

Impact of Progressive and Conventional Thread Designs on Primary Implant Stability: An In-vitro Comparison

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Poster: P112

Introduction

To reduce implant failure in poor bone quality and support shorter treatment protocols, efforts have focused on enhancing initial stability through modifications in implant body and thread design. However, evidence comparing conventional and progressive thread designs is limited. This in-vitro study aims to evaluate the primary stability of screw implants with different macrogeometries and thread designs (conventional vs. progressive) across various bone densities using resonance frequency analysis (RFA) and insertion torque (Ncm).

Materials & Methods

240 implants were placed in polyurethane blocks (SawBones, Pacific Research Laboratories, WA, USA) (Fig. 1). The blocks had densities of 10, 15, and 20 pcf (0.16, 0.24, and 0.32 g/cc), corresponding to bone qualities D4, D3, and D2, respectively. Insertion torque and ISQ values from resonance frequency analysis were recorded. Implants were divided into two main groups: implants with standard thread design (SI, n=120) and implants with progressive thread design (PI, n=120). The SI group consisted of 30 Camlog Screw Line (CS), 30 Astra Tech (EVS), 30 Xive (XS), and 30 Blue Diamont (BDS) implants, while the PI group consisted of 30 Camlog Progressive Line (CP), 30 Prime Taper (EVP), 30 Omni Taper (OP), and 30 Anyridge (ARP)

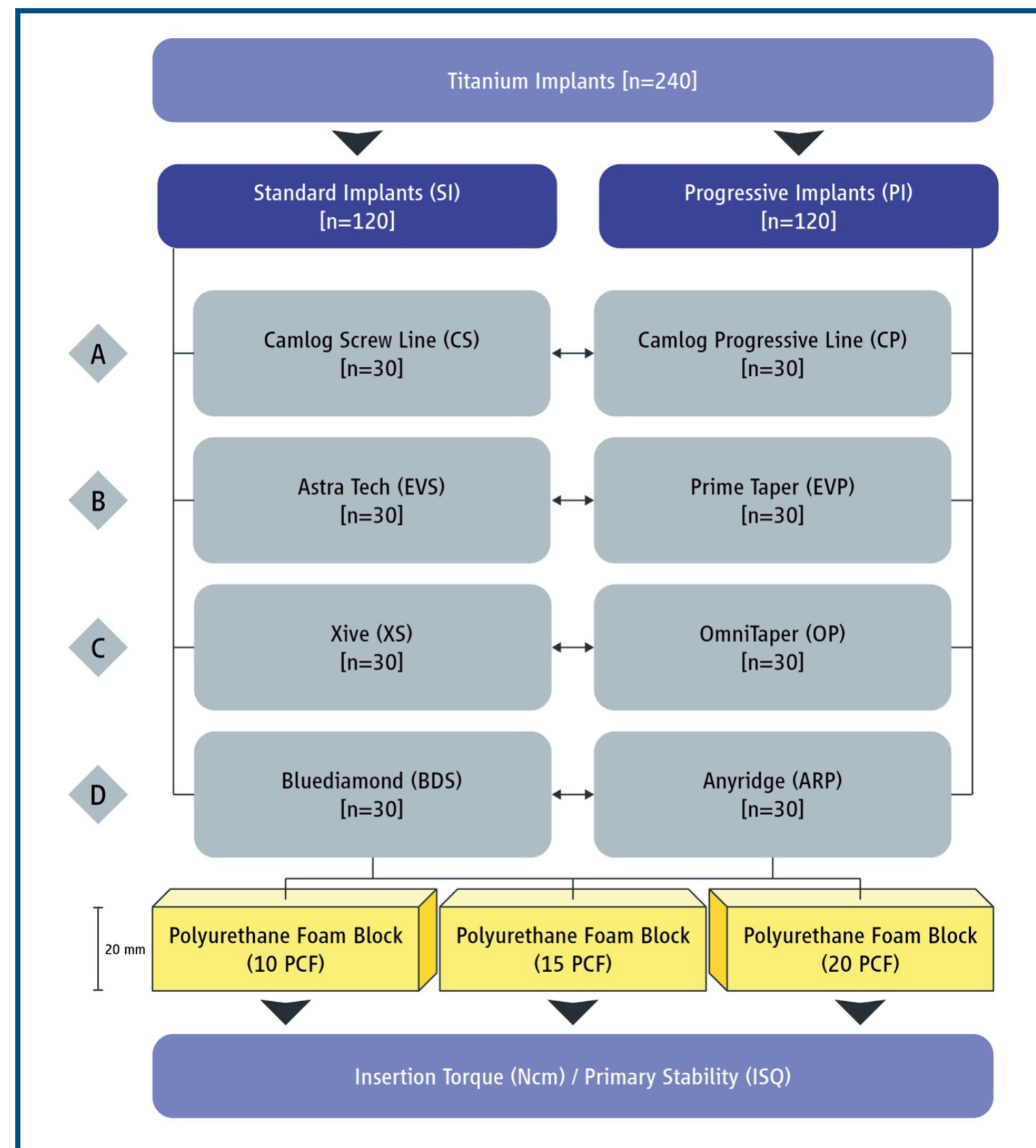


Fig. 1. Study design

implants (Manufacturers: Camlog implants by Camlog, Wimsheim, Germany; Astra Tech, Xive, and PrimeTaper by Dentsply Sirona, Mölndal, Sweden; and Blue Diamond and Anyridge by MegGen, Daegu, South Korea). Subgroups (A,B, C,D) were created for comparative analysis between SI and PI implants from the same manufacturer (Fig. 1 & 3). Implants were placed according to the manufacturer's protocol (Fig. 4). The Mann-Whitney U test compared two independent samples, and the Kruskal-Wallis H test assessed differences among multiple groups. Post-hoc comparisons used Tukey and Kramer's test, with significance set at $p = 0.05$.

Results

Overall, the PI group exhibited higher primary stability and insertion torque values compared to the SI group in all PCF classes. The mean primary stability of the SI group was 54.8 ± 10.9 ISQ, which was significantly lower than the 58.6 ± 9.2 ISQ observed for the PI group ($p = 0.03$) (Tab. 1-3) (Fig. 5) Furthermore, the insertion torque exhibited a significant difference between the two groups, with the SI group demonstrating a mean value of 22.7 ± 13.1 Ncm, compared to the PI group's mean value of 27.3 ± 14.2 Ncm ($p = 0.01$) (Tab.3) (Fig. 6). There was a positive correlation between primary stability and insertion torque values (0.66). A comprehensive evaluation of the ISQ and Ncm data for each subgroup revealed no significant disparities between subgroups C and D (Fig. 2).

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Conclusion

The results of the present in-vitro study indicate that implants with a progressive thread design exhibit higher primary stability and insertion torque in different artificial bone densities compared to implants with a conventional thread design. However, these results are not consistent across all implants tested and may be system specific. In-vitro studies fall short of accurately simulating the complex intraoral environment, necessitating confirmation of the results through clinical research.



Fig. 3 Study Implants.

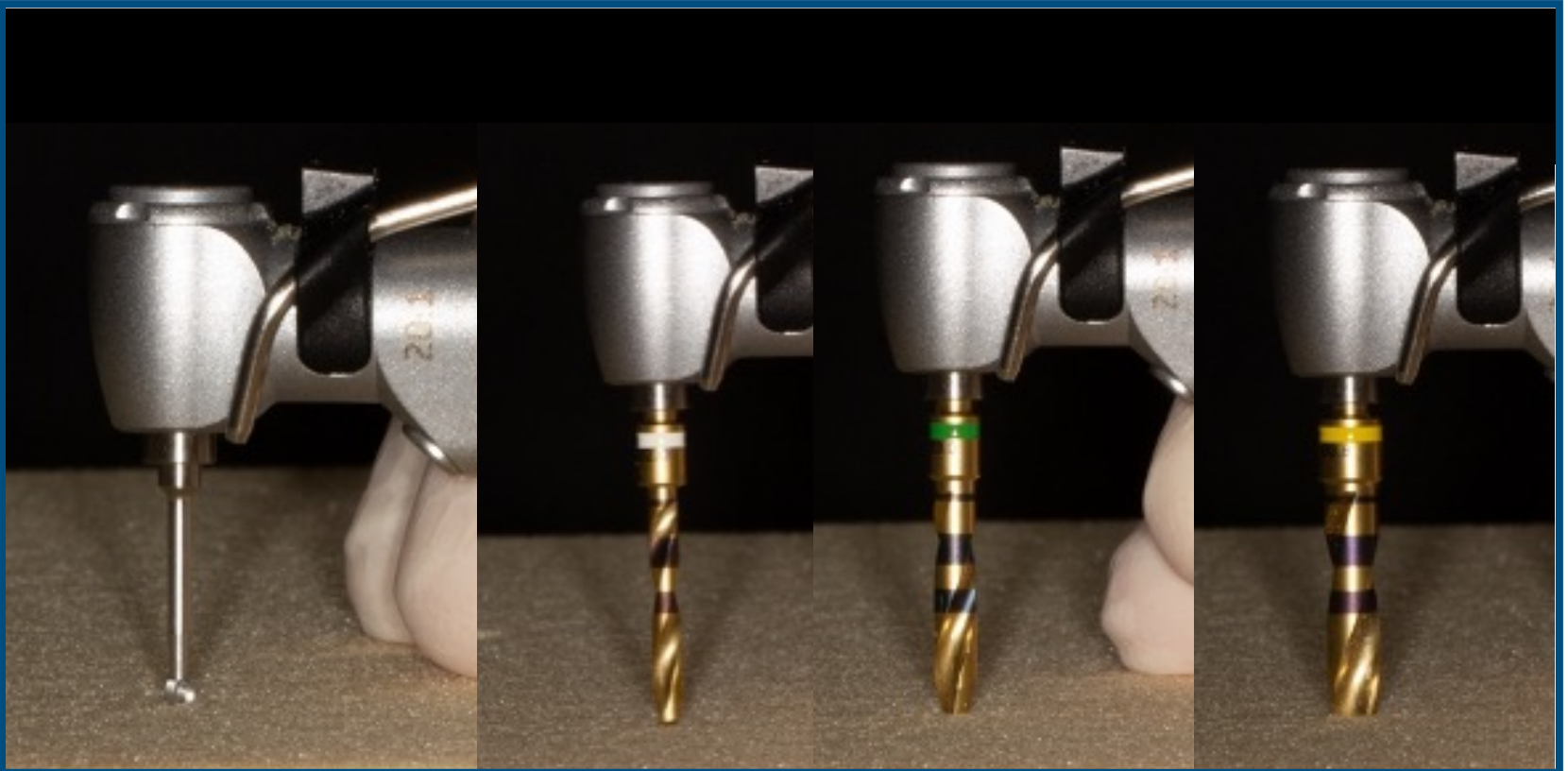


Fig. 4 Exemplary drilling protocol for OmniTaper EV implants in Sawbone models.

Variable	N	Mean	Standard Deviation	Median	Min	25% Perz.	75% Perz	Max
Primary Stability (ISQ)	120	54,80	10,85	55,75	12,00	51,00	61,00	75,00
Insertion Torque (Ncm)	120	22,72	13,12	21,00	6,00	10,75	32,00	55,00

Table 1. Primary stability and insertion torque for standard implant group (SI).

Variable	N	Mean	Standard Deviation	Median	Min	25% Perz.	75% Perz	Max
Primary Stability (ISQ)	120	58,62	9,22	57,75	43,50	53,00	62,12	79,00
Insertion Torque (Ncm)	120	27,32	14,15	24,50	5,00	14,00	39,00	56,00

Table 2. Primary stability and insertion torque for progressive implant group (PI).

Variable	Test Variable U	p-value Mann Whitney U-Test
Primary Stability (ISQ)	6056.5	0.033
Insertion Torque (Ncm)	5774.0	0.008

Table 3. Progressive thread implants (PI) exhibited significantly higher primary stability and insertion torque than conventional thread implants (SI) across varying bone densities.

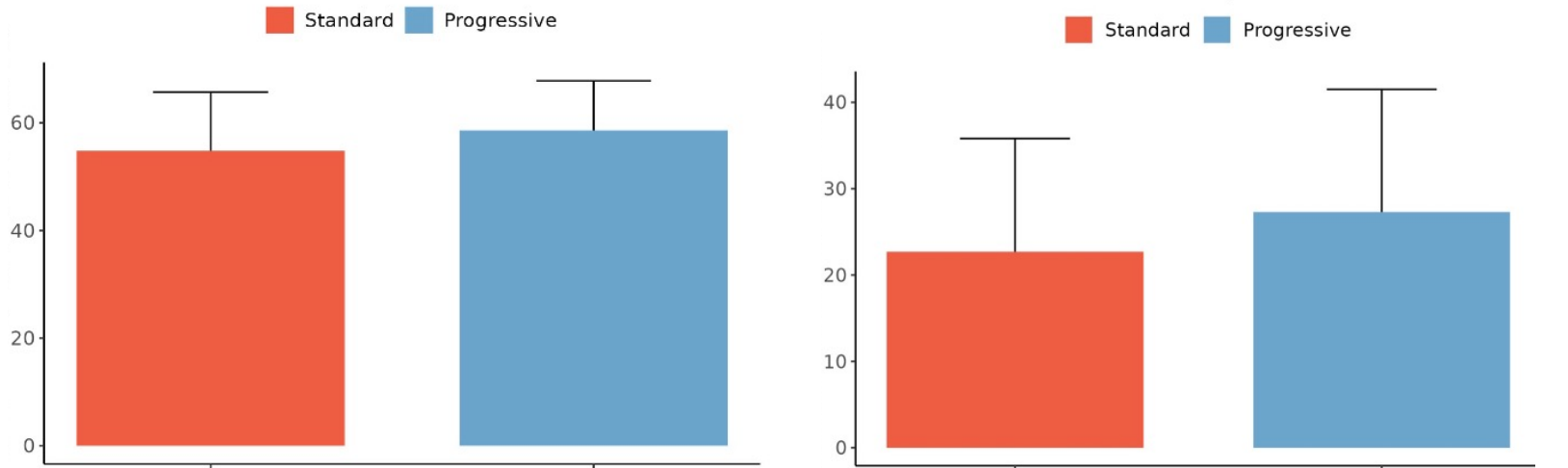


Fig. 5. ISQ values for all implants (SI + PI)

Fig. 6. Ncm values for all implants (SI + PI)

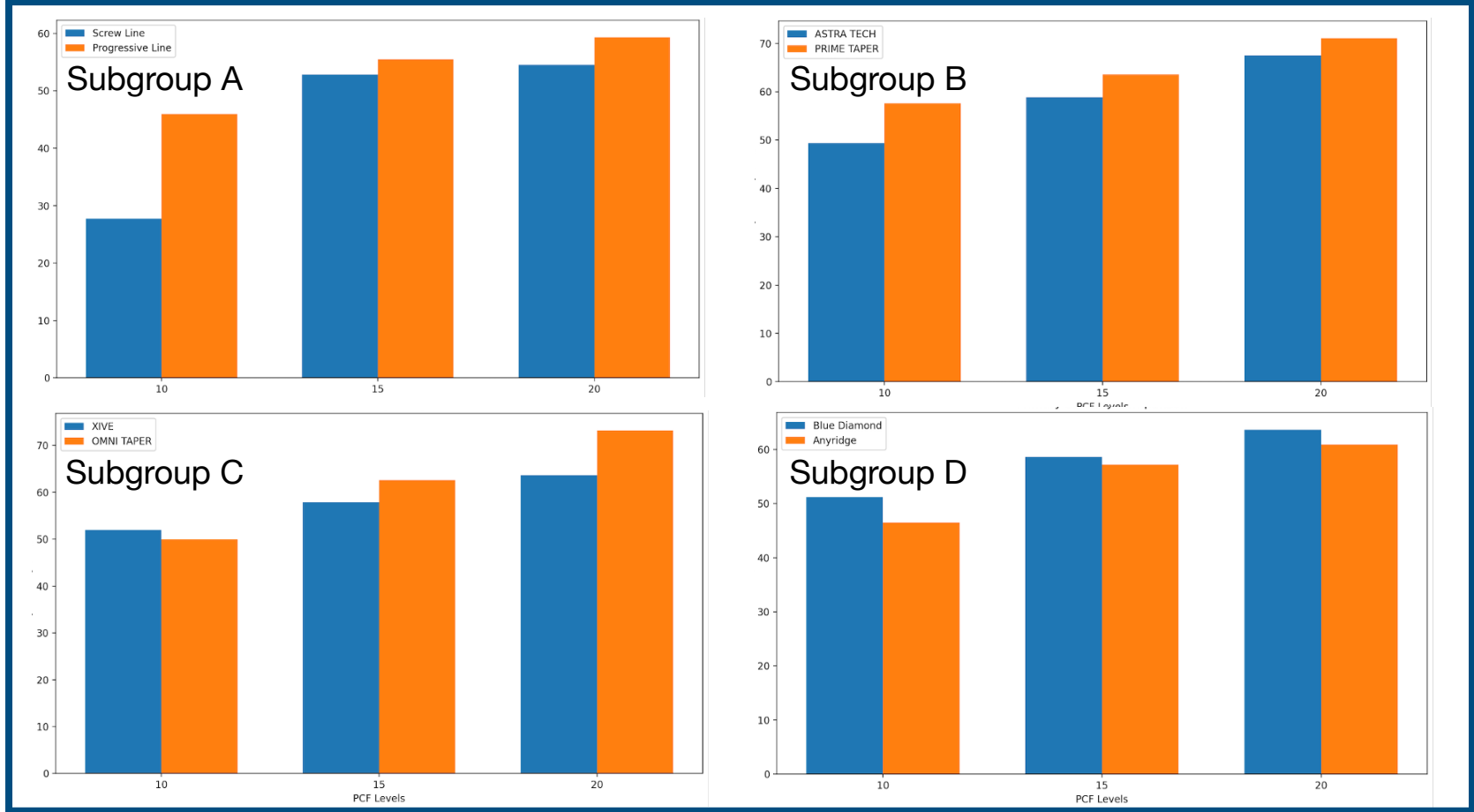


Fig. 2. Primary stability in ISQ of subgroups A-D in different bone densities (10, 15, and 20 pcf), corresponding to bone qualities D4, D3, and D2.