Provide the child with an open drawing pad and sharpened no. 2 pencil. Ask the child to write his name on a piece of paper.

  **Score:** How the pencil is held

- **Child’s size lace-up shoe with long, flat laces**
  Place the shoe in front of the child and ask the child to tie the shoelaces into a bow. If needed, you can demonstrate how to tie the bow.

  **Score:** How the laces are held, not the ability to tie the laces
Photo and Video Examples

T-GAP Group Scoring Practice!