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## Appendix A: Machine Learning Models

### Cox Lasso

The Cox Lasso applies Lasso (L1) regularization to the Cox proportional hazards model for regression on right-censored time-to-event outcomes. The method performs variable selection by applying a penalty during model fitting that sets less important predictor coefficients to zero. The remaining (non-zero) coefficients comprise the selected predictors. A tuning parameter controls the extent of this shrinkage: larger values of the tuning parameter correspond to more shrinkage and thus the selection of fewer predictors. We fit the Cox Lasso using the *glmnet* package in R, with the tuning parameter selected via cross-validation to balance model simplicity and fit.[1]

### Survival Random Forest

The survival random forest, as implemented in the *randomForestSRC* R package, uses an ensemble tree method designed for right-censored time-to-event data. A log-rank split rule is used, and the estimates associated with each terminal node are computed using the Kaplan-Meier estimator (survival estimate) and the Nelson-Aalen estimator (cumulative hazard estimate). Estimates for an individual are averaged over all bootstrap samples for which the individual is out of bag (OOB). Prediction error for the forest is measured by 1-C, where C is Harrell's concordance index, a measure of accuracy in ranking pairs in terms of their predicted and actual survival.[2]

### Generalized additive model

A generalized additive model (GAM) is a regression model that allows for non-linear relationships between predictors and the outcome. In the R package *mgcv*, which we used for our model, smooth terms are fit using penalized regression splines. The generalized additive model accommodates right-censored time-to-event data by fitting a Cox proportional hazards model with the smooth terms incorporated in the partial likelihood.[3]

### Gradient boosted regression

Gradient boosting uses an iterative method to fit a regression function to the data. At each iteration, the gradient, or the derivative of the loss function with respect to the current regression function, is calculated. The regression function is then updated in the direction of this gradient, improving the fit. Gradient boosted regression as implemented in the R package *gbm*, which we used for our model, uses regression trees as the functions. To accommodate right-censored time-to-event data, the model uses the negative log partial likelihood under the Cox proportional hazards model as the loss function.[4,5]

http://dx.doi.org/10.2106/JBJS.21.00113


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http://dx.doi.org/10.2106/JBJS.21.00113


# Supplementary Tables

Supplementary Table 1a: Complete/incomplete case comparison

| Variable* | Full data N = 24935 | Cox Lasso/GAM complete cases N = 18887 | Random forest/GBM complete cases** N = 13272 |
|---|---|---|---|
| Years: surgery to present (1/2020) | 8.1 (4.1) | 8.4 (4.1) | 6.5 (3.1) |
| Revision | 1219 (4.9%) | 975 (5.2%) | 619 (4.7%) |
| Follow-up time/Time to revision | 6.7 (4.2) | 7.1 (4.2) | 5.2 (3.1) |
| Age at surgery | 28 (11) | 28 (10) | 28 (11) |
| Age at injury | 27 (10) | 26 (10) | 26 (10) |
| Missing | 1251 | 0 | 0 |
| Sex | | | |
| Male | 14019 (56%) | 10452 (55%) | 7302 (55%) |
| Female | 10916 (44%) | 8435 (45%) | 5970 (45%) |
| BMI | 25.0 (3.8) | 25.0 (3.8) | 25.0 (3.8) |
| Missing | 7920 | 5462 | 0 |
| QOL score at surgery | 3.49 (1.86) | 3.49 (1.86) | 3.52 (1.88) |
| Missing | 5149 | 0 | 0 |
| Sports score at surgery | 4.28 (2.73) | 4.28 (2.73) | 4.34 (2.74) |
| Missing | 5324 | 192 | 0 |
| Below median on all KOOS | 3972 (20%) | 3698 (20%) | 2541 (19%) |
| Missing | 4981 | 0 | 0 |
| Hospital type | | | |
| Southeast | 9335 (37%) | 6853 (36%) | 4621 (35%) |
| West | 3974 (16%) | 3080 (16%) | 2112 (16%) |
| Central | 2162 (8.7%) | 1616 (8.6%) | 1013 (7.6%) |
| North | 958 (3.8%) | 547 (2.9%) | 308 (2.3%) |
| Private | 8506 (34%) | 6791 (36%) | 5218 (39%) |
| Meniscus injury | 13145 (53%) | 9957 (53%) | 7219 (54%) |
| Cartilage injury | 5801 (23%) | 4464 (24%) | 3008 (23%) |
| Any further injury | 171 (0.7%) | 92 (0.5%) | 59 (0.4%) |
| PCL injury | 398 (1.6%) | 213 (1.1%) | 127 (1.0%) |
| MCL injury | 1993 (8.0%) | 1458 (7.7%) | 1125 (8.5%) |
| LCL injury | 464 (1.9%) | 302 (1.6%) | 241 (1.8%) |
| PLC injury | 243 (1.0%) | 134 (0.7%) | 93 (0.7%) |
| Graft choice | | | |
| BPTB | 9891 (40%) | 7393 (39%) | 5363 (40%) |
| Hamstring | 14481 (58%) | 11142 (59%) | 7591 (57%) |
| Unknown/Other | 563 (2.3%) | 352 (1.9%) | 318 (2.4%) |
| Damaged side. | | | |
| Right | 12675 (51%) | 9598 (51%) | 6733 (51%) |
| Left | 12260 (49%) | 9289 (49%) | 6539 (49%) |
| Missing | 0 (0%) | 0 (0%) | 0 (0%) |
| Previous surgery on opposite knee | 1804 (7.2%) | 1340 (7.1%) | 975 (7.3%) |
| Previous surgery on same knee | 4213 (17%) | 3167 (17%) | 1852 (14%) |

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| | | | |
|---|---|---|---|
| Time injury to surgery (years) | 1.63 (3.26) | 1.63 (3.27) | 1.54 (3.10) |
| Missing | 1255 | 0 | 0 |
| Systemic Antibiotic Prophylaxis | 24769 (99%) | 18784 (99%) | 13231 (100%) |
| Missing | 58 (0.2%) | 39 (0.2%) | 28 (0.2%) |

*Statistics presented: Mean (SD); n (%)
**Fixation device variables (used in random forest and gradient boosted regression models) are omitted from this table for readability (see supplement Table 2c).

Supplementary Table 1b: Cox Lasso/generalized additive model complete/incomplete case comparison

| Variable* | Incomplete N = 6048 | Complete N = 18887 | Total N = 24935 | P-value** |
|---|---|---|---|---|
| Years: surgery to present (1/2020) | 7.0 (4.0) | 8.4 (4.1) | 8.1 (4.1) | <0.001 |
| Revision | 244 (4.0%) | 975 (5.2%) | 1219 (4.9%) | <0.001 |
| Follow-up time/Time to revision | 5.7 (4.0) | 7.1 (4.2) | 6.7 (4.2) | <0.001 |
| Age at surgery | 30 (11) | 28 (10) | 28 (11) | <0.001 |
| QOL score at surgery | 3.43 (1.86) | 3.49 (1.86) | 3.49 (1.86) | 0.33 |
| Missing | 5149 | 0 | 5149 | |
| Graft choice | | | | <0.001 |
| BPTB | 2498 (41%) | 7393 (39%) | 9891 (40%) | |
| Hamstring | 3339 (55%) | 11142 (59%) | 14481 (58%) | |
| Unknown/Other | 211 (3.5%) | 352 (1.9%) | 563 (2.3%) | |
| Femur fixation device | | | | <0.001 |
| Interference screw | 1942 (32%) | 6345 (34%) | 8287 (33%) | |
| Suspension/cortical device | 3065 (51%) | 10007 (53%) | 13072 (52%) | |
| Unknown/Other | 1041 (17%) | 2535 (13%) | 3576 (14%) | |
| Time injury to surgery (years) | 1.61 (3.21) | 1.63 (3.27) | 1.63 (3.26) | 0.76 |
| Missing | 1255 | 0 | 1255 | |

*Statistics presented: Mean (SD); n (%)
**Statistical tests performed: t-test, chi-square test

Supplementary Table 1c: Random forest/gradient boosted regression complete/incomplete case comparison

| Variable* | Incomplete N = 11663 | Complete N = 13272 | Total N = 24935 | P-value** |
|---|---|---|---|---|
| Years: surgery to present (1/2020) | 9.9 (4.4) | 6.5 (3.1) | 8.1 (4.1) | <0.001 |
| Revision | 600 (5.1%) | 619 (4.7%) | 1219 (4.9%) | 0.084 |
| Follow-up time/Time to revision | 8.4 (4.6) | 5.2 (3.1) | 6.7 (4.2) | <0.001 |
| Age at surgery | 29 (11) | 28 (11) | 28 (11) | <0.001 |
| Age at injury | 27 (10) | 26 (10) | 27 (10) | <0.001 |
| Missing | 1251 | 0 | 1251 | |
| Sex | | | | <0.001 |
| Male | 6717 (58%) | 7302 (55%) | 14019 (56%) | |
| Female | 4946 (42%) | 5970 (45%) | 10916 (44%) | |
| BMI | 25.2 (3.8) | 25.0 (3.8) | 25.0 (3.8) | <0.001 |
| Missing | 7920 | 0 | 7920 | |
| QOL score at surgery | 3.43 (1.82) | 3.52 (1.88) | 3.49 (1.86) | 0.002 |
| Missing | 5149 | 0 | 5149 | |

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| | | | | |
|---|---|---|---|---|
| Sports score at surgery | 4.16 (2.70) | 4.34 (2.74) | 4.28 (2.73) | <0.001 |
| Missing | 5324 | 0 | 5324 | |
| Below median on all KOOS | 1431 (21%) | 2541 (19%) | 3972 (20%) | <0.001 |
| Missing | 4981 | 0 | 4981 | |
| Hospital type | | | | <0.001 |
| Southeast | 4714 (40%) | 4621 (35%) | 9335 (37%) | |
| West | 1862 (16%) | 2112 (16%) | 3974 (16%) | |
| Central | 1149 (9.9%) | 1013 (7.6%) | 2162 (8.7%) | |
| North | 650 (5.6%) | 308 (2.3%) | 958 (3.8%) | |
| Private | 3288 (28%) | 5218 (39%) | 8506 (34%) | |
| Meniscus injury | 5926 (51%) | 7219 (54%) | 13145 (53%) | <0.001 |
| Cartilage injury | 2793 (24%) | 3008 (23%) | 5801 (23%) | 0.017 |
| Any further injury | 112 (1.0%) | 59 (0.4%) | 171 (0.7%) | <0.001 |
| PCL injury | 271 (2.3%) | 127 (1.0%) | 398 (1.6%) | <0.001 |
| MCL injury | 868 (7.4%) | 1125 (8.5%) | 1993 (8.0%) | 0.003 |
| LCL injury | 223 (1.9%) | 241 (1.8%) | 464 (1.9%) | 0.61 |
| PLC injury | 150 (1.3%) | 93 (0.7%) | 243 (1.0%) | <0.001 |
| Graft choice | | | | 0.006 |
| BPTB | 4528 (39%) | 5363 (40%) | 9891 (40%) | |
| Hamstring | 6890 (59%) | 7591 (57%) | 14481 (58%) | |
| Unknown/Other | 245 (2.1%) | 318 (2.4%) | 563 (2.3%) | |
| Damaged side. | | | | 0.74 |
| Right | 5942 (51%) | 6733 (51%) | 12675 (51%) | |
| Left | 5721 (49%) | 6539 (49%) | 12260 (49%) | |
| Missing | 0 (0%) | 0 (0%) | 0 (0%) | |
| Previous surgery on opposite knee | 829 (7.1%) | 975 (7.3%) | 1804 (7.2%) | 0.48 |
| Previous surgery on same knee | 2361 (20%) | 1852 (14%) | 4213 (17%) | <0.001 |
| Time injury to surgery (years) | 1.74 (3.44) | 1.54 (3.10) | 1.63 (3.26) | <0.001 |
| Missing | 1255 | 0 | 1255 | |
| Systemic Antibiotic Prophylaxis | 11538 (99%) | 13231 (100%) | 24769 (99%) | <0.001 |
| Missing | 30 (0.3%) | 28 (0.2%) | 58 (0.2%) | |
| Femur fixation device | | | | <0.001 |
| ACL TightRope | 28 (0.2%) | 16 (0.1%) | 44 (0.2%) | |
| Aesculap Position ACL | 27 (0.2%) | 27 (0.2%) | 54 (0.2%) | |
| BioComposite SwiveLock C | 1 (<0.1%) | 0 (0%) | 1 (<0.1%) | |
| Biodegr screw | 50 (0.4%) | 53 (0.4%) | 103 (0.4%) | |
| BioRCI | 4 (<0.1%) | 3 (<0.1%) | 7 (<0.1%) | |
| BioRCI-HA | 2 (<0.1%) | 0 (0%) | 2 (<0.1%) | |
| Biosure HA | 4 (<0.1%) | 31 (0.2%) | 35 (0.1%) | |
| Biosure HA Interference screw | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) | |
| Biosure PK | 0 (0%) | 2 (<0.1%) | 2 (<0.1%) | |
| BioTenodesis Screw System | 1 (<0.1%) | 0 (0%) | 1 (<0.1%) | |
| Bone Mulch | 483 (4.2%) | 135 (1.0%) | 618 (2.5%) | |
| Bone Mulch Screw | 1 (<0.1%) | 0 (0%) | 1 (<0.1%) | |
| BTB TightRope | 87 (0.8%) | 45 (0.3%) | 132 (0.5%) | |
| Comp non-degr | 139 (1.2%) | 185 (1.4%) | 324 (1.3%) | |
| Cortical button | 78 (0.7%) | 76 (0.6%) | 154 (0.6%) | |

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| | | | | |
|---|---|---|---|---|
| Endobutton | 3260 (28%) | 5349 (41%) | 8609 (35%) | |
| EndoButton CL | 2 (<0.1%) | 0 (0%) | 2 (<0.1%) | |
| Endobutton CL BTB | 465 (4.1%) | 811 (6.2%) | 1276 (5.2%) | |
| Endobutton CL Ultra | 16 (0.1%) | 43 (0.3%) | 59 (0.2%) | |
| EzLoc | 1152 (10%) | 594 (4.5%) | 1746 (7.1%) | |
| EZLoc | 3 (<0.1%) | 0 (0%) | 3 (<0.1%) | |
| Full Thread Interference screw | 2 (<0.1%) | 2 (<0.1%) | 4 (<0.1%) | |
| Guardsman Femoral | 1 (<0.1%) | 1 (<0.1%) | 2 (<0.1%) | |
| Linvatec Cannulated | 1 (<0.1%) | 0 (0%) | 1 (<0.1%) | |
| Metal int screw | 635 (5.5%) | 866 (6.6%) | 1501 (6.1%) | |
| Other suspension devices/cortical | 9 (<0.1%) | 13 (<0.1%) | 22 (<0.1%) | |
| Other Suspension devices/cortical | 226 (2.0%) | 305 (2.3%) | 531 (2.2%) | |
| Other transfemoral devices | 2 (<0.1%) | 0 (0%) | 2 (<0.1%) | |
| Peek Interference Screw | 14 (0.1%) | 5 (<0.1%) | 19 (<0.1%) | |
| Profile interference screw | 86 (0.8%) | 333 (2.5%) | 419 (1.7%) | |
| Profile Interference Screw | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) | |
| Propel Cannulated | 0 (0%) | 2 (<0.1%) | 2 (<0.1%) | |
| Propel cannulated int. screw | 188 (1.6%) | 33 (0.3%) | 221 (0.9%) | |
| RCI screw | 431 (3.8%) | 316 (2.4%) | 747 (3.0%) | |
| RCI Screw | 11 (<0.1%) | 7 (<0.1%) | 18 (<0.1%) | |
| Rigidfix | 508 (4.4%) | 100 (0.8%) | 608 (2.5%) | |
| Rigidfix BTB cross-pin | 205 (1.8%) | 182 (1.4%) | 387 (1.6%) | |
| Rigidfix BTB cross pin | 0 (0%) | 2 (<0.1%) | 2 (<0.1%) | |
| Rigidfix ST cross pin Kit | 3 (<0.1%) | 0 (0%) | 3 (<0.1%) | |
| Sheated Cannulated Interference Screw | 6 (<0.1%) | 14 (0.1%) | 20 (<0.1%) | |
| Soft screw | 12 (0.1%) | 3 (<0.1%) | 15 (<0.1%) | |
| Soft Screw | 10 (<0.1%) | 16 (0.1%) | 26 (0.1%) | |
| SoftSilk | 1615 (14%) | 1828 (14%) | 3443 (14%) | |
| TendonSoft | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) | |
| Tightrope ABS | 18 (0.2%) | 18 (0.1%) | 36 (0.1%) | |
| ToggleLoc | 144 (1.3%) | 591 (4.5%) | 735 (3.0%) | |
| Transfix II | 852 (7.4%) | 256 (1.9%) | 1108 (4.5%) | |
| TunneLoc | 462 (4.0%) | 469 (3.6%) | 931 (3.8%) | |
| UltraButton | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) | |
| Universal Wedge | 212 (1.9%) | 433 (3.3%) | 645 (2.6%) | |
| Missing | 207 | 103 | 310 | |
| Tibia fixation device | | | | <0.001 |
| ACL TightRope | 5 (<0.1%) | 4 (<0.1%) | 9 (<0.1%) | |
| Aesculap Position ACL | 15 (0.1%) | 25 (0.2%) | 40 (0.2%) | |
| AO Screw | 2 (<0.1%) | 0 (0%) | 2 (<0.1%) | |
| Bio-Intrafix Screw | 1 (<0.1%) | 1 (<0.1%) | 2 (<0.1%) | |
| Bio Composite Interference Screw | 1 (<0.1%) | 5 (<0.1%) | 6 (<0.1%) | |
| Bio Intrafix | 371 (3.2%) | 351 (2.7%) | 722 (2.9%) | |
| BioComposite SwiveLock C | 22 (0.2%) | 2 (<0.1%) | 24 (<0.1%) | |
| Biodegr screw | 675 (5.9%) | 712 (5.4%) | 1387 (5.6%) | |
| BioRCI | 183 (1.6%) | 486 (3.7%) | 669 (2.7%) | |

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| | | | |
|---|---|---|---|
| BioRCI-HA | 5 (<0.1%) | 9 (<0.1%) | 14 (<0.1%) |
| BIORCI Screw | 1 (<0.1%) | 3 (<0.1%) | 4 (<0.1%) |
| Biosure HA | 294 (2.6%) | 1768 (13%) | 2062 (8.4%) |
| Biosure HA Interference screw | 23 (0.2%) | 32 (0.2%) | 55 (0.2%) |
| Biosure PK | 47 (0.4%) | 119 (0.9%) | 166 (0.7%) |
| BioTenodesis Screw System | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) |
| BTB TightRope | 2 (<0.1%) | 1 (<0.1%) | 3 (<0.1%) |
| Comp non-degr | 445 (3.9%) | 813 (6.2%) | 1258 (5.1%) |
| ComposiTCP 60 | 0 (0%) | 4 (<0.1%) | 4 (<0.1%) |
| Cortical button | 0 (0%) | 2 (<0.1%) | 2 (<0.1%) |
| Cramp | 1 (<0.1%) | 0 (0%) | 1 (<0.1%) |
| Delta Tapered Bio-Interference screw | 1 (<0.1%) | 0 (0%) | 1 (<0.1%) |
| Endobutton | 14 (0.1%) | 44 (0.3%) | 58 (0.2%) |
| Endobutton CL BTB | 6 (<0.1%) | 4 (<0.1%) | 10 (<0.1%) |
| Full Thread Interference screw | 2 (<0.1%) | 1 (<0.1%) | 3 (<0.1%) |
| Intrafix | 954 (8.3%) | 696 (5.3%) | 1650 (6.7%) |
| Intrafix Screw | 1 (<0.1%) | 1 (<0.1%) | 2 (<0.1%) |
| Linvatec Cannulated | 2 (<0.1%) | 1 (<0.1%) | 3 (<0.1%) |
| Low Profile Cancelless | 4 (<0.1%) | 12 (<0.1%) | 16 (<0.1%) |
| Metal int screw | 733 (6.4%) | 875 (6.7%) | 1608 (6.5%) |
| Milagro | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) |
| Other suspension devices/cortical | 16 (0.1%) | 14 (0.1%) | 30 (0.1%) |
| Other Suspension devices/cortical | 114 (1.0%) | 168 (1.3%) | 282 (1.1%) |
| Other transtibial devices | 2 (<0.1%) | 0 (0%) | 2 (<0.1%) |
| Peek Interference Screw | 14 (0.1%) | 11 (<0.1%) | 25 (0.1%) |
| Profile interference screw | 83 (0.7%) | 333 (2.5%) | 416 (1.7%) |
| Profile Interference Screw | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) |
| Propel Cannulated | 1 (<0.1%) | 2 (<0.1%) | 3 (<0.1%) |
| Propel cannulated int. screw | 516 (4.5%) | 461 (3.5%) | 977 (4.0%) |
| RCI screw | 2355 (21%) | 2050 (16%) | 4405 (18%) |
| RCI Screw | 48 (0.4%) | 44 (0.3%) | 92 (0.4%) |
| Rigidfix | 1 (<0.1%) | 0 (0%) | 1 (<0.1%) |
| Rigidfix BTB cross-pin | 7 (<0.1%) | 6 (<0.1%) | 13 (<0.1%) |
| Sheated Cannulated Interference Screw | 1 (<0.1%) | 1 (<0.1%) | 2 (<0.1%) |
| Soft screw | 523 (4.6%) | 395 (3.0%) | 918 (3.7%) |
| Soft Screw | 13 (0.1%) | 19 (0.1%) | 32 (0.1%) |
| SoftSilk | 1948 (17%) | 2232 (17%) | 4180 (17%) |
| SoftSilk 2 | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) |
| Staple | 56 (0.5%) | 53 (0.4%) | 109 (0.4%) |
| Suture washer star. Box of 1 | 1 (<0.1%) | 4 (<0.1%) | 5 (<0.1%) |
| TendonSoft | 0 (0%) | 1 (<0.1%) | 1 (<0.1%) |
| Tightrope ABS | 7 (<0.1%) | 7 (<0.1%) | 14 (<0.1%) |
| TunneLoc | 456 (4.0%) | 477 (3.6%) | 933 (3.8%) |
| Universal Wedge | 62 (0.5%) | 415 (3.2%) | 477 (1.9%) |
| WasherLoc | 1395 (12%) | 473 (3.6%) | 1868 (7.6%) |
| WasherLoc Screw | 5 (<0.1%) | 0 (0%) | 5 (<0.1%) |

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| | | | | |
|---|---|---|---|---|
| Missing | 229 | 131 | 360 | |
| Fixation device combination | | | | <0.001 |
| Bone Mulch/Intrafix | 103 (0.9%) | 118 (0.9%) | 221 (0.9%) | |
| Bone Mulch/WasherLoc | 376 (3.2%) | 16 (0.1%) | 392 (1.6%) | |
| Endobutton/Biodegr. int. screw | 87 (0.7%) | 292 (2.2%) | 379 (1.5%) | |
| Endobutton/BioIntrafix | 92 (0.8%) | 204 (1.5%) | 296 (1.2%) | |
| Endobutton/BioRCI | 159 (1.4%) | 453 (3.4%) | 612 (2.5%) | |
| Endobutton/Biosure HA | 283 (2.4%) | 1722 (13%) | 2005 (8.0%) | |
| Endobutton/Comp non-degr. | 171 (1.5%) | 324 (2.4%) | 495 (2.0%) | |
| Endobutton/Intrafix | 488 (4.2%) | 400 (3.0%) | 888 (3.6%) | |
| Endobutton/Met. int. screw | 91 (0.8%) | 172 (1.3%) | 263 (1.1%) | |
| Endobutton/RCI | 1791 (15%) | 1606 (12%) | 3397 (14%) | |
| EzLoc/WasherLoc | 1004 (8.6%) | 437 (3.3%) | 1441 (5.8%) | |
| Metal int screw x 2 | 336 (2.9%) | 523 (3.9%) | 859 (3.4%) | |
| Other combination | 3024 (26%) | 3646 (27%) | 6670 (27%) | |
| RCI/RCI | 284 (2.4%) | 279 (2.1%) | 563 (2.3%) | |
| RCI/Softsilk | 138 (1.2%) | 23 (0.2%) | 161 (0.6%) | |
| Rigidfix BTB/Met. int. screw | 77 (0.7%) | 52 (0.4%) | 129 (0.5%) | |
| Rigidfix BTB/Prop. cannulated screw | 119 (1.0%) | 127 (1.0%) | 246 (1.0%) | |
| Rigidfix/Bio-Intrafix | 173 (1.5%) | 22 (0.2%) | 195 (0.8%) | |
| Rigidfix/Intrafix | 285 (2.4%) | 76 (0.6%) | 361 (1.4%) | |
| Softsilk x 2 | 1415 (12%) | 1586 (12%) | 3001 (12%) | |
| Softsilk/RCI | 98 (0.8%) | 90 (0.7%) | 188 (0.8%) | |
| ToggleLoc/Bio-screw | 55 (0.5%) | 209 (1.6%) | 264 (1.1%) | |
| Transfix/Biodegr int. screw | 249 (2.1%) | 24 (0.2%) | 273 (1.1%) | |
| Transfix/Metal int. screw incl RCI | 101 (0.9%) | 4 (<0.1%) | 105 (0.4%) | |
| TunneLoc/TunneLoc | 445 (3.8%) | 447 (3.4%) | 892 (3.6%) | |
| Universal Wedge x 2 | 62 (0.5%) | 414 (3.1%) | 476 (1.9%) | |
| Universal Wedge/Bio-screw | 137 (1.2%) | 6 (<0.1%) | 143 (0.6%) | |
| Missing | 20 | 0 | 20 | |

*Statistics presented: Mean (SD); n (%)
**Statistical tests performed: t-test, chi-square test

Supplementary Table 2a: Cox Lasso performance with imputation

| | **Training data imputed (predictions averaged)** | | | **Training and test data imputed (predictions averaged)** | | |
|---|---|---|---|---|---|---|
| Year | Concordance | Calibration statistic | P-value | Concordance | Calibration statistic | P-value |
| 1 | 0.681 | 4.89 | 0.18 | 0.685 | 4.74 | 0.192 |
| 2 | 0.679 | 10.21 | 0.017 | 0.681 | 17.87 | < 0.001 |
| 5 | 0.678 | 3.24 | 0.357 | 0.678 | 1.57 | 0.667 |

Supplementary Table 2b: Random forest performance with imputation

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| | Training data imputed | | | Training and test data imputed | | |
|---|---|---|---|---|---|---|
| Year | Concordance | Calibration statistic | P-value | Concordance | Calibration statistic | P-value |
| 1 | 0.683 | 1.9 | 0.593 | 0.69 | 1.76 | 0.624 |
| 2 | 0.68 | 8.94 | 0.03 | 0.689 | 10.08 | 0.018 |
| 5 | 0.677 | 2.96 | 0.399 | 0.69 | 3.64 | 0.303 |

Supplementary Table 2c: Generalized additive model performance with imputation

| | Training data imputed (predictions averaged) | | | Training and test data imputed (predictions averaged) | | |
|---|---|---|---|---|---|---|
| Year | Concordance | Calibration statistic | P-value | Concordance | Calibration statistic | P-value |
| 1 | 0.686 | 4.93 | 0.177 | 0.689 | 9.32 | 0.025 |
| 2 | 0.684 | 10.52 | 0.015 | 0.685 | 17.17 | < 0.001 |
| 5 | 0.682 | 5.3 | 0.151 | 0.682 | 4.78 | 0.189 |

Supplementary Table 2d: Gradient boosted regression performance with imputation

| | Training data imputed (predictions averaged) | | | Training and test data imputed (predictions averaged) | | |
|---|---|---|---|---|---|---|
| Year | Concordance | Calibration statistic | P-value | Concordance | Calibration statistic | P-value |
| 1 | 0.675 | 0.42 | 0.936 | 0.685 | 1.37 | 0.713 |
| 2 | 0.672 | 1.99 | 0.575 | 0.682 | 4.53 | 0.21 |
| 5 | 0.668 | 4.22 | 0.239 | 0.681 | 11.67 | 0.009 |

Supplementary Table 3a: Random forest restricted to Lasso-selected variables

| | Complete cases | | | Training and test data imputed | | |
|---|---|---|---|---|---|---|
| Year | Concordance | Calibration statistic | P-value | Concordance | Calibration statistic | P-value |
| 1 | 0.671 | 5.95 | 0.114 | 0.669 | 7.22 | 0.065 |
| 2 | 0.673 | 38.28 | < 0.001 | 0.669 | 12.29 | 0.006 |
| 5 | 0.677 | 137.74 | < 0.001 | 0.669 | 5.15 | 0.161 |

Supplementary Table 3b: Gradient boosted regression restricted to Lasso-selected variables

| | Complete cases | Training and test data imputed |
|---|---|---|

http://dx.doi.org/10.2106/JBJS.21.00113


| Year | Concordance | Calibration statistic | P-value | Concordance | Calibration statistic | P-value |
|---|---|---|---|---|---|---|
| 1 | 0.683 | 2535.36 | < 0.001 | 0.684 | 6.07 | 0.108 |
| 2 | 0.683 | 5731.62 | < 0.001 | 0.682 | 10.27 | 0.016 |
| 5 | 0.685 | 10008.69 | < 0.001 | 0.68 | 8.62 | 0.035 |