As edited by Dr. Oheneba Boachie-Adjei, Dr. Matthew Cunningham, Dr. John Kostuik, Dr. Raymund Woo and the Complex Spine Study Group et al
A fusion of DENALI® and MESA®, offering a complete array of unique screws, rod connectors, and hooks, coupled with exciting innovations in instrumentation, this comprehensive system is poised to address the entire range of complex spinal pathologies.

RANGE® Spinal System
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**Note:** Instrumented levels are based on Surgeon preference and patient pathology. This methodology manual is intended to be used as a guideline for correction techniques with the RANGE Spinal System.
Single Thoracic

Right T4-L1

Exposure and Preparation
Screw Placement
Concave Left Rod Placement
Countertorsion
Thoracic Concave Translation
Convex Right Rod Placement
Final Deformity Correction
LIV Horizontalization
Additional Surgical Considerations
**NOTE:** Instrumented levels are based on Surgeon preference and patient pathology. This methodology manual is intended to be used as a guideline for correction techniques with the RANGE Spinal System.

1. **Exposure and Preparation**
   Perform facetectomies throughout.

2. **Screw Placement**
   Use MESA® Polyaxial Screws at the most proximal levels (T4 and T5) for ease of rod attachment and establishment of the proximal foundation. Otherwise, use MESA Uni-Planar or MESA 360˚ Screws throughout the spine. Confirm the screw heads are unlocked and all screws are at appropriate levels and aligned to accept the rod when applied.

3. **Concave Left Rod Placement**
   Place Deformity Crickets™ on the concave side screws (3A). These will provide translation of screws and spine to the rod later. Pre-bend the rods in the physiological sagittal plane. For ease of rod insertion, place Deformity Crickets on only the upper half of the concave screws. After introducing rod, place Deformity Crickets over the lower half of the rod. Do not
tightly the Deformity Crickets, as they are only meant to ensure screw capture on the rod at this point. They will be used later for translation correction of the spine and reduction of the rods to the screws.

Rotate the rod into the sagittal plane (3B). This is preferably performed using the Rod Rotation Wrench and a Vise Grip. Seat the rod into the proximal fixation points T4 and T5 by tightening the Deformity Crickets (3C).

Continued on next page
Partially lock the T4 and T5 fixation points using the Superfly™ over the Deformity Crickets (3D). Fully lock the T4 and T5 fixation points with the Quick Locker to establish the proximal foundation of the deformity instrumentation (3E). The rod should be held in the physiological sagittal plane with the Rod Rotation Wrench or a Vise Grip.
Countertorsion
Apply Deformity Cricket Extenders on the concave side, and Manipulators to the convex apical screws to ease manipulation maneuvers during spinal vertebral derotation and translation (4A). The Manipulators on the convex screws aid in spine translation and partial derotation. During this maneuver, maintain countertorsion of the Lowest Instrumented Vertebra (LIV) to prevent en bloc rotation and coupling of the spine.
NOTE: When performing countertorsion, Transverse Couplers may be used on periapical vertebrae to facilitate rotational maneuvers (4B).
Thoracic Concave Translation
Translation of the concave thoracic apex to the rod is performed by gradually tightening the Deformity Crickets from either end sequentially with progression toward the apex of the deformity (5A). By performing the translation simultaneously with several Deformity Crickets, the chance of screw pull-out and loss of fixation is reduced. The rod should be held in the physiological sagittal plane with the Rod Rotation Wrench or a Vise Grip. Once all Deformity Crickets are maximally tightened, the rod will be captured in each of the screw heads.

Continued on next page
Partially lock all of the concave fixation points using the Superfly over the Deformity Crickets (5B). The Deformity Crickets may now be removed from the concave screws.

Unlock all convex apical screws whose manipulators have been applied.

**Convex Right Rod Placement**

Place Deformity Crickets on the convex screws. The convex rod is introduced using the technique similar to the concave/corrective rod (6A). The proximal fixation points, T4 and T5, are partially locked using the Superfly over the Deformity Crickets and the rod is checked for proper sagittal plane alignment. Next, fully lock the T4 and T5 screws using the Quick Locker.

The Deformity Crickets are then tightened sequentially to reduce the rod into the screws.

Continued on next page
The Superfly is used to create a partial lock of each of the convex rod fixation points (6B). If necessary, the rod contour may be adjusted using the Medial/Lateral or In-situ Benders.
Final Deformity Correction

The final deformity correction is now performed using a variety of compression/distraction and direct vertebral derotation (DVD) maneuvers. For compression/distractraction, begin proximal to the apex. Compress or distract against a screw that has been buttressed with a DC Ring or a Vise Grip (7A & 7B). Remove the applied DC Rings.

NOTE: The surgeon may also perform compression and/or distraction prior to partial locking by releasing the Deformity Cricket one to two turns to achieve final deformity correction. This method employs a similar technique to that of a standard set screw system.
LIV Horizontalization

Confirm horizontal position of the Lowest Instrumented Vertebra (LIV) and fully lock these fixation points using the Quick Locker. Repeat final locking of each screw with the Quick Locker to confirm rigid fixation throughout (8A). Transverse Connector(s) may be applied to the construct if indicated. Confirm at least 5 mm of rod length extends beyond the most proximal and distal screws.
Additional Surgical Considerations Include:

a. Do not attempt to forcefully derotate spine using the Deformity Crickets. The majority of the force should be applied to the Manipulators and rib hump on the convex side of the thoracic deformity, while simultaneously derotating the Deformity Crickets around the rod.

b. Screws are more resistant to plowing through the pedicle during compression/distraction maneuvers if the screw is moved caudally against the thicker bone of the caudal/foraminal aspect of the pedicle.

c. Optional: In-situ bending of rod(s):
   i. Beginning at curve apex, Medial/Lateral Benders may be used to segmentally correct the deformity.
   ii. Minimize focal bending around a single screw to reduce the risk of bone failure. Placing Medial/Lateral Benders around at least two screws is preferred.
   iii. The pear-shaped screwdriver handle can be placed between the pivot points of the Medial/Lateral Benders to improve leverage when bending across a long segment.

d. For rigid deformities consider coronal bending of the concave rod at the apex while the rod is partially locked. Maintain final rod position with the coronal benders and simultaneously apply the Quick Locker to finally lock the screws.
Double Major

T4-L3; Right Thoracic, Left Lumbar

Exposure and Preparation
Screw Placement
Concave Left Rod Placement
Coutertorsion
Thoracic Translation
Convex Right Rod Placement
Lumbar Concave Translation
Final Deformity Correction
LIV Horizontalization
Additional Surgical Considerations
**Exposure and Preparation**
Perform facetectomies throughout.

**Screw Placement**
Use MESA Polyaxial Screws at the most proximal levels (T4 and T5) for ease of rod attachment and establishment of the proximal foundation. Otherwise, use MESA Uni-Planar or MESA 360° Screws throughout the spine. Confirm the screw heads are unlocked and all screws are at appropriate levels aligned to accept the rod when applied.

**Concave Left Rod Placement**
Place Deformity Crickets on the concave side screws (3A). These will provide translation of screws and spine to the rod later. Pre-bend the rods in the physiological sagittal plane.

**NOTE:** Instrumented levels are based on Surgeon preference and patient pathology. This methodology manual is intended to be used as a guideline for correction techniques with the RANGE Spinal System.
For ease of rod insertion, place Deformity Crickets on only the upper half of the concave screws. After introducing rod, place Deformity Crickets over the lower half of the rod. Do not tighten the Deformity Crickets, as they are only meant to ensure screw capture on the rod at this point. They will be used later for translation correction of the spine and reduction of the rods to the screws. Rotate the rod into the sagittal plane (3B). This is preferably performed by using the Rod Rotation Wrench and a Vise Grip. Seat the rod into the proximal fixation points T4 and T5 by tightening the Deformity Crickets (3C).

Continued on next page
Partially lock the T4 and T5 fixation points using the Superfly over the Deformity Crickets (3D). Fully lock the T4 and T5 fixation points with the Quick Locker to establish the proximal foundation of the deformity instrumentation (3E). The rod should be held in the physiological sagittal plane with a Rod Rotation Wrench or a Vice Grip. Maintain rod sagittal alignment with the Rod Rotation Wrench.

**Countertorsion**
Apply the Deformity Crickets and Cricket Extenders to the periapical concave thoracic and convex lumbar screws. Apply the Manipulators to the periapical convex thoracic and concave lumbar screws. This will ease manipulation maneuvers during spinal vertebral derotation and translation (4A). Advance Deformity Crickets to make contact with rods prior to Direct Vertebral Derotation. Simultaneous convex and concave direct vertebral derotation or countertorsion is carried out (4B).

Continued on next page
NOTE: When performing countertorsion, Transverse Couplers may be used on periapical vertebrae to facilitate rotational maneuvers (4C).
Thoracic Translation
Translation of the concave thoracic and convex lumbar apices to the rod is performed gradually by tightening the Deformity Crickets from either end sequentially with progression toward the apex of the deformity (5A). By performing the translation simultaneously with several Deformity Crickets, the chance of screw pull-out and loss of fixation is reduced. The rod should be held in the physiological sagittal plane with the Rod Rotation Wrench or a Vise Grip. Once all of the Deformity Crickets are maximally tightened, the rod will be captured in each of the screw heads.
Partially lock all fixation points on the left rod using the Superfly over the Deformity Crickets (5B). The Deformity Crickets may now be removed from the left side. Unlock all apical screws whose Manipulators have been applied. Place Deformity Crickets on the right side.
Convex Right Rod Placement

The convex right rod is introduced using the technique similar to the concave/corrective rod (6A). The proximal fixation points, T4 and T5, are partially locked using the Superfly over the Deformity Crickets and the rod is checked for proper sagittal plane alignment (6B). Next, fully lock the T4 and T5 screws using the Quick Locker (6C).
Lumbar Concave Translation

The Deformity Crickets are then tightened sequentially to reduce the rod into the screw and the Superfly is used to create a partial lock of each of the convex rod fixation points (7A). If necessary, the rod contour may be adjusted using the Medial/Lateral or In-situ Benders.
**Final Deformity Correction**
The final deformity correction is now performed using a variety of compression/distraction and direct vertebral derotation (DVD) maneuvers. For compressions/distraction maneuvers, begin with compression of the convex lumbar apex to the Lowest Instrumented Vertebra (LIV). Next, begin compression of the convex thoracic apex. Finally, perform distraction on the concave lumbar apex to achieve horizontalization of the LIV. Compress or distract against a screw that has been buttressed with a DC Ring or a Vise Grip (8A & 8B). Remove the applied DC Rings.

**NOTE:** The surgeon may also perform compression and/or distraction prior to partial locking by releasing the Deformity Cricket one to two turns to achieve final deformity correction. This method employs a similar technique to that of a standard set screw system.
LIV Horizontalization
Confirm horizontal position of Lowest Instrumented Vertebra (LIV) and fully lock these fixation points using the Quick Locker. Repeat final locking of each screw with the Quick Locker to confirm rigid fixation throughout (9A). Transverse Connector(s) may be applied to the construct, if indicated. Confirm at least 5 mm of rod length extends beyond the most proximal and distal screws.
Additional Surgical Considerations Include:

a. Do not attempt to forcefully derotate spine using the Deformity Crickets. The majority of the force should be applied to the Manipulators and rib hump on the convex side of the thoracic deformity, while simultaneously derotating the Deformity Crickets around the rod.

b. Screws are more resistant to plowing through the pedicle during compression/distraction maneuvers if the screw is moved caudally against the thicker bone of the caudal/foraminal aspect of the pedicle.

c. Optional: In-situ bending of rod(s):
   i. Beginning at curve apex, Medial/Lateral Benders may be used to segmentally correct the deformity.
   ii. Minimize focal bending around a single screw to reduce the risk of bone failure. Placing Medial/Lateral Benders around at least two screws is preferred.
   iii. The pear-shaped screwdriver handle can be placed between the pivot points of the Medial/Lateral Benders to improve leverage when bending across a long segment.

d. For rigid deformities consider coronal bending of the concave rod at the apex while the rod is partially locked. Maintain final rod position with the coronal benders and simultaneously apply the Quick Locker to final lock the screws.
Thoracolumbar /Lumbar

- Exposure and Preparation
- Screw Placement
- Convex Left Rod Placement
- Countertorsion
- Concave Lumbar Translation
- Final Deformity Correction
- LIV Horizontalization
- Additional Surgical Considerations
NOTE: Instrumented levels are based on Surgeon preference and patient pathology. This methodology manual is intended to be used as a guideline for correction techniques with the RANGE Spinal System.

Exposure and Preparation
Perform facetectomies throughout.

Screw Placement
Use MESA Polyaxial, Uni-planar or MESA 360° Screws at all levels. Confirm the screw heads are unlocked and all screws are at appropriate levels and aligned to accept the rod when applied.

Convex Left Rod Placement
Place the Deformity Crickets bilaterally (3A). These will provide translation of the screws and spine to the rod later. Pre-bend the rods in the physiological sagittal plane.
Introduce the convex rod through the Deformity Crickets. Apply Cricket Extenders bilaterally. Do not tighten the Deformity Crickets as they are only meant to ensure screw capture at this point. They will be used later for translation correction of the spine and reduction of the rod to the screws.

Rotate the rod into the sagittal plane (3B). This is preferably performed by using the Rod Rotation Wrench and a Vise Grip. The Deformity Crickets are then tightened sequentially to reduce the rod into the screws (3C).

Countertorsion
Stabilize Upper Instrumented Vertebra (UIV) and Lowest Instrumented Vertebra (LIV) to prevent en bloc rotation and coupling of the spine. Derotate periapical screws around the rod by rotating concave and convex Cricket Extenders simultaneously.

Continued on next page
NOTE: When performing countertorsion, Transverse Couplers may be used on periapical vertebrae to facilitate rotational maneuvers (4A).
**Concave Lumbar Translation**

Introduce the concave rod through the Deformity Crickets (5A). Translation is performed gradually by tightening the concave side Deformity Crickets (5B). By performing the translation simultaneously with several Deformity Crickets, the chance of screw pull-out and loss of fixation is reduced. The rod should be held in the physiological sagittal plane with the Rod Rotation Wrench or a Vise Grip. Once all Deformity Crickets are maximally tightened, the rod will be captured in each of the screw heads.

The Superfly is used to create a partial lock of each of the fixation points (5C). If necessary, the rod contour may be adjusted using the Medial/Lateral or In-situ Benders.
Final Deformity Correction
Compression of the periapical convex lumbar screws is achieved prior to concave lumbar distraction. Compress or distract against a screw that has been buttressed with a DC Ring or Vise Grip. Remove the applied DC Rings (6A & 6B).

**NOTE:** The surgeon may also perform compression and/or distraction prior to partial locking by releasing the Deformity Crickets one or two turns to achieve final deformity correction. This method employs a similar technique to that of a standard set screw system.
LIV Horizontalization
Confirm horizontal position of the Lowest Instrumented Vertebra (LIV) and fully lock these fixation points using the Quick Locker. Repeat final locking of each screw with the Quick Locker to confirm rigid fixation throughout (7A). Transverse Connector(s) may be applied to the construct, if indicated. Confirm at least 5 mm of rod length extends beyond the most proximal and distal screws.
Additional Surgical Considerations Include:

a. Screws are more resistant to plowing through the pedicle during compression/distraction maneuvers if the screw is moved caudally against the thicker bone of the caudal/foraminal aspect of the pedicle.

b. Optional: In-situ bending of rod(s):
   i. Beginning at curve apex, Medial/Lateral Benders may be used to segmentally correct the deformity.
   ii. Minimize focal bending around a single screw to reduce the risk of bone failure. Placing Medial/Lateral Benders around at least two screws is preferred.
   iii. The pear-shaped screwdriver handle can be placed between the pivot points of the Medial/Lateral Benders to improve leverage when bending across a long segment.

c. For rigid deformities consider coronal bending of the concave rod at the apex while the rod is partially locked. Maintain final rod position with the coronal benders and simultaneously apply the Quick Locker to final lock the screws.
Kyphosis (T1-L3)

Scheuermann’s

- Initial Considerations
- Screw Placement
- Bilateral Rod Placement
- Bilateral Compression T1-T2 (Proximal Foundation)
- Sequential Bilateral Rod Introduction Into Deformity Crickets
- Segmental Compression Toward Apical Vertebra
- LIV Horizontalization
- Additional Surgical Considerations
**NOTE:** Instrumented levels are based on Surgeon preference and patient pathology. This methodology manual is intended to be used as a guideline for correction techniques with the RANGE Spinal System.

**Initial Considerations**
Perform wide facetectomies at all levels with excision of ligamentum flavum and multiple Ponte osteotomies symmetrically placed about the apex of the Kyphosis.

**Screw Placement**
Use MESA Polyaxial screws at the three most proximal levels (T1 to T3) for ease of rod attachment and establishment of the proximal foundation. Otherwise, use MESA Uni-Planar or MESA 360° Screws throughout the spine, particularly if scoliosis is also present. Confirm the screw heads are unlocked and all screws are at appropriate levels and aligned to accept the rod when applied.
Bilateral Rod Placement
Place Deformity Crickets bilaterally from T1 to T4. Introduce both rods utilizing the Deformity Crickets to seat the rods into the screw heads (3A).

Partially lock these fixation points using the Superfly over the Deformity Crickets (3B). Remove all applied Deformity Crickets. Fully lock the T1 fixation points bilaterally with the Quick Locker to establish the proximal foundation of the deformity instrumentation (3C).
Bilateral Compression T1-T2 (Proximal Foundation)
Segmentally compress the fully locked T1 and partially locked T2 screws bilaterally (4A).
Next, fully lock the T2 screws (4B). This sequence completes the proximal foundation of the reconstruction.
Sequential Bilateral Rod Introduction Into Deformity Crickets

Apply bilateral Deformity Crickets to the screws below T4 from proximal to distal to capture the rods (5A). Sequentially tighten the Deformity Crickets from proximal to distal with slow progression to translate the spine to the rod. This Deformity Cricket tightening and rod translation is completed gradually (5B). By performing the translation simultaneously with several Deformity Crickets, the chance of screw pull-out and loss of fixation is reduced.

Once a given Deformity Cricket is maximally tightened, the rod will be captured in that screw head, and can be partially locked with the Superfly (5C). After partial locking is completed of four vertebral body segments, the Deformity Crickets may be removed and placed on the more distal screws to facilitate rod translation of those fixation points.
Segmental Compression Toward Apical Vertebra

Fully lock apical screw with Quick Locker. Perform segmental periapical compression between fully locked screw and next partially locked screw (6A). Compress against a screw that has been buttressed with a DC Ring or Vise Grip. Work away from apex for maximum posterior vertebral shortening and closure of osteotomy sites. Remove the applied DC Rings.
Segmental Compression
Toward Apical Vertebrae
Fully lock apical screws with Quick Locker. Perform segmental periapical compression between a fully locked screw and the next partially locked screw (6A). Compress against a screw that has been buttressed with a DC Ring or Vise Grip. Work away from the apex for maximum posterior vertebral shortening and closure of osteotomy sites. Remove the applied DC Rings.
LIV Horizontalization
Confirm horizontal position of the Lowest Instrumented Vertebra (LIV) and fully lock these fixation points using the Quick Locker. Repeat final locking of each screw with the Quick Locker to confirm rigid fixation throughout (7A). Transverse Connector(s) may be applied to the construct if indicated. Confirm at least 5 mm of rod length extends beyond the most proximal and distal screws.
Additional Surgical Considerations Include:

a. For severe and rigid deformities consider the use of a transverse connector proximally prior to apical and distal rod cantilever translation. Also perform PSO or apical osteotomies to facilitate curve correction.

b. Selection of fusion levels should be the first lordotic lumbar level caudally, and T1 to T2 cephalad. Anterior release and interbody distraction is seldom necessary with newer posterior shortening techniques (Ponte or pedicle subtraction osteotomies). Implant selection should favor curve magnitude and flexibility.
GLOSSARY

IMPLANTS

MESA® POLYAXIAL SCREW

MESA® UNI-PLANAR SCREW

MESA® 360° SCREW

NATURAL BRIDGE® LP SEMI-ADJUSTABLE TRANSVERSE CONNECTORS

NATURAL BRIDGE® LP ADJUSTABLE TRANSVERSE CONNECTORS

5.5 mm RODS

Titanium Alloy

Cobalt Chrome: RANGE® Rigid Rod (R² Rod)
INSTRUMENTS

DEFORMITY CRICKET™
801-90066

CRICKET™ EXTENDER
801-90073

MANIPULATOR
801-90054

SUPERFLY™
801-90060

QUICK LOCKER
801-90008

ROD ROTATION WRENCH
101-90259

VISE GRIP
101-90157

ROD HOLDER
1801-90006

PROVISIONAL SCREWDRIVER HANDLE
101-90186

PROVISIONAL SCREWDRIVER SHAFT
101-90101
Glossary

Instruments

- Ratcheting Rod Cutter
  - 101-90194

- Telescoping Rod Cutter
  - 101-90277

- Rod Puller Plus
  - 801-90070

- Deformity Rod Benders
  - 101-90284

- Medial / Lateral Benders
  - 101-90229, 101-90230

- In-Situ Benders
  - 101-90217, 101-90218

- DC Ring
  - 101-90147

- Parallel Compressor
  - 801-90050

- Parallel Distractor
  - 801-90051

- Wedge Distractor
  - 801-90026
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DEFINITIONS

APICAL* – In a curve, the vertebra most deviated laterally from the vertical axis that passes through the patient’s sacrum.

DIRECT VERTEBRAL DEROTATION (DVD) – The application of forces along the transverse plane on individual vertebrae.

EN BLOC DEROTATION – Manipulation of several vertebrae in tandem via derotation maneuvers.

INFLEXION VERTEBRAE* – The localized vertebra where curves change direction from convex to concave and vise versa.

LOWEST INSTRUMENTED VERTEBRA (LIV) – The lowest level in a deformity reconstruction that receives an implant.

NEUTRAL VERTEBRA – The most cephalad vertebra below the apex of the major curve without rotation.

PERIAPICAL – The vertebrae forming the apex of the deformity. Usually forms the stiffest segment on bending and may be comprised of three or more vertebrae.

UPPER INSTRUMENTED VERTEBRA (UIV) – The uppermost level in a deformity reconstruction that receives an implant.

SEGMENTAL DEROTATION – Manipulation of individual vertebra via derotation maneuvers.

STABLE VERTEBRA – The most cephalad vertebra below the major curve which is most closely bisected by the Central Sacral Vertical Line (CSVL).

*From the SRS Glossary
MISSION
Advancement of medical science and patient care through collaborative, evidence-based research to enhance treatment of complex spinal pathologies.