further simplify use and expand indications. Combination plates allowing conventional screws to be combined with locked screws in the same plate followed shortly thereafter. This strategy facilitated bicortical locked fixation and has improved the ability of locked periarticular plates to function as aids to reduction. Variable angled locked plates have been developed by most manufacturers to allow the surgeon more control over implant positioning. These implants are useful in the setting of altered anatomy: osteotomy fixation, periprosthetic fractures and non-union surgery.

More and more in the United States it is hard to find implants that are not angular stable. Percutaneous and bridging techniques are applied to all fractures, many times at the expense of articular reduction, for expediency. Non-unions associated with locked plating occur, but the specific incidence is unknown and related information is largely anecdotal. Though the original impetus for the design of these implants was periosteal preservation, this has been largely forgotten in the quest for ever stronger fixation, as a result we may be birthing an entire new generation of oligotrophic non-unions which are harder to treat than their typically hypertrophic ancestors who were associated with conventional plates.

At this time, the primary indication for angular stable plate fixation is the stabilization of fractures in the setting of compromised bone where physiological loads during rehabilitation are in excess of those which can be resisted by conventional plates. The future is angular stable fixation of the articular surface combined with implants that will allow for controlled dynamization.

4:11 – 4:16 pm

Principles/Indications for Locking Plates for the Axial Skeleton
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I. Introduction
Plate evolution in the treatment of spinal disorders has occurred in response to complications, and with the hope of finding long-lasting solutions. With the introduction and acceptance of each new style of fixation, one problem is solved while another is introduced. The concept of locking technology is not new to spine surgery, and is intermediate in the development of today’s most common implants. We’ll discuss the progressive development of implant technology in the anterior cervical, though the same trends can be followed in the anterior thoracolumbar spine and posterior spinal implants. Understanding the problems that were seen after the development of each new step in the technology may help avoid these complications in cross-specialty use.

II. The Evolution of Plates in the Anterior Cervical Spine
a. ACDE – Popularized in the late 1950’s by Smith and Robinson\cite{10} and Cloward\cite{3} without the use of plates. Complications discussed included graft dislodgement.

b. Early Plate Fixation – Initially plates were developed to diminish the risks of graft dislodgement and loss of alignment, and to decrease the need for external immobilization. Caspar popularized in late 1980’s\cite{2}. However, new problems arose including non-unions, hardware failure, and loss of fixation/position of hardware. Also needed bicortical fixation to provide sufficient stability\cite{11}.

c. The Locked Plate – Two main problems were solved: (1) screws are locked to the plate, so decrease the risk of dislodgement, and (2) increased strength of fixation without having to gain bicortical purchase (a concern in the anterior cervical spine)\cite{9,12}. Morscher developed the first plate and many others followed. Did not always prevent loss of fixation either\cite{8}. In addition, concern for stress shielding and abnormal loading lead to the next development\cite{6}.

d. Even More Recent Design Changes – In response to the bridging of subsiding grafts and subsequent non-unions, dynamic plates were developed and now share market share evenly with
static plates, though have not improved fusion rates\(^8\). Dynamic plates allowed settling and maintained bone contact\(^1,4\). With all these different plate styles on the market, there was clear need for defined nomenclature – Statically locked plates, Rotationally Dynamic Plates, Translationally Dynamic Plates\(^7\).

III. What have we learned
a. Newer is not always better – Stronger/expensive not always better
b. Fixed-Angle Screws – increased strength, allowing unicortical purchase
c. Locked Screws – They also limit the risk of screw backout.
d. Diminished Load-Sharing with Locked Screws – the greatest potential detriment to this style of implant, though the concerns have not been born out universally in the literature. The concern has lead to the development of Dynamic Implants.

IV. References