

Redefining Treatment Sequencing in the Osteoporotic Spine: The Convergence of ‘Fix and Treat’ and ‘Treat and Fix’ Strategies

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Introduction

Osteoporosis frequently coexists with spinal degeneration and deformity, creating a cycle of mechanical instability and biological fragility. Instrumentation in osteoporotic bone increases risks of screw loosening, cage subsidence, pseudoarthrosis, proximal junctional failure, and revision surgery, making treatment sequencing (surgery vs pharmacotherapy) clinically important. Yet there is no consensus on whether to stabilize first and optimise bone afterwards (“Fix and Treat”) or to improve bone quality first and then perform definitive reconstruction (“Treat and Fix”). This review evaluates both paradigms and proposes a practical framework for sequencing decisions in osteoporotic spine pathology.

Materials and Methods

We reviewed PubMed, Scopus, MEDLINE, and the Cochrane Library through 1 October 2025. Included studies assessed surgical outcomes in osteoporotic patients undergoing spinal instrumentation/fusion who received antiresorptive or anabolic therapy initiated pre- or postoperatively. Outcomes included fusion, fixation-related complications (e.g., loosening), construct failure, and reoperation. Evidence was synthesized by clinical urgency and construct demands, supplemented by senior authors’ experience managing high-risk cases, including staged strategies and perioperative bone-health pathway.

Results

Fifty-five studies met inclusion criteria. “Fix and Treat” was most applied in urgent settings (neurological compromise, acute instability, rapidly progressive deformity), where delaying decompression or stabilization may worsen outcomes. Across heterogeneous designs, postoperative anabolic therapy—particularly teriparatide and emerging evidence for romosozumab—was associated with improved fusion and fewer instrumentation-related complications compared with no therapy or antiresorptive-only strategies. In elective cases, “Treat and Fix” appeared advantageous: short-course preoperative anabolic therapy (≥3 months) improved bone-implant integration, increased screw purchase/pullout strength, and enhanced construct stability, with reduced early loosening in several clinical series. Biomechanical and finite element analyses supported preoperative optimisation, predicting the greatest benefit in long constructs, osteotomies, and revision procedures, where fixation demands are highest.

Conclusion

“Fix and Treat” and “Treat and Fix” represent complementary approaches rather than opposing strategies. Sequencing should be individualised along a continuum defined by surgical urgency, baseline bone quality, construct complexity, and expected time-to-pharmacologic response, leveraging perioperative optimisation to improve durability and reduce complications.

Table 1: Current evidence for pharmacologic strategies for “Fix-and-Treat” or “Treat-and-Fix”

| Authors and Year                        | Study Design    | Surgical Procedure                 | Agents                          | Outcomes                                                                                                                                                                                                                                                                                 | Duration of therapy                                | Level of Evidence |
|-----------------------------------------|-----------------|------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------|
| Lin et al <sup>21</sup> 2018            | Meta-analysis   | Posterior lumbar fusion            | Bisphosphonates                 | Bisphosphonates may increase solid intervertebral fusion and decrease subsequent vertebral compression fractures, pedicle screw loosening, and cage subsidence                                                                                                                           | NA                                                 | I                 |
| Inoue et al <sup>22</sup> 2024          | Prospective     | Kyphoplasty                        | Romosozumab vs Bisphosphonates  | Romosozumab is more effective than Bisphosphonates in preventing subsequent fractures following kyphoplasty                                                                                                                                                                              | 6 months                                           | III               |
| Yagi et al <sup>23</sup> 2016           | Prospective     | Multilevel posterior lumbar fusion | Teriparatide vs control         | Bone mineral content, BV/TV (Bone volume over Total volume) and subcortical bone thickness was significantly higher in UIV+1 (vertebrae 1 level above upper segment instrumented), and proximal junctional kyphosis type 2 was significantly lower in patients who received Teriparatide | 6 months                                           | III               |
| Sawada et al <sup>24</sup> 2025         | Retrospective   | Posterior lumbar fusion            | Romosozumab                     | Romosozumab administered approximately two months before surgery significantly increased Hounsfield unit values at the UIV+1, and was associated with a 68% reduction in the odds of proximal junctional kyphosis                                                                        | 2 months                                           | III               |
| Kim et al <sup>25</sup> 2024            | Retrospective   | Posterior lumbar fusion            | Teriparatide                    | Longer duration (>6 months) of teriparatide therapy postoperatively showed better union and better clinical outcome                                                                                                                                                                      | >6 months                                          | III               |
| Shinuya et al <sup>26</sup> 2022        | Retrospective   | Vertebroplasty with PSF            | Teriparatide vs control         | No significant difference in subsequent fracture, screw loosening or functional outcomes                                                                                                                                                                                                 | 3 months                                           | III               |
| Kavabata et al <sup>27</sup> 2020       | Retrospective   | Posterior spinal fusion            | Bisphosphonates vs Teriparatide | Teriparatide therapy resulted in lower mechanical complications and lesser pseudoarthrosis                                                                                                                                                                                               | 24 months                                          | III               |
| Kim et al <sup>22</sup> 2018            | Retrospective   | Posterior lumbar fusion            | Teriparatide vs Risedronate     | Teriparatide therapy had significantly less screw pull out rate                                                                                                                                                                                                                          | Teriparatide – 6 months<br>Risedronate – 12 months | III               |
| Kaliya-Perumal et al <sup>28</sup> 2017 | Retrospective   | Multilevel posterior lumbar fusion | Teriparatide vs control         | Fewer screw loosening and higher fusion rate in Teriparatide group                                                                                                                                                                                                                       | 7.4 ± 2.4 months                                   | III               |
| Ishikawa et al <sup>29</sup> 2024       | Prospective FEA | NA                                 | Romosozumab                     | Romosozumab therapy led to significant gains in BMD, biomechanical properties and pullout strength                                                                                                                                                                                       | 3 months                                           | III               |
| Tani et al <sup>31</sup> 2021           | Prospective FEA | NA                                 | Denosumab                       | Post-denosumab spine showed increased pullout strength and compressive resistance                                                                                                                                                                                                        | 24 months                                          | III               |

\*FEA: Finite Element analysis  
\*BMD: Bone Mineral Density  
\*UIV: Upper Instrumented Vertebrae  
\*NA: Not applicable

Current evidence for pharmacologic strategies for “Fix-and-Treat” or “Treat-and-Fix”

Table 2: Decision making factors when considering “Treat and Fix” or “Fix and Treat”

| Factor                        | Favor “Treat and Fix”        | Favor “Fix and Treat”                |
|-------------------------------|------------------------------|--------------------------------------|
| Neurologic compromise         | Absent                       | Present                              |
| Mechanical instability        | Stable deformity             | Unstable compression burst fracture  |
| Pain severity                 | Controlled                   | Intractable                          |
| Construct complexity          | Long-segment, fusion-reliant | Short-segment, decompression-focused |
| Prior instrumentation failure | Present                      | Absent                               |
| Time to optimize BMD          | Acceptable (≥8-12 weeks)     | Not acceptable (<8 weeks)            |

Decision making factors when considering "Treat and Fix" or "Fix and Treat"