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***Progression to total hip arthroplasty following hip arthroscopy***

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**ABSTRACT**

**Background**: Hip arthroscopy is a minimally invasive surgical technique increasingly being used to treat hip pathology.

There is evidence that a proportion of patients require total hip arthroplasty in the years immediately following arthroscopy, suggesting that these patients have derived only a limited benefit from the procedure. Identification of risk factors for early progression to hip arthroplasty may enable refinement of hip arthroscopy indications and more informed decision making.

The aim of this study is to identify the proportion of patients in a hip arthroscopy cohort who progress to total hip arthroplasty within 2 years of arthroscopy, and to analyse risk factors for this early progression.

**Methods**: A retrospective cohort analysis was conducted on all patients who underwent hip arthroscopy at one tertiary institution from 2004-2013. Hospital data were linked to the Australian Orthopaedic Association National Joint Replacement Registry in 2016 to identify subsequent hip arthroplasty.

**Results**: There were 989 arthroscopies performed on 947 patients; 447 were female (48.1%), the mean age was 41.1 years (SD 14.23), and osteoarthritis was present at arthroscopy in 31.5%. Total hip arthroplasty occurred in 129 patients (13%) within 2 years. Multi-variable

logistic regression revealed osteoarthritis, age >50 and previous arthroscopy were significant risk factors for arthroplasty within 2 years (adjusted odds ratios (CIs): 4.6 (2.91-7.16), 3.8 (2.44-5.87), 2.5 (1.16-5.81)).

**Conclusions**: Osteoarthritis, older age, and history of arthroscopy were independent risk factors for early progression to arthroplasty; these factors should be considered within clinical decision-making, and when discussing potential arthroscopy outcomes with patients.

**Keywords**: arthroplasty, replacement, hip, arthroscopy, risk factors

Word Count: 248 (Abstract), 3977 (Total)

## INTRODUCTION

Hip arthroscopy is a minimally invasive surgical technique for diagnosing and treating hip pathology (1). It is a less invasive alternative than open procedures, and may have a role, although yet unproven, in delaying the progression of osteoarthritis (OA) (2) and need for total hip arthroplasty (THA).

Advances in techniques and equipment in recent years has enabled an increase in the applications of hip arthroscopy (3), which is associated with a significant increase in the number of arthroscopies being performed, particularly in the private sector in Australia. This is reflected in a 600% increase by trainee surgeons from 2006 to 2010 (1), and a projected growth of 15% per year (4).

With the increased use of hip arthroscopy it is important that the procedures are performed on those patients most likely to obtain clinical benefit. Two recent studies have

shown that a proportion of patients proceed to THA within 24 months of hip arthroscopy. Sing et al (5) demonstrated that 8.7% patients progressed to a THA within 24 months and a study from the United Kingdom demonstrated a similar number of patients (10.6%) underwent THA within 24 months (6).

The identification of risk factors associated with early conversion to THA after hip arthroscopy has become a focus of recent research to enable prediction of patients unlikely to benefit from hip arthroscopy. Pre-existing OA (3,7, 8) has consistently been identified as a significant risk factor for early arthroplasty following hip arthroscopy.

Age at arthroscopy has also been associated with risk of early progression to THA, however studies have not accounted for the influence of co-existing OA (5, 6, 8). Schairer et al (2) demonstrated a relationship between age and subsequent THA (2), but other studies have been less conclusive (7,9,10), or based on specific sample populations with restricted generalisability (9, 10). Obesity may also influence the risk of progression from hip arthroscopy to THA (2, 11).

The aim of this study is to examine a cohort of patients who underwent hip arthroscopy in a large private tertiary hospital to:

1) Identify the proportion of patients who progressed to THA within 24 months.

2) Identify the risk factors for progression to THA in these patients.

**METHODS**

A retrospective cohort analysis was conducted on all patients who underwent hip arthroscopy at Epworth HealthCare's three metropolitan sites over a 10 year period (2004-2013 inclusive) (see Figure 1.). Patients were excluded from the study if they had extracapsular procedures only, had a THA in situ, or had a diagnosis of septic arthritis. Information on patient demographics, hip laterality, arthroscopic indications, diagnoses, pathology present including Outerbridge grade of cartilage change, intervention performed, previous arthroscopy, diabetes comorbidity and use of anti-coagulants was extracted from medical records including operative reports. The diagnosis of OA was extracted from operative notes as recorded by the surgeon; when absent, a diagnosis was allocated on the basis of diffuse Grade IV Outerbridge changes. Imaging data was not available to identify radiological signs of OA at the time of the hip arthroscopy. Unfortunately the network's radiology provider changed during the study period and access to images was not always available. Also, the majority of patients had hard copy films done at institutions outside Epworth and it was thought to be impractical to search for all the images. We therefore relied on the intra-operative findings documented at arthroscopy to make the diagnosis of OA. The incidence of acute complications (occurring within in 28 days of arthroscopy) was recorded.

These data were individually linked to the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) to identify which patients had subsequently undergone THA, and when this occurred. Both total joint arthroplasty and resurfacing operations were considered to represent THAs. The laterality of THA was matched to that of arthroscopy, so as to avoid erroneous arthroscopy and contralateral arthroplasty associations. The AOANJRR captures the occurrence of all hip arthroplasties in

Australia (both total arthroplasty and resurfacing operations), enabling complete follow-up of arthroplasty incidence amongst our cohort. The specified time period was chosen to enable a minimum follow-up period of 2 years (to a maximum of 12 years) for THA progression.

The results were analysed using IBM SPSS (version 22.0). Univariate logistic regression analyses was used to initially identify statistically significant risk factors for THA within 2 years (reference categories: male gender; age <50 years; BMI <25; the absence of OA, labral pathology treatment, FAI treatment, complications; or previous ipsilateral arthroscopy). Multivariable logistic regression was then used to confirm these risk factors, with adjustment for potential confounders. Independent variables for analyses were specified *a priori* and included age, sex, body mass index (BMI <25 kg/m² normal weight, 25-29kg/m² overweight, e30 kg/m² obese)(12), OA diagnosis, non-arthritic cartilage change, Outerbridge grade of femoral or acetabular cartilage change, procedure undertaken, prior arthroscopy, diabetes, and post-operative complications. The dependent variable was the occurrence of THA within 2 years of arthroscopy (recorded as a binary outcome), which was used to characterise early progression to THA. Patients who had simultaneous bilateral arthroscopies contributed two arthroscopies to the analysis, as each side represented a possible dependent variable outcome (early progression to THA). When an arthroscopy was repeated on the same side, only the most recent arthroscopy was included in the analysis.

Overall, missing data were low. Patients with missing operation reports (n=4, 0.4%) or missing BMI data (n=60, 6%) were excluded from the regression analyses. As 14% of acetabular or femoral Outerbridge grades were missing, these variables were also excluded

from the multivariate model. Diabetes did not present with sufficient frequency (n=19) to be included as a predictor variable.

Ethics approval was granted by Epworth Healthcare's Ethics Review Board.

## RESULTS

### Patient Characteristics

There were 947 patients (989 hips) who had a hip arthroscopy and medical records available for analysis. Of these, 48.1% (447/989) were performed on females, the mean age at arthroscopy was 41.1 years (SD 14.23) and 26.8% (265/989) were performed on patients aged over 50 years. There were 32.3% patients (319/989) with a BMI in the overweight range (25- 29) kg/m² and 16.1% (159/989) of patients in the obese range (BMI e30). Osteoarthritis, as recorded in the patient records was present at arthroscopy in 31.5% (312/989). Treatment of labral pathology occurred in 58.7% (581) of patients, and treatment of Femoral Acetabular Impingement (FAI) in 60% (590/989) of patients. There was a low incidence of post or intraoperative complications (1.5%; 15/989); including 1 deep vein thrombosis, 3 neuropraxias, 2 perineal tissue injuries and 2 wound infections.

### Progression to THA

Progression to THA within 2 years following hip arthroscopy occurred in 129 (13%) of patients. Over the whole time period studied, 210 (21%) patients who had a hip arthroscopy underwent a THA, with 81 patients undergoing THA after 2 years (mean 3.85, range 2.07-14.33). Early THA occurred in 15% (71/447) of females, 11% (58/542) of males,

7% (49/724) of those aged <50, 25% (43/171) of those aged 50-59, 37% (28/76) aged 60-69, and in 50% (9/18) of those e 70 or older. Ten percent (43/450) of normal weight patients underwent early THA, as did 14% (46/319) of overweight patients, and 20% (32/159) of obese patients. Of those with OA; 29% (90/312) underwent early THA compared to 6% (39/675) of those without OA.

**Odds of early progression to THA**

Univariate logistic regression identified independent risk factors for early THA as overweight (OR 1.6, CI 1.02-2.48), and obesity (OR 1.9, CI 1.22-2.98). Treatment for FAI was associated with a reduced risk of progression to early THA (OR 0.61, CI 0.42-0.88). However, these factors were not significant on multivariate analysis.

Multivariate logistic regression analysis revealed that OA (OR 4.6, CI 2.91-7.16), age e 50 years (OR 3.8, CI 2.44-5.87) and previous arthroscopy of the ipsilateral hip (OR 2.6, CI 1.16-5.81) were independent risk factors for progression to hip arthroplasty within 2 years.

There were no significant differences in potential risk factors (age, OA, previous arthroscopy) between those with or without BMI data. There was a higher proportion of missing BMI data in patients with a diagnosis of FAI (No BMI data 40%, BMI data 61%, Chi square 10.7, p= 0.001), however this variable was not shown to significantly predict THA progression in the multivariate model.

**DISCUSSION**

This study is the first to evaluate progression of hip arthroscopy to hip arthroplasty in a large tertiary hospital cohort through linkage to a national arthroplasty registry. The proportion of patients who progressed to THA within 2 years post arthroscopy was 13% in this study. Malviya et al. (6) and Schairer et al. (2) demonstrated similar rates of progression to THA at 2 years follow-up, with 10.6% and 11.7% of patients progressing respectively. This proportion of patients continues to represent a significant number who may gain only a limited benefit from the procedure, and might be better managed by non-operative treatment and planning for future THA. Continued refinement of hip arthroscopy indications therefore remains pertinent.

A major strength of this study comes from the 10 year study timeframe, the large number of individual patient record reviews, and the data linkage to the AOANJRR. The AOANJRR offers comprehensive capture of all THAs performed in public and private hospitals around Australia. This means that THAs performed in a different setting (or geographical area) to the index hip arthroscopy procedure would still have been captured. This study approach enabled complete follow up of progression to THA for our cohort, and the sample size provides sufficient power for risk factor analysis, which is lacking in earlier studies (11). Several previous studies been restricted to large scale database analyses, which have relied on coding data for diagnoses, and assumed laterality of all subsequent THAs (2, 5, 6). Our study used individual operation reports that more accurately record existing hip pathology, and confirmation that THA matched the same side as the arthroscopy. Taken together, these approaches offer greater confidence when interpreting this study's findings.

As anticipated, OA was demonstrated to independently predict progression to early THA (OR 4.6) and has previously been identified in the existing literature (3, 7, 8). This study used an operative diagnosis of OA as we did not have access to pre-operative radiographs or MRI findings. Previous research has found that pre-operative imaging is associated with progression to THA. Use of preoperative imaging by Philippon et al. (13) found that joint space narrowing (<2mm), and Tonnis Grade 2 or 3 to be 81% and 65% was predictive of progression to THA at a median 23 months following hip arthroscopy.

The independent influence of patient age on early progression to THA was also confirmed in this study. The rate of early progression to THA increased from 7% for the <50 years old group, to 25% for those 50-59 years, 33% for those 60-69 years, and 50% for those >70 years. The multivariate model identified that when co-existing OA was considered, being aged over 50 years remained a significant risk factor for early THA, consistent with a previous study by Schairer et al.(2). The odds of early THA identified in this study increased from 2.9, to 5.5 and 8.9 for the respective age groups >50, and should inform surgeon-patient discussion and decision making. Although different comparator groups were used, our findings are also broadly consistent with those reported by Domb et al.(10) who found an increased risk of progression to THA for patients aged >50 years (17.3%) compared to those <30 years (1.9%). As 50 % of patients >70years of age in our study progressed to THA within 2 years this highlights the need for clear surgeon-patient discussions of expectations of treatment in this age group.

Obesity was not found to be an independent risk factor for early THA progression in the multivariate model. A trend in the progression to early THA was seen with increasing

BMI category: with <25, 25-29 and e 30kg/m² categories associated with 10%, 14% and 20% rates of early THA respectively. Univariate analysis did identify a significant influence of overweight and obesity (OR 1.6 & 1.9 respectively) when BMI was viewed in isolation. However, this influence did not remain significant when BMI was considered in conjunction with other risk factors. This finding differs from that of Schairer et al.(2) who found an independent influence of obesity (odds ratio 2.4), and the meta-analysis by Bech et al. (14) which reported (odds ratio 2.2). This difference may be due to the different characteristics of the study samples, with specific regard to patient co-morbidities. Only 9.6% of Schairer et al's sample had co-existing OA compared to 31.5% in our sample, and the Gupta et al.(11) study, on which much of Bech et al's conclusion are based, excluded patients with OA. These studies do however, call for the clinical significance of these results to be considered in light of the rate of THA conversion among obese patients. In our study this incidence was 14% and 20% for BMI 25- 29 and e 30 respectively, and 22.8% and 8% for obese patients in Schairer et al.'s and Bech et al.'s studies respectively. This suggests that the majority of patients with BMI e 25 and e 30 avoid early progression to THA, and being overweight or obese has not been demonstrated to be a risk factor for early progression to THA following hip arthroscopy.

We also acknowledge the limitations of this study. The diagnosis of OA was based on non-standardised operation reports. This has the potential to introduce greater variability in OA diagnosis, and may contribute to the high percentage of patients in our cohort with OA (31.5%), that was not seen in Schairer et al.'s larger population review (2). In addition, this study did not use preoperative measures to define OA, such as radiographs or measures of

joint space narrowing. The likelihood of progression to THA due to OA, as identified in this study cannot be generalized to give a prospective risk to patients who have OA preoperatively defined by other means.

Furthermore, the authors recognize the indications for hip arthroscopy may vary from FAI and labral pathology in the younger population, to OA in an older population. The different cohorts that receive hip arthroscopy are likely to have different management strategies and thresholds for considering THA. For example, a younger person with FAI would likely have a very high threshold for THA, with different hip preservation strategies implemented before considering THA. An older person with OA may have a much lower threshold for THA, and be considered for this early on in their management strategy. The findings reported here, will therefore have different relevance to patients with different arthroscopy indications.

The success of arthroscopy in patients at higher risk of early progression to THA may be considered with reference the patient's expectations and individual goals. Patients who identified short term goals following their arthroscopy, and were able to meet these goals before undergoing THA may consider their hip arthroscopy successful despite the early need for THA. Those patients with goals or expectations following their arthroscopy that were unable to meet these because of their early THA may however consider their arthroscopy as unnecessary. Surgeon-patient discussions of expectations of hip arthroscopy therefore, remain important when considering the utility of THA in patients at higher risk of early THA.

The identified risk factors for early THA post arthroscopy (age > 50 and OA) are also known risk factors for THA in the general population. This study did not have a control group to compare the progression to early THA, so we were unable to identify whether hip arthroscopy might delay THA.

The risk factors for progressing to early THA identified in this study and previous studies can help to identify patients at higher risk of early progression to THA. Surgeons can use this information to consider the appropriate indications for hip arthroscopy and to have a well-informed discussion with their patients regarding expected outcomes from arthroscopy.

## CONCLUSION

Hip arthroscopy performed on patients with OA, aged older than 50 or with a previous arthroscopy of the hip is associated with a significantly higher likelihood of progression to THA within 2 years. Obesity was not a significant risk factor for early progression to THA, when considered in conjunction with other risk factors.

## DISCLOSURE

There were no funding sources or conflicts of interest to report.



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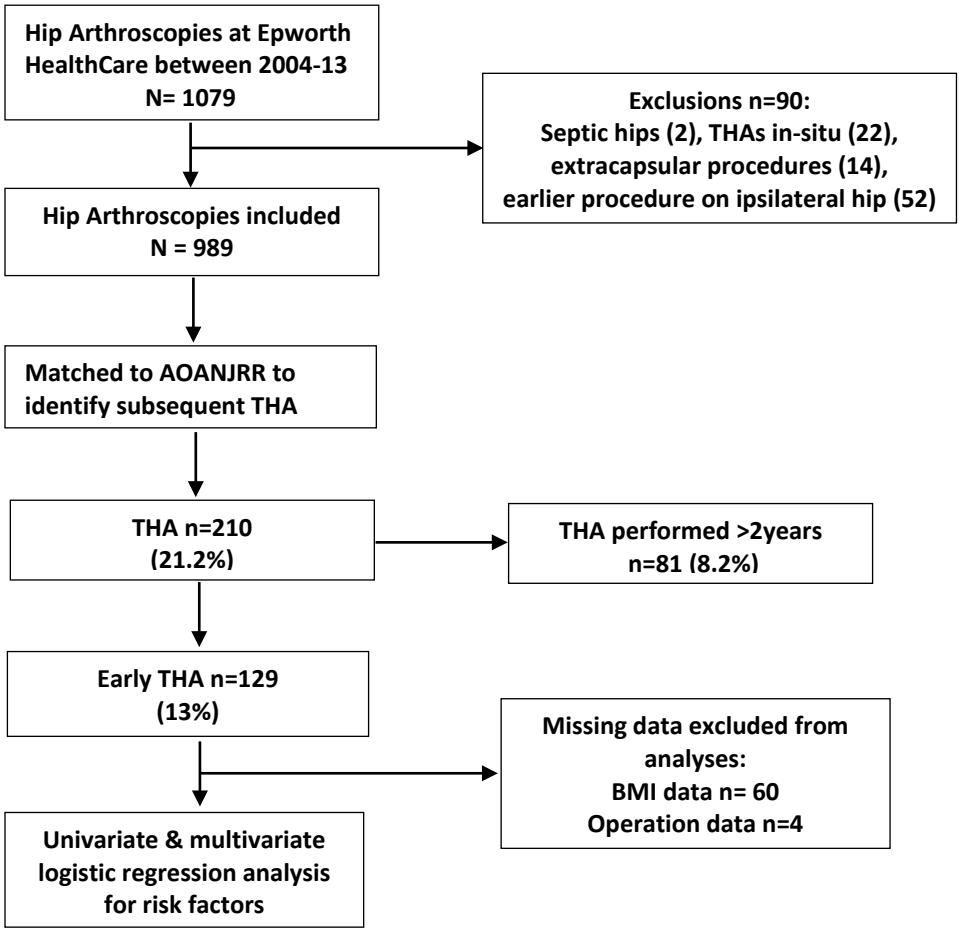
**Figure Legend:**

- **Figure 1. Arthroscopy Cohort Results**
- **Table 1. Patient Characteristics**
- **Table 2. Prevalence and Odds of progressing to early THA**
- **Table 3. Time points of THA after 2 years**

**Figure 1. Arthroscopy Cohort Results.**



## Table 1. Patient Characteristics

| Patient Characteristic | | Sample | % of sample |
|---|---|---|---|
| **Gender** | Male | 513 | 51.9 |
| | Female | 476 | 48.1 |
| **Age** | <50 years | 724 | 73.2 |
| | 50-59 years | 171 | 17.3 |
| | 60-69 years | 76 | 7.7 |
| | ≥70 years | 18 | 1.8 |
| **Body Mass Index** | <25 kg/m² | 450 | 45.5 |
| | 25-29 kg/m² | 319 | 32.3 |
| | ≥30 kg/m² | 159 | 16.1 |
| | Missing | 60 | 6 |
| **OA** | Absent | 675 | 68.3 |
| | Present | 312 | 31.5 |
| | Missing | 2 | 0.2 |
| **Labral Pathology Treated** | No | 404 | 41.3 |
| | Yes | 581 | 58.7 |
| | Missing | 4 | 0.4 |
| **FAI Treatment** | No | 395 | 39.9 |
| | Yes | 590 | 59.7 |
| | Missing | 4 | 0.4 |
| **Complications** | No | 974 | 98.5 |
| | Yes | 15 | 1.5 |
| **Previous arthroscopy†** | No | 945 | 95.6 |
| | Yes | 44 | 4.4 |

† on same side

## Table 2. Prevalence and Odds of progressing to early THA

| Patient Characteristic | | Prevalence (%) | Univariate - | Multivariate - |
|---|---|---|---|---|
| **Gender** | Male | 58 (11) | 1.00 | |
| | Female | 71 (15) | 1.38 (0.95-2.00) | |
| **Age** | <50 years | 49 (7) | 1.00 | |
| | 50-59 years | 43 (25) | 4.63 (2.95-7.27) * | 2.90 (1.75-4.79)* |
| | 60-69 years | 28 (33) | 8.04 (4.64-13.91) * | 5.50 (2.94-10.30) * |
| | ≥70 years | 9 (50) | 13.78 (5.23-36.28) * | 8.86 (3.10-25.37) * |
| **Body Mass Index** | <25 kg/m2 | 43 (10) | 1.00 | |
| | 25-29 kg/m2 | 46 (14) | 1.60 (1.02-2.48) * | 1.29 (0.79-2.10) |
| | ≥30 kg/m2† | 32 (20) | 2.39 (1.45-3.93) * | 1.51 (0.86-2.65) |
| | Missing | 8 (13) | | |
| | <30 kg/m2 | 89 (24) | 1.00 | |
| | ≥30 kg/m2‡ | 32 (20) | 1.91 (1.22-2.98)* | 1.29 (0.79-2.14) |
| **OA** | Absent | 39 (6) | 1.00 | |
| | Present | 90 (29) | 6.61 (4.41-9.92) * | 4.56 (2.91-7.16) * |
| **Labral Pathology Treated** | No | 54 (13) | 1.00 | |
| | Yes | 75 (13) | 0.96 (0.66-1.40) | |
| **FAI Treatment** | No | 65 (16) | 1.00 | |
| | Yes | 64 (11) | 0.61 (0.42-0.88) * | 0.87 (0.36-2.09) |
| **Complications** | No | 128 (13) | | |
| | Yes | 1 (7) | ^ | |
| **Previous arthroscopy** | No | 118 (12) | 1.00 | |
| | Yes | 11 (25) | 2.34 (1.15-4.75) * | 2.59 (1.16-5.81) * |

* Significant predictor of THA within 2 years; p<0.05, ^ Insufficient prevalence for inclusion in a logistic regression model

†BMI <25 to ≥30 comparison, ‡ BMI ≥30 (Obese) to BMI <30 (non-obese) comparison

Femoral and Cartilage variables were excluded from analysis given missing data (n=136)

Adjusted odds ratios were derived from multivariate binary logistic regression models with age, body mass, OA, FAI treatment, and previous arthroscopy of the same side entered simultaneously as predictors

**Table 3. Time points of THA after 2 years**

| Number | Time | Number | Time | Number | Time | Number | Time |
|---|---|---|---|---|---|---|---|
| 1 | 2.07 years | 22 | 2.61 years | 43 | 3.33 years | 64 | 4.88 years |
| 2 | 2.07 | 23 | 2.67 | 44 | 3.33 | 65 | 4.94 |
| 3 | 2.08 | 24 | 2.68 | 45 | 3.42 | 66 | 5.02 |
| 4 | 2.08 | 25 | 2.7 | 46 | 3.47 | 67 | 5.06 |
| 5 | 2.09 | 26 | 2.71 | 47 | 3.55 | 68 | 5.19 |
| 6 | 2.13 | 27 | 2.81 | 48 | 3.63 | 69 | 5.23 |
| 7 | 2.13 | 28 | 2.85 | 49 | 3.64 | 70 | 5.24 |
| 8 | 2.13 | 29 | 2.93 | 50 | 3.69 | 71 | 5.61 |
| 9 | 2.14 | 30 | 2.96 | 51 | 3.87 | 72 | 5.63 |
| 10 | 2.24 | 31 | 2.97 | 52 | 3.92 | 73 | 5.95 |
| 11 | 2.26 | 32 | 3.09 | 53 | 3.99 | 74 | 6.1 |
| 12 | 2.3 | 33 | 3.1 | 54 | 4.02 | 75 | 6.67 |
| 13 | 2.31 | 34 | 3.11 | 55 | 4.05 | 76 | 6.9 |
| 14 | 2.34 | 35 | 3.2 | 56 | 4.15 | 77 | 7.39 |
| 15 | 2.38 | 36 | 3.21 | 57 | 4.31 | 78 | 7.99 |
| 16 | 2.39 | 37 | 3.21 | 58 | 4.33 | 79 | 8.08 |
| 17 | 2.41 | 38 | 3.21 | 59 | 4.4 | 80 | 10.3 |
| 18 | 2.42 | 39 | 3.26 | 60 | 4.43 | 81 | 14.33 |
| 19 | 2.52 | 40 | 3.26 | 61 | 4.69 | | |
| 20 | 2.53 | 41 | 3.29 | 62 | 4.73 | | |
| 21 | 2.6 | 42 | 3.3 | 63 | 4.87 | | |