Implant Failure of Posterior Lower Spinal Instrumentation

(A clinical & surgical Challenge)

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The purpose of this study

• To highlight the topic of implant failure
• To study the causes of failure and its prevention
• To enhance the radiological differences between successful and failed cases (markers of failure) indicating the sources of error and assessing the implant status
Over the last two decades

Pedicle screws in spinal stabilization has dramatically increased
Despite its advantages

It is associated with risks of screw/rod breakage and/or screw/rod disconnection.

Which can necessitate additional surgical procedures to achieve spinal fusion.

ALL THESE ARE RELATIVE?!
Radiological Failure analysis

1. Manifestations of failure: loose screws, loose rods, rod-screw disconnection, rod fracture, and/or screw fracture;
2. The effect of implant failure;
3. The point of instrumentation failure;
4. Screw axis, screw length & diameter, rod length & diameter, and rod contouring;
5. The radiographs of the failed cases were interpreted in comparison to the successful cases.
We found that

Most of the failures (90%) occurred within 6 months after surgery, with small number (10%) in the following 6 months (usually coinciding with some form of trauma), with no reported cases after 1 year postoperative.

? FUSION ?
We found that

All forms of implant failure were more common in patients with multilevel fusions.
We found that

The commonest form fracture screw (34%), followed by rod fracture (24%), rod loosening (22%), then the least form, loose screw (16%)
Our data showed

The screw fracture (most common failure), most of them in cases of traumatic instability with anterior column defects

Defects more than 50% collapse of the anterior vertebral body height was more frequent in the failure group trauma cases
Our data showed

The most common in mechanical failure clinically is at the lower screw
Our data showed

The loose screw (least form of failure),
most of them in degenerative instability &
rest in iatrogenic instability
Our data showed

• Autograft (laminectomy augmented by bone strips from the iliac crest) was the routine procedure in 90% of cases of the control group, with 10% of cases having anterior interbody fusion

• Posterolateral fusion alone, using only the autograft obtained from laminectomy, allografts, and/or synthetic bone was the rule in the majority (80%) of cases of the failure group, with 20% of the cases having no bony fusion whatsoever
Another important finding in this study

The addition of supplemental fixation sites was a criterion of many cases of the control group:

• use of a metal crosslink,
• addition of two more screws at the pathology level or extra level, especially in junctional zones,
• or anterior interbody fusion with cages
What is going on?
Failures are not unavoidable complications or ongoing degeneration

• In a properly performed fusion
• In the right patient
• For the right diagnosis
• By the right surgeon !!!!!?
Failure After Spinal Fusions.. WHY ??

The 3 Ws

1. The wrong patient
2. The wrong diagnosis
3. The wrong surgeon
The wrong patient?

- A patient chosen for fixation with an underlying pathology that will not benefit from the procedure
"The Patient Comes First"

William James Mayo, M.D. (1861-1911)

Consider all the time that you are at a time...
The Patient
The wrong diagnosis?

- Misdiagnosis
- Inadequate preoperative studies
- Poor choice of surgical technique
The wrong surgeon?

FDA Final Rule

should be performed only by experienced spinal surgeons with specific training
Hidden agendas play an important role in influencing medical care in general.
Objective of lumbar spine stabilization is to stop the motion at a painful segment in the spine.
The ultimate success of a spinal fusion rests on whether the fusion heals solidly in the desired position with NO PSEUDOARTHROSIS.
Pseudarthrosis
(failure of successful spinal fusion)

Implant Failure
The instrumentation (pedicle screws and rods) loosen and move from their original positions or even break.
Fusion (Arthrodesis) = bone graft
Stabilization = instrument (implants)

Instrumentation is used to assist in obtaining a solid fusion
BIOMECHANICS OF CONSTRUCT FAILURE

- Failure of the Implant
- Failure of the Implant–Bone Interface
- Failure of Bone–Bone Interface
Failure of the Implant

The point of failure (At points of maximum stress)

1. usually at the screw–plate/rod junction
2. between the tip of the screw and the plate/rod
Moreover,

Using a spinal fixation device may induce stress shielding in the vertebral body.
Similar to screws

Plates/rods break at the point at which maximum stress is applied
Important to know

REGARDING:
The maximum stresses in the rod & screws

- The rod diameter is the most important factor
- The maximum stress values decreases as the diameters increases
- The axial compressive force increases as the rod diameter increases.
- The stress levels in the distal screw are always higher than those in the proximal screw
Both anterior and posterior surgery will be required when the objectives of surgery cannot be achieved with a single approach. When:

- complete burst fractures
- anterior defect
- gross residual anterior compression
In instability at the lumbosacral junction

The bending moments on the implant may result in implant failure.

In this situation interbody anterior column structural support should be considered.
Posterior pedicle screw fixation systems require two level stabilization for single level burst injuries, but single level stabilization may be adequate for fracture dislocations.
Anterior column reconstruction

1. at the thoracolumbar junction after a burst fracture & at the sacroiliac junction.

2. The absence of satisfactory anterior stabilizing devices
Also important

Long rigid multisegmental fixation constructs tend to load the more caudal screws far more than the rostral screws.

**THUS**

the use of a shorter length implant, may decrease the risk of caudal construct failure.
Failure of the Implant–Bone Interface

The surgeon should attempt to distribute loads such that no single portion of the implant or spine carries an excessive portion of the load

By

1. improving the integrity of the existing implant–bone interfaces,
2. providing additional implant–bone interfaces, improving the integrity of the bone, and
3. by normalizing the geometry
Screw pullout

Pullout is mainly a function of the volume of bone between the threads.

Pullout resistance is proportional not only to the volume of bone between screw threads but also to the triangular area defined by the screw.

Thus:

Triangulation of pedicle screws provides additional resistance to pullout.
Rod Placement

It is important to secure the rod with the rod holder while tightening the locking nut to prevent unnecessary torque on the adjoining bone/screw interfaces.
Rod Loosening
To Conclude

The spine is a dynamic structure and the optimal treatment for complex spinal conditions remains a challenge.