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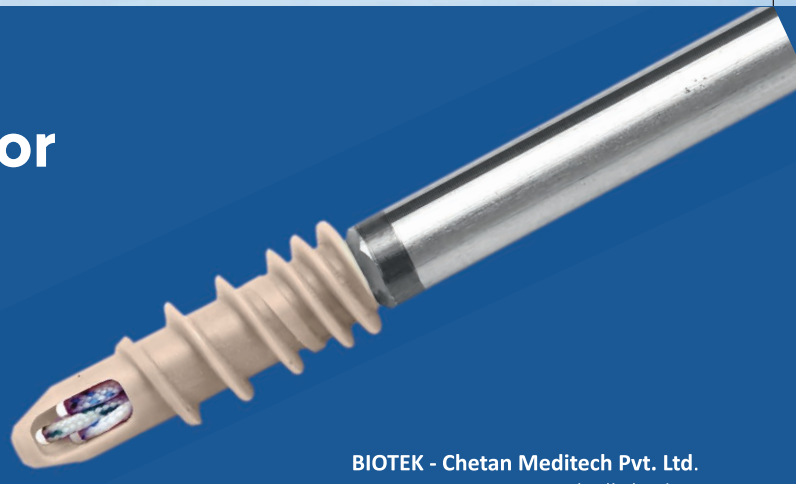

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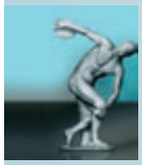

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Aims and Scope

Journal of Arthroscopy and Joint Surgery (JAJS) is committed to bring forth scientific manuscripts in the form of original research articles, current concept reviews, meta-analyses, case reports and letters to the editor. The focus of the Journal is to present wide-ranging, multi-disciplinary perspectives on the problems of the joints that are amenable with Arthroscopy and Arthroplasty. Though Arthroscopy and Arthroplasty entail surgical procedures, the Journal shall not restrict itself to these purely surgical procedures and will also encompass pharmacological, rehabilitative and physical measures that can prevent or postpone the execution of a surgical procedure. The Journal will also publish scientific research related to tissues other than joints that would ultimately have an effect on the joint function.

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Research paper

Indian Orthopaedic surgeons are less burned out than their Western colleagues

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ABSTRACT

Background: Burnout is a tridimensional psychological syndrome, the consequences of which in surgeons can be devastating. A preliminary review of the literature has demonstrated a paucity of validated studies measuring the levels of surgeon burnout throughout Asia. The purpose of this paper was to assess the prevalence and factors associated with burn out in Indian orthopedic surgeons and compare them to their western colleagues.
Materials & methods: This nationwide cross-sectional study was conducted at the Indian Orthopaedic Association Annual Meeting, via a validated burnout assessment instrument. Variables were compared using the chi-square, Mantel-Haenszel and Mann-Whitney-*U* tests. Variables associated with burnout subscales and overall burnout were explored using multiple linear and logistic regression.
Results: There were 299 responses to the survey, 23.1% of the surgeons were allocated burnout status. There was a significant ($p < 0.001$) association between burnout, all measures of satisfaction and health. This association also existed for half-days in public practice ($p = 0.03$) and marital status ($p < 0.001$).
Conclusion: This is the first study to assess burnout among orthopedic surgeons in Asia. The use of a validated instrument facilitates future cross study comparisons. There were low levels of burnout in the Indian orthopedic profession, when compared to western countries, albeit a variety of sociocultural factors may play a role. There was evidence to suggest that the number of half-day sessions per week in public practice was associated with burnout, possibly attributed to longer hours and less flexibility. Satisfaction with training pathway was consistently significantly associated with all burnout subscales, a focus for future interventions. A strongly significant association persisted with our previous Australian study between burnout and marital status, emotional support and family stability critical for burnout minimization.

1. Introduction

Burnout is a tridimensional psychological syndrome of emotional exhaustion, inter-personal depersonalization and a reduced self-evaluation of accomplishment.[1] Doctors and other allied health professionals are especially susceptible to burnout, when compared to the general population.[2] This was suggested as an "inevitable consequence" of the maladaptive adaptation to the demands of working in the health care system.[3] The long hours, emotional patient interactions and high-pressure environment, responded to with low prioritization of self-care and denial of individuals own emotions.[4,5]

The principal symptoms of burnout in doctors are the objectification of patients and colleagues, emotional and physical exhaustion, poor judgment, cynicism and depersonalization in relationships.[2] Burnout in doctors, particularly surgeons is of critical importance as the consequences can be devastating for the individual, patients and institution.[6] Orthopedic surgeons were placed in the top five most burnout specialties when compared with other doctors and hospital staff.[7]

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A review of burnout[7] described the consequences for doctors to include emotional and physical illness, reduced satisfaction, drug abuse and poor health (such as hypertension, sleep disturbance and myocardial infarction). Manifesting institutionally as poor performance, increase turnover and medical errors and associated deficits in quality of medical care and safety for patients.

Previously the prevalence of burnout in surgeons has been reported as 30–38% and 50–60% in orthopedic surgeons, compared to 28% in throughout the general US working population.[2,7] This was found to be consistently higher in residents and trainees.[7] Our team has found that 53% of Australian orthopaedic trainees were burned out.[2] Analyzing the positive or negative association between work-related (including career position and satisfaction with work-life balance) and non-work-related (demographic data) factors with burnout.[2] A preliminary review of the literature has demonstrated a paucity of validated studies measuring the levels of burnout in doctors throughout Asia and the sub-continent. This study is the first to assess the prevalence and factors associated with burn out in Indian orthopedic surgeons.

2. Methods

2.1. Design, participants and setting

This nationwide cross-sectional study was conducted at the Indian Orthopaedic Association Annual Meeting, in December 2013. A hard copy survey was distributed to attendees throughout each session and completed forms collected at the end of each session. 2200 copies of the survey were distributed and there were 299 responses. All participants had complete data pertaining to burnout assessment. Ethics approval was obtained from the 'Institutional Ethics Approval of Dr. D.Y. Patil Hospital and Research Centre'.

2.2. Data collection

In November 2013 a pilot survey was trialed by 10 consultants at our institution, assessing the overall ambiguity, comfort and feasibility of questions. Preliminary feedback was satisfactory and no modifications were made. The survey was divided into two sections; a self-developed questionnaire and a validated burnout assessment tool.

The self-developed questionnaire assessed a variety of work related and non-work related factors potentially associated with burnout (Table 2). It comprised of 12 questions related to participant demographics, four items measuring satisfaction with career, work-life balance, income and training pathway and a subjective self-assessment of overall health (adapted from the short-form-health survey – SF-36).[2,8]

The Maslach Burnout Inventory (MBI)–Human Services Survey was the validated burnout assessment instrument of choice. It consists of three subscales and corresponding dimensions: nine items quantifying emotional exhaustion (stress dimension), five items measuring depersonalization (interpersonal context dimension) and eight items calculating personal achievement (self evaluation dimension).[1,6]

2.3. Statistical analysis

The overall scores of participants in each subscale were categorized into low, medium and high levels of burnout, subject to a priori guidelines by MindGarden Inc. (Menlo Park, CA, USA). A correlation exists between burnout and high levels of emotional exhaustion and depersonalization, albeit personal achievement is inversely proportional. Consistent with previous studies, we have defined participant burnout as high emotional exhaustion or depersonalization subscale scores (Table 1).[2]

Characteristics of participants were first analysed according to final burnout status (Table 2). Nominal categorical variables were presented as proportions and compared using the chi-square test. Ordered categorical variables with >2 categories (age, current position, years worked as an orthopaedic surgeon, half-day sessions per week in public practice, half-day sessions per week in private practice, income bracket compared to peers in orthopaedic surgery) were analysed for evidence of a trend for increasing or decreasing proportions of the outcome from the first to the last category using the Mantel-Haenszel test for trend. Where a trend was confirmed this was then tested for significant departures from the observed trend. All continuous variables were non-normally distributed. These variables were presented as medians with inter-quartile ranges (IQR), and compared using the Mann-Whitney-*U* test.

Variables associated with each of the three-burnout subscales were explored using multiple linear regression. Variables evaluated are listed in Table 4. The univariate association between each of the three burnout subscales and these variables was first explored using simple linear regression. Dummy variables were created for categorical variables with more than 2 categories. Those variables whose association with the subscale had a $p < 0.20$ were then included in the multivariate model. Using stepwise backward elimination, variables were removed until only variables with $p < 0.05$ remained in the model.

Variables associated with burnout were explored using logistic regression. Those variables whose univariate association with burnout had a $p < 0.20$ were then included in the multivariate model. Using stepwise backward elimination, variables were removed until only variables with $p < 0.05$ remained in the model. Variables that had a significant association with burnout after controlling for the confounding effect of other variables are presented in Table 6. All analyses were conducted using IBM SPSS Statistics v21 (IBM Corp, Armonk, New York, USA). P values of <0.05 were considered statistically significant.

3. Results

There were 299 (13.6%) responses from the 2200 copies of the survey distributed. Overall 15%, 17% and 38% of participants scored high levels of emotional exhaustion, depersonalization and low personal accomplishment respectively; resulting in 69 (23.1%) of the surgeons allocated a burnout status (Table 1).

The association between burnout status and participant demographics is illustrated in Table 2. There was a significant ($p < 0.001$) association between burnout and all measures of satisfaction and health. This association also existed for half-days

Table 1
Rates of various levels for each subscale of the MBI – Human Services Survey.

Subscales of the Maslach Burnout Inventory	Low (% of participants)	Level Medium (% of participants)	High (% of participants)
Emotional Exhaustion	0–16 (58)	17–26 (27)	≥27 (15)
Depersonalization	0–6 (48)	7–12 (35)	≥13 (17)
Personal accomplishment	≥39 (38)	32–38 (30)	0–31 (32)

Table 2
Characteristics of participants according to burnout status.

	Burnout		
	Yes	No	
n (%) Total = 299	69 (23.1)	230 (76.9)	
	Median(IQR)	Median(IQR)	p
Number of children	1 (0–2)	1 (0–2)	0.26
How would you rate your health (scale 1–5: 1 = poor, 5 = excellent) <0.001	3 (2–3)	3 (3–4)	
Satisfaction with career (scale 1–5: 1 = low, 5 = high) <0.001	5 (3–5)	5 (4–5)	
Satisfaction with work-life balance (scale 1–5: 1 = low, 5 = high) <0.001	2 (2–4)	4 (3–4)	
Satisfaction with income (scale 1–5: 1 = low, 5 = high) <0.001	2 (2–4)	4 (3–4)	
Satisfaction with training pathway (scale 1–5: 1 = low, 5 = high) <0.001	2.5 (1–4)	4 (3–5)	
	n (row %)	n (row %)	p
Age bracket (years)			
20–29	9 (15)	53 (85)	
0.21[a]			
30–39	22 (32)	46 (68)	
40–49	9 (13)	61 (87)	
≥50–59	29 (29)	70 (71)	
Sex			
Male	67 (23)	219 (77)	
0.51[b]			
Female	2 (15)	11 (85)	
Marital status			
Married or Defacto	41 (18)	181 (82)	
<0.001			
Never married	19 (31)	43 (69)	
Divorced	9 (60)	6 (40)	
Partner in medical profession			
Yes	32 (20)	131(80)	0.12
No	37 (27)	99 (73)	
Current position			
Resident/senior resident	18 (24)	58 (76)	0.89
Consultant	24 (20)	94 (80)	
Head of department	7 (29)	17 (71)	
Assistant professor/lecturer	15 (25)	46 (75)	
Associate/full Professor	4 (22)	14 (78)	
Years worked as an Orthopaedic surgeon			
0–9	41 (22)	144 (78)	
0.72[a]			
10–19	23 (31)	51 (69)	
≥20	5 (13)	33 (87)	
Practice region			
North India	19 (23)	64 (77)	0.14
South India	16 (24)	52 (76)	
East India	15 (38)	24 (62)	
West India	15 (19)	66 (81)	
Central India	4 (15)	22 (85)	
Half-day sessions per week in public practice			
0–3	21 (19)	90 (81)	
0.03[a]			
4–5	16 (22)	58 (78)	
6–7	4 (15)	23 (85)	

Table 2 (*Continued*)

	n (row %)	n (row %)	p
8 or more	28 (34)	55 (66)	
Half-day sessions per week in private practice			
0–3	25 (29)	60 (71)	
0.13[a]			
4–5	15 (27)	40 (73)	
6–7	4 (11)	31 (89)	
8 or more	25 (22)	90 (78)	
Income bracket compared with peers in orthopaedic surgery			
Bottom 25%	40 (33)	80 (67)	
0.07[a]			
25–49%	10 (13)	67 (87)	
50–74%	10 (16)	54 (84)	
Top 25%	9 (29)	22 (71)	
Smoking status			
Non-smoker	46 (22)	167 (78)	0.18
Smoker	23 (29)	56 (71)	
Considered leaving the profession in past year			
No	54 (21)	203 (79)	0.02
Yes	15 (38)	24 (62)	

[a] Mantel-Haenszel test for trend.
[b] Chi-square test may not be valid due to expected counts <5 in one or more cells.

in public practice ($p = 0.03$) and marital status; 60% of divorcees were burnt out in comparison to burnout in 31% who were never married and 18% who were married or in a de facto relationship ($p < 0.001$). 38% of surgeons who had considered leaving the profession in the past year were burnt out, comparative to 21% who had not ($p = 0.02$). No other demographic variable was significantly associated to burnout.

3.1. Regression modeling

Self-rated health, satisfaction with income, and satisfaction with training pathway were found to have a significant (negative) association with the emotional exhaustion score (Table 4). For each one unit increase in a variable, the emotional exhaustion score fell by the value of the corresponding regression coefficient. This model explains 28% of the variability in the emotional exhaustion score ($R^2 = 0.28$).

Having a spouse in the medical profession, income bracket, satisfaction with career and satisfaction with training pathway were found to have a significant (negative) association with the depersonalization score (Table 4). For each one unit increase in a variable, the depersonalization score fell by the value of the corresponding regression coefficient. This model explains 19% of the variability in the emotional exhaustion score ($R^2 = 0.19$).

Satisfaction with training pathway was the only variable found to have a significant association with the personal accomplishment score (Table 4). For each one unit increase in this variable, the personal accomplishment score increased by 1.21 points. This model explains 4% of the variability in the personal accomplishment score ($R^2 = 0.04$).

The univariate association between variables of interest and burnout via logistic regression are listed in Table 3. Age, marital status, spouse in medical profession, years worked as an orthopedic surgeon, practice region, number of half-day sessions in public or private practice, income bracket, smoker and health status, satisfaction and considering leaving the profession were included in the multivariate analysis ($p < 0.2$ criterion). The only variables with significant association with burnout after controlling for confounding factors of all the other variables were Age ($p = 0.01$), marital status ($p = 0.001$), income bracket ($p = 0.05$), health ($p < 0{,}001$) and satisfaction with training pathway ($p = 0.02$) (Table 4).

4. Discussion

This is the first study to assess burnout among orthopedic surgeons in India. The use of a validated instrument allows for historical and future cross study, country and occupational comparisons. The results and trends observed in this study may be extrapolated to the surrounding regions with similar socio-demographic and medical institutional contexts.

An unexpected finding identified from the study is the low level of burnout in the Indian orthopedic profession (23.1%), when compared to western countries; Australia (53% of registrars) and USA (50% and 56% for orthopedic surgeons and trainees).[2] This result is consistent with another MBI burnout study in doctors and dentists in North India, who exhibited very low levels of burnout, which is surprising given the high levels of poverty, health care needs, shortage of health professionals and heavy work hours.[9] The reduced burnout may be attributed to three primary factors: Less litigation in India compared to western countries, albeit this trend is changing. More Indian surgeons working in private practice, therefore with more control over their work-life balance.[9] Finally the poor socio-demographic context may influence the self-perception of the burnout subscales, work related stresses dismissed as the norm. Carod-Artal and Vázquez-Cabrera encourage caution however when interpreting the MBI internationally as the values vary, subject to the diverse socio-cultural factors of differing countries. They continue to warn of the negative implications if validation of survey instruments in developing countries is not independent of those in developed countries.[10]

Bhugra et al. concluded that private practice provides surgeons with more control over their professional lives and may be responsible for low levels of burnout.[9] However our study did not demonstrate any significant association with the burnout and the number of half-day sessions in private practice ($p = 0.13$). Conversely there was evidence to suggest that the number of half-day sessions per week in public practice was associated with

Table 3
Univariate analysis of the association between Burnout subscale and each explanatory variable.

Explanatory variable	p
Emotional exhaustion	
Age	0.13
Number of children	0.30
Marital status	0.10
Current position	0.11
Years worked as orthopaedic surgeon	0.63
Spouse in medical field	0.14
Sex	0.47
Practice region	0.74
Number of half-day session/week in public practice	0.24
Number of half-day session/week in private practice	0.66
Income bracket	0.004
Smoker	0.16
Self-rated health	<0.001
Satisfaction with career	<0.001
Satisfaction with work life balance	<0.001
Satisfaction with income	<0.001
Satisfaction with training pathway	<0.001
Considered leaving the profession	0.001
Depersonalisation	
Age	0.71
Number of children	0.02
Marital status	0.04
Current position	0.46
Years worked as orthopaedic surgeon	0.15
Spouse in medical field	<0.001
Sex	0.36
Practice region	0.14
Number of half-day session/week in public practice	0.67
Number of half-day session/week in private practice	0.24
Income bracket	<0.001
Smoker	0.56
Self-rated health	<0.001
Satisfaction with career	<0.001
Satisfaction with work life balance	0.01
Satisfaction with income	<0.001
Satisfaction with training pathway	<0.001
Considered leaving the profession	0.001
Personal accomplishment	
Age	0.29
Number of children	0.44
Marital status	0.67
Current position	0.08
Years worked as orthopaedic surgeon	0.75
Spouse in medical field	0.19
Sex	0.32
Practice region	0.28
Number of half-day session/week in public practice	0.19
Number of half-day session/week in private practice	0.42
Income bracket	0.05
Smoker	0.78
Self-rated health	0.03
Satisfaction with career	0.76
Satisfaction with work life balance	0.83
Satisfaction with income	0.18
Satisfaction with training pathway	<0.001
Considered leaving the profession	0.31

burnout. This association took the form of a trend with increasing probability of burnout with increasing number of half-day sessions per week in public practice ($p = 0.03$). There were no significant departures from this trend ($p > 0.25$). The public sector is more demanding in terms of over time and less flexibility, thus possibly contributing to physician burnout.

Interestingly satisfaction with training pathway was the only variable to have a significant association to personal accomplishment ($p < 0.001$) and the other burnout subscales (Table 5). Correspondingly after controlling for confounding variables it

Table 4
Multivariate analysis analysis: variables associated each of the Burnout subscales.

	Regresssion coefficient	95%CI	p
Emotional exhaustion score			
Self-rated health	−2.98	−4.02–−1.93	<0.001
Satisfaction with income	−1.74	−2.66–−0.83	<0.001
Satisfaction with training pathway	−1.80	−2.59–−1.00	<0.001
Depersonalisation score			
Spouse in the medical profession	−1.8	−3.06–0.61	0.003
Income bracket	−0.97	−1.57–−0.38	0.001
Satisfaction with career	−1.10	−1.74–−0.47	0.001
Satisfaction with training pathway	−0.72	−1.20–−0.23	0.004
Personal accomplishment			
Satisfaction with training pathway	1.21	0.54–1.88	<0.001

maintained a significant association with overall burnout ($p = 0.02$).

Whereas satisfaction with income was only significantly associated with emotional exhaustion ($p < 0.001$). Thus surgeons self evaluation and personal accomplishment stems from factors external to monetary reward. Facilitation of training pathways perceived as less stressful, balanced and fulfilling to its recipients a plausible target to reduce burnout in the surgeons they produce. There is a deficit in the literature exploring the relationship between specific training modalities (independent research tie, professional development, mentorship programs) and burnout in orthopedic surgeons.

Marital status had a strongly significant association with burnout ($p < 0.001$). A similar correlation observed by Bhugra et al. was attributed to the Indian context wherein marriage and maintenance of a stable family are exceptionally valued.[9] We found that divorcees were twice as likely (60%) to be burnt out compared to individuals who had never been married (31%) and almost four times as likely as married people (18%). This substantiates the impact emotional turbulence in domestic affairs may have on burnout status. Sargent et al. described positive marital functioning and satisfaction as a powerful protective factor for physician burnout.[11] The provision of emotional support, family stability and a source of stress relief through a harmonious marriage are important factors in reduction of burnout and psychological distress, irrespective of context. However there was no meaningful relationship between having a spouse in the medical field and burnout, though it was significantly associated with depersonalization ($p = 0.003$).

Self-rated health had the strongest association to emotional exhaustion and is significantly associated to burnout ($p < 0.001$). In comparison to our previous study in Australian orthopedic surgeons who had a insignificant association ($p = 0.47$).[2] Thus stipulating a potential focus for current and future burnout prevention programs; access to gym and healthy eating facilities for time poor surgeons a recommendation for burnout minimization.

Contrasting previous studies, the relationship between current career position and burnout or any of its subscales was insignificant ($p = 0.89$). Arora et al. described surgical trainees and residents to have higher emotional exhaustion and depersonalization scores and lower personal accomplishment when compared to senior faculty.[7] Sargent et al. study results show a surge in burnout and psychiatric morbidity in residents comparative to faculty members. Potential causes including increased work hours, poor work-life balance, debt load and professional relationships.[12] A potential cause for the disparity between our study and previous reports may be a differing hierarchal burden structure in the USA and India, in terms of roles and responsibility.

Table 5
Univariate analysis of variables for their association with burnout.

Category	OR	95% CI	p
Sex (female vs male)	1.68	0.36–7.78	0.51
Age			
20–29	1.0[a]		0.01[b]
30–39	2.82	1.18–6.73	
40–49	0.87	0.32–2.35	
>50	2.44	1.07–5.59	
Number of children[c]	0.89	0.68–1.15	0.36
Marital status			
Married or De Facto	1.0[a]		0.001[b]
Never married	1.95	1.03–3.69	
Divorced	6.62	2.23–19.64	
Spouse in medical Profession (Yes vs No)	1.53	0.89–2.63	0.12
Current position			
Resident or senior resident	1.0[a]		0.90[b]
Consultant	0.82	0.41–1.65	
Head of department	1.33	0.48–3.71	
Assistant professor/lecturer	1.05	0.48–2.31	
Associate/full professor	0.92	0.27–3.15	
Years worked as orthopaedic surgeon			
0–9	1.0[a]		0.10[b]
10–19	1.58	0.87–2.89	
20–29	0.53	0.20–1.45	
Practice region			
North India	1.0[a]		0.15[b]
South India	1.04	0.49–2.21	
East India	2.11	0.92–4.80	
West India	0.77	0.36–1.64	
Central India	0.61	0.19–2.00	
Number of half-day session/week in public practice			
0–3	1.0[a]		0.07[b]
4–5	1.18	0.57–2.45	
6–7	0.75	0.23–2.39	
8 or more	2.18	1.13–4.21	
Number of half-day session/week in private practice			
0–3	1.0[a]		0.19[b]
4–5	0.90	0.42–1.92	
6–7	0.31	0.10–0.97	
8 or more	2.2	0.35–1.27	
Income bracket			
Bottom 25%	1.0[a]		0.004[b]
25–49%	0.30	0.14–0.64	
50–74%	0.37	0.17–0.80	
Top 25%	0.82	0.35–1.94	
Smoker(yes vs no)	0.67	0.37–1.20	0.18
Self-rated health[c]	0.42	0.30–0.59	<0.001
Satisfaction with career[c]	0.58	0.45–0.74	<0.001
Satisfaction with work life balance[c]	0.66	0.54–0.81	<0.001
Satisfaction with income[c]	0.56	0.44–0.72	<0.001
Considered leaving profession (Yes vs No)	2.35	1.15–4.79	0.02

[a] Reference category.
[b] Overall P value for the category.
[c] Odds ratio for a 1 unit change in the variable (higher vs lower).

Table 6
Multivariate analysis: variables associated with burnout.

Category	OR	95% CI	p
Age			
20–29	1.0[†]		0.01[*]
30–39	3.44	1.15–10.33	
40–49	0.73	0.21–2.59	
>50	2.74	0.98–7.64	
Marital status			
Married or De Facto	1.0[†]		0.001[*]
Never married	2.59	1.04–6.47	
Divorced	17.34	3.02–99.55	
Income bracket			
Bottom 25%	1.0[†]		0.05[*]
25–49%	0.31	0.12–0.78	
50–74%	1.30	0.48–3.50	
Top 25%	0.49	0.11–2.07	
Self-rated health	0.42	0.28–0.64	<0.001
Satisfaction with training pathway	0.73	0.56–0.85	0.02

[*] Overall P value for the category.
[†] Reference category.
[‡] odds ratio for a 1 unit change in the variable (higher vs lower).

4.1. Recommendations for the future

Burnout in orthopedic surgeons may have devastating consequences for patient mortality and morbidity. The link between burnout and patient safety and medical errors is well established in the surgical literature, the depersonalization dimension associated with lower patient satisfaction and longer recovery times.[3,13] Past interventions to reduce burnout have targeted individuals rather than organizational and social contexts within which they practice.[3] Halbesleben and Rathert recommended implementation of proactive steps to reduce burnout through system wide intervention programs, which will ultimately result in and improvement in patient quality of care.[13]

Given then novelty of this assessment in Indian surgeons and the significant variability to previous western studies, similar research would be valuable throughout the region, enabling cross study comparisons, validation and assessment of whether similar trends and associations exist. Additionally, the Indian medical industry is changing structurally, particularly in regards to patient relations (increase in litigation) thus it would be worthwhile to repeat this study in five to ten years and evaluate the change.

4.2. Limitations

The available published studies, including our own previous study in Australian Orthopedic Surgeons, utilize public forums such as annual conferences as an avenue to asses an unbiased large distribution of doctors. However this introduces inherent limitations including a relatively low response rate (consistent amongst all studies of this kind). There may be a predisposition for burnt out surgeons to respond, in hope of initiating awareness or change, conversely their time constraints may inhibit them from participating. The assumption is that the number of respondents is a sufficient sample size demonstrating the general distribution (299 participants). This enables cross-study comparisons with similar methodological sampling. Additionally, the assessment of only surgeons whom attended the conference, potentially eliminates a demographic of those who cannot afford to or do not have time to attend, particularly in India. Finally caution is advised when interpreting MBI results internationally as the values vary dependent upon the many socioeconomic and cultural between countries.

5. Conclusion

Burnout is a critical syndrome, affecting individuals in the medical field, particularly orthopedic surgeons. 23.1% of Indian orthopedic surgeons were burnt out; significantly lower than the rates measured in developed western nations. Marital status, health and satisfaction with training pathway have strongly significant association with burnout. Thus this study provides a point of reference/baseline for future burnout research in orthopedic and in general surgeons in India and surrounding countries in the east. Clearly delineating the key associations to

burnout, which future minimization interventions can target. One must remain mindful to the epidemic of burnout and continued vigilance and pro-active policy initiatives are the need of the hour.

Conflict of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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Review article

Dimensions of distal femur in terms of total knee arthroplasty among different origins – A systematic review

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ABSTRACT

Background: The achievement of optimal results out of total knee arthroplasty surgery depends on fit and sizing of the implant over the bone. Mismatch between resected bone and implant alters the outcome of the surgery. Identifying the medial-lateral and anterior–posterior measurement in the resected femur lays the foundation for identifying the implant size. The ratio of medial-lateral and anterior–posterior measurement figures out the match between implant and bone. The bony architecture is influenced by ethnicity. Therefore it becomes essential to study distal bone notability from different indigenous origin groups.

Questions/purposes: This study incorporates a systematic review analysis of the English literature published on the anthropometric dimensions of the distal femur. The anterior–posterior and medial-lateral width values are assessed to determine the inherent ethnic differences in bony parameters.

Methods: An extensive search in seven search engines was performed to produce 9820 responses. This collection was imported in endnote library to finally obtain 6320 publications after duplication. Further detailed examination produced only 65 papers to undergo full-text inspection. After a thorough review of the full text, only 20 papers were found to be relevant for a systematic review.

Results: There were 8 different racial populations assessed in the various studies. Caucasians were studied by most of the authors. All papers imply the need of alterations in the current implant sizing to improve fitment in Asian population.

Conclusions: Most of the studies were performed with patients of Caucasian origin. The Asian sub-populations studies demonstrated the incongruence in implant sizing and anthropometric measures and therefore recommending that these ethnic differences need to be addressed in future implant design.

Contents

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1. Introduction

The accuracy in placing the appropriate fit femoral implant is an essential factor in achieving the optimum results in total knee arthroplasty including normal range of motion. Mismatch between the bone and prosthetic size implies severe longevity related complications. Undersized component leads to loosening of the implant and oversized causes soft tissue impingement. All these discussion leads to the need of the increased accuracy in the implant sizes with proper fit. Various evidences are available to support the fact that Asian sub-populations are smaller in size than the Western population. Therefore it becomes essential to design implants suitable for Asian population considering this variation to obtain the optimum results. Various authors studied distal femoral morphometry using different tools and techniques to determine different parameters in the proposed subgroup. The important measurement in the distal femur is femoral medio-lateral and anterio-posterior dimensions. Their ratio defines the geometrical shape of the femur. This systematic review involves the collection and result concluded from such papers, involving the normal bone anatomical samples form a variety of ethnic groups.

2. Material and methods

A standard search was run through Ovid MEDLINE(R) and other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to 27th October 2014 and PubMed, CINAHL, Scopus, Cochrane and Web of Sciences. A total number of 9820 results were obtained, limiting to humans, English language and samples with intact bone anatomy only. The following Prisma chart shows the further selection criteria (Fig. 1).

3. Results

Table 1 summarizes the relevant values of fAP and fML.

20 relevant papers were extracted from the above strategy. The samples of results were from seven different ethnic groups.

3.1. Asians

Mahfouz et al.,[20] collected knee CT (cadaveric or skeletal) of 80 East-Asians (40 males and 40 females) to generate 3D model and measure. The values obtained in males are fAP – 54.9 ± 4.4 mm, fML – 85.4 ± 4.3 mm and fML/fAP – 1.56 ± 0.11. Corresponding values in females are fAP – 50.0 ± 4.0 mm, fML – 74.8 ± 3.3 mm and fML/fAP – 1.5 ± 0.1.

3.2. Chinese

Yue et al.,[5] involved CT scans of 20 male and 20 female knee joints of Chinese descent. Using a 3D modeling software, these CT images were segmented to construct a 3D model of the sample to be measured. The values obtained are as follows: In males – fAP is 65.0 ± 2.8 mm and fML is 82.6 ± 3.6 mm. In females – fAP is 58.8 ± 2.5 mm and fML is 72.8 ± 2.6 mm. The aspect ratio is 1.27 ± 0.03 in males and 1.24 ± 0.04 in females. (The dimensions of Chinese knees were generally smaller than white knees. In addition, Chinese females had a significantly narrower distal femur than white females, whereas Chinese males had a wider proximal tibia than their white counterparts.)

Yue et al.,[10] created 3D anatomical model of the femur from CT of all 40 Chinese subjects (20 males and 20 females). They measured fML, fLAP and fMAP to calculate aspect ratio as fML/fLAP. The values in male are fML 82.6 ± 3.6 mm, fLAP 65.0 ± 2.8 mm, fMAP 62.2 ± 3.9 mm and fML/fLAP 1.27 ± 0.03. The corresponding values in females are fML 72.8 ± 2.6 mm, fLAP 58.8 ± 2.5 mm, fMAP 55.3 ± 2.7 mm and fML/fLAP 1.24 ± 0.04.

Yan et al.,[13] included 100 subjects (50 males and 50 females) of Chinese descent in their study. The collection of CT of these subjects produced 3D model to be measured. The values obtained are; in males fML is 69.62 ± 3.10 mm, fAP is 65.61 ± 2.49 mm and aspect ratio (fML/fAP) 1.06 ± 0.04. In females fML is 61.14 ± 3.07 mm, fAP 59.41 ± 2.53 mm and aspect ratio (fML/fAP) 1.03 ± 0.05.

Yue et al.,[14] recruited 50 males and 50 females to get their knee scanned by CT. These CT created 3D femur model of these samples to be further analyzed to measure fAP and fML. The author does not directly provide the fML and fAP.

Li et al.,[17] reconstructed 3D models from CT images of 148 Chinese samples (61 males and 87 females). The values found in males are fML 72.7 ± 3.8 mm, fAP 56.5 ± 2.5 mm and aspect ratio (fML/fAP) 1.29 ± 0.04. The corresponding values in females are fML 64.4 ± 2.6 mm, fAP 52.8 ± 2.6 mm and aspect ratio (fML/fAP) 1.22 ± 0.05.

Cheng et al.,[19] included 94 males and 78 females of Chinese ethnicity. Computer Tomographic Angiography (CTA) images constructed 3D model to be studied for morphological features.

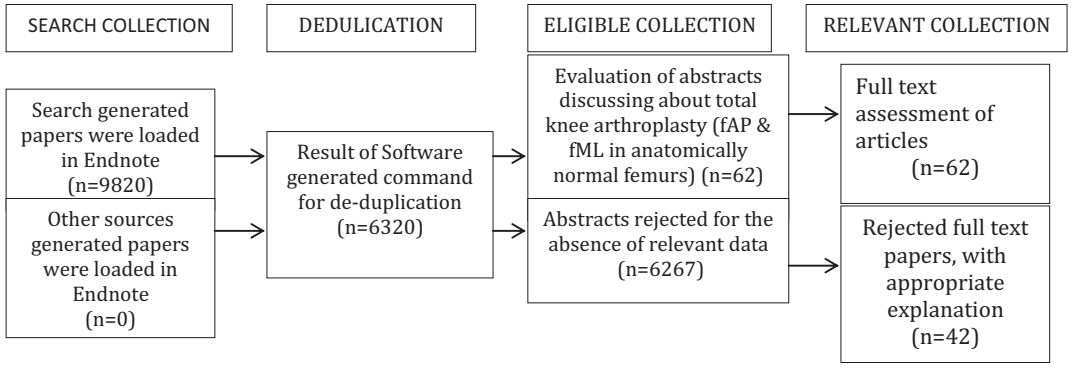

Fig. 1. Prisma flowchart.

Table 1
The following table summarizes the relevant values of fAP and fML.

Sno.	Paper	Author	Method	Year	Ethnic	Sample size			Male				
						Total	Male	Female	fML	fAP		Aspect(fML/fAP)	
										Medial	Lateral	fML/ fAPM	fML/fAPL
1	Anthropometric measurements of knee joints in Thai population- correlation to the sizing of current knee prostheses	Chaichankul et al.	MRI based measurements	2011	Thai	200	81	119	70.15 ± 3.87	48.55 ± 3.73		145 ± 11	
2	Anthropometric Measurements of the Human Distal Femur- A Study of the Adult Malay Population	Hussain et al.	3D modeling using full leg CT	2013	Malay	100	50	50	74.88 ± 3.55	63.93 ± 3.36			1.17 ± 0.05
3a	Classification of gender and race in the distal femur using self organizing maps	Heever et al.	MRI	2012	Africans	18	18	0	71.7 ± 3.25	66.7± 3.73	68.9 ± 4.55		103.5 ± 5.75
3b	Classification of gender and race in the distal femur using self organizing maps	Heever et al.	3D laser scanning	2012									
4a	Determination of representative dimension parameter values of Korean knee joints for knee joint implant design.	Kwak et al.	3D modeling using cadaveric Knee joint CT	2012	Korean	88	88						
5	Differences of knee anthropometry between Chinese and white men and women	Bing et al.	CT Based 3D modeling	2011	Chinese	40	20	20	82.6 ± 3.6 (72.6–87.1)		65.0 ± 2.8 (59.4–70.3)		1.27 ± 0.03 (1.22–1.33)
6	Gender analysis of the anterior femoral condyle geometry of the knee	Li et al.											
6	Gender analysis of the anterior femoral condyle geometry of the knee	Li et al.	127 MRI/34 CT based 3D modeling	2014	Caucasians	161	96	65	75.1 ± 4.5		59.2 ± 3.4		
7	Gender and Side-to-Side Differences of Femoral Condyles Morphology-Osteometric Data from 360 Caucasian Dried Femori	Terzidis et al.	Dry bone caliper	2012	Greek-Caucasians	360	192	168	88.6 ± 0.42		6.11 ± 0.33		
8	Gender differences in the anatomy of the distal femur	Gillespie et al.	3D Scanning of dry bones	2011	Caucasians	683	429	254					
8	Gender differences in the anatomy of the distal femur	Gillespie et al.	3D Scanning of dry bones	2011	Africans	524	118	406					
9	Gender differences in the distal femur dimensions and variation patterns in relation to TKA component sizing	Rosenstein et al.	MRI	2008	Caucasians????	100	50	50					1/ 0.80 ± 0.05
10	Gender differences in the knees of Chinese population	Bing et al.	MRI based 3D model	2011	Chinese	40	20	20	82.6 ± 3.6		65.0 ± 2.8		1.27 ± 0.03

Table 1 (*Continued*)

Sno.	Paper	Author	Method	Year	Ethnic	Sample size			Male				
						Total	Male	Female	fML	fAP		Aspect(fML/fAP)	
										Medial	Lateral	fML/ fAPM	fML/fAPL
11	Gender differences in the morphology of the trochlea and the distal femur	Pinskerova et al.	2D MRI measurements	2014	Caucasians????	200	100	100					
12	Gender differences of the morphology of the distal femur and proximal tibia in a Korean population	Lim et al.	MRI based measurements	2013	Korean	115	56	59	81.5 ± 5.70		60.85 ±4.05		1/ 0.845 ± 0.05
13	Gender-based differences in the dimensions of the femoral trochlea and condyles in the Chinese population- correlation to the risk of femoral component overhang	Yan et al.	3D modeling using knee CT	2014	Chinese	200	100	100	69.62 ± 3.10		65.61 ± 2.49		1.06 ± 0.04
14	How the gender or morphological specific TKA prosthesis improves the component fit in the Chinese population	Yue et al.	3D modeling using knee CT	2014	Chinese	100	50	50					
15	Is there any relation between distal parameters of the femur and its height and width	Yazar et al.	Dry Bone CT based measurements	2012	Caucasians	66	male/female bones were not distinguished		only fML				
16	Knee morphology as a guide to knee replacement	Mensch et al.	Cadaveric knee caliper measurements	1975	Caucasians	30	14	16	81.1 ± 3.4	29.9 ± 2.6	31.4 ± 2.6		
16	Knee morphology as a guide to knee replacement	Mensch et al.	Radiographs	1975	Caucasians	38	30	23	82.1 ± 4.7	29.2 ± 2.2	31.4 ± 2.3		
16	Knee morphology as a guide to knee replacement	Mensch et al.	Radiographs	1975	Africans	4	30	23	82.1 ± 4.7	29.2 ± 2.2	31.4 ± 2.3		
16	Knee morphology as a guide to knee replacement	Mensch et al.	Radiographs	1975	Oriental	1							
17	Morphological measurement of the knee- race and sex effects			2014									
18	Morphological study of the knee for designing total knee prostheses	Dupuis et al.	Dry bone caliper based	2001	Caucasians	100	combined						
19	Three dimensional morphometry of the knee to design the total knee arthroplasty for Chinese population	Cheng et al.	computer tomographic angiography (CTA) of the lower limb	2009	Chinese	172	94	78	74.4 ± 2.9		66.6 ± 2.4		111.7 ± 3.3
20	Three-dimensional morphology of the knee reveals ethnic differences	Mahfouz et al.	3D modeling using knee CT/ MRI	2012	Caucasians	840	500	340	85.9 ± 4.7		61.2 ± 3.6		1.41 ± 0.06
20	Three-dimensional morphology of the knee reveals ethnic differences	Mahfouz et al.	3D modeling using knee CT/ MRI	2012	Africans	80	40	40	84.9 ± 4.7		61.2 ± 2.9		1.39 ± 0.07

Table 1 (*Continued*)

Sno.	Paper	Author	Method	Year	Ethnic	Sample size			Male				
						Total	Male	Female	fML	fAP		Aspect(fML/fAP)	
										Medial	Lateral	fML/fAPM	fML/fAPL
20	Three-dimensional morphology of the knee reveals ethnic differences	Mahfouz et al.	3D modeling using knee CT/MRI	2012	East Asians	80	40	40	85.4 ± 4.3		54.9 ± 4.4		1.56 ± 0.11

Sno.	Female					Combined			
	fML	fAP		Aspect(fML/fAP)		fML	fAP		Aspect (fML/fAP)
		Medial	Lateral	fML/fAPM	fML/fAPL				
1	59.91 ± 3.75	43.32 ± 3.69		139 ± 12		64.06 ± 6.31	45.43 ± 4.5		141 ± 12
2	64.53 ± 3.12	57.39 ± 3.29			1.13 ± 0.05				
3a									
3b									
4a									
5	72.8 ± 2.6 (70.0–79.1)		58.8 ± 2.5 (53.2–63)		1.24 ± 0.04 (1.17–1.32)				
6									
6	65.7 ± 2.8		54.6 ± 3.0						
7	7.85 ± 0.30		5.54 ± 0.21						
8									
8									
9					1/0.76 ± 0.03				
10	72.8 ± 2.6		58.8 ± 2.5		1.24 ± 0.04				
11									
12	76.7 ± 3.71		57.6 ± 3.2		1/0.76 ± 0.03	78.6 ± 5.1		59.15 ± 4.28	1/0.78 ± 0.04
13	61.14 ± 3.07		59.41 ± 2.53		1.03 ± 0.05	65.38 ± 5.25		62.51 ± 3.99	
14									
15						71.13 ± 5.24		??	
16	69.7 ± 2.7	24.5 ± 1.5	26.6 ± 1.5			75.0 ± 6.5	26.6 ± 3.0	28.9 ± 3.2	
16	69.9 ± 2.6	24.5 ± 1.2	26.5 ± 1.8			76.8 ± 7.2	27.1 ± 3.0	29.3 ± 3.2	
16	69.9 ± 2.6	24.5 ± 1.2	26.5 ± 1.8			76.8 ± 7.2	27.1 ± 3.0	29.3 ± 3.2	
16									
17									
18					71.9 ± 5.6		62.9 ± 4.5		
19	66.8 ± 3.1		61.0 ± 2.7		109.6 ± 3.6	71.0 ± 3.0		64.1 ± 2.7	111.1 ± 2.7
20	75.8 ± 3.3		55.9 ± 3.3		1.36 ± 0.06				
20	76.8 ± 4.9		57.4 ± 8.3		1.38				
20	74.8 ± 3.3		50.0 ± 4.0		1.5 ± 0.1				

In males, the value of fAP is 66.6 ± 2.4 mm and fML is 74.4 ± 2.9 mm. In females, the value of fML is 61.0 ± 2.7 mm and fML is 66.8 ± 3.1 mm. The Aspect ratio is calculated as fML/fAP × 100. The aspect ratio found in males is 111.7 ± 3.3 and 109.6 ± 3.6.

3.3. Thai

Chaichankul et al.,[1] studied 200 Thai volunteer subjects knee MRI. They simulated femoral sizing and rotation in accordance to anterior referencing systems and transepicondylar (TE) axis, respectively. The distal femur mediolateral and anterior–posterior diameter is measured after the re-sectioning the femur. Another characteristic, aspect ratio is calculated from the following formula: fML/fAP × 100. The value of fAP is 48.55 ± 3.73 mm and 43.32 ± 3.69 mm in male and female respectively. The fML is 70.15 ± 3.87 mm in males and 59.91 ± 3.75 mm in females. The significant ($p < 0.0001$) is found to be in differences between fAP, fML and aspect ratio between the two sexes.

3.4. Malay

Hussain et al.,[2] scanned 100 distal femurs for Malay population to measure fML and fAP using CT. The data included 50 males and 50 females. The scanned CT images were used to construct 3D model. The mean value of male subject was found to be fML – 74.88 ± 3.55 mm and fAP – 63.93 ± 3.36 mm. The mean value of females was fML is 64.53 ± 3.12 mm and 57.39 ± 3.29 mm.

3.5. Caucasians

Heever et al.,[3] performed MRI in 20 male and 22 female cadaveric specimens of Caucasian origin. Parameters studied were fAPM (femoral anterior posterior medially) and fAPL (femoral anterior posterior lateral). 3D models constructed using MRI were imported in 3Matic software to be further analyzed. fAPM is lower in value than fAPL. The value of aspect ratio is thus calculated with the formula fML/fAPL. The fML in males is 77.7 ± 5.7 mm and in females it is 67.7 ± 3.56 mm. The fAPL is 71.5 ± 3.67 mm in males and 66.4 ± 4.17 mm. The corresponding normalized aspect ratio is found to be 108 ± 6.19 in males and 102.1 ± 5.79 in females (Fig. 2).

Yue et al.,[5] performed knee MRI in 20 males and 16 females. Further these images were segmented to construct a 3D bone model using a 3D modeling software. The values of fAP and fML are extracted from these models. The fAP is found to be 67.5 ± 3.6 mm for males and 59.7 ± 2.6 mm for females. The fML is 76.4 ± 4.0 mm in females and 86.0 ± 5.6 mm in males. The aspect ratio is calculated using a simple formula fML/fAP. Males and females have similar values of aspect ratio with the values of 1.28 ± 0.07 in males and 1.28 ± 0.06 in females.

Li et al.,[6] collected 96 male and 65 female Caucasian knee data with 34 CT scanned structure and 127 MRI scanned structures.

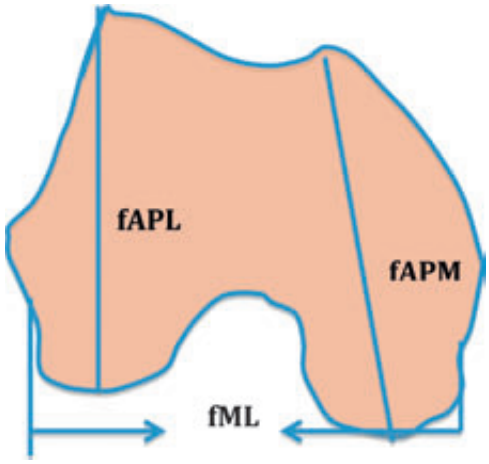

Fig. 2. fAP and fML.

CT images were segmented using a region-growing method and MRI images were segmented using a manual segmentation method to produce 3D bony models of the knee. It is reported in the study that there is an established compatible accuracy of MRI model with respect to CT models. In males, fAP is 59.2 ± 3.4 mm and fML is 75.1 ± 4.5 mm. In females, fAP is 54.6 ± 3.0 mm and fML is 65.7 ± 2.8 mm.

Terzidis et al.,[7] included a sample of 360 (192 males and 168 females) dried Caucasian femurs to measure fML, fLAP and fMAP. The fML is 88.6 ± 4.2 mm in males and 78.5 ± 0.30 mm in females. In, males, fAP is 61.1 ± 0.34 mm medially and 61.1 ± 3.3 laterally. Similarly in females, fAP is 55.9 ± 2.9 mm medially and 55.4 ± 2.1 mm laterally.

Gillespie et al.,[8] used microscribe digitizer to create 3D surface and measure fML and fAP to calculate aspect ratio in 660 female and 547 males. Out of these, Caucasians were 683 (254 females and 429 males) and African-Americans were 524 (406 females and 118 males). The author did not provide the individual values of fAP and fML. The calculated aspect ratio (ML/AP) as combined data of both the ethnic groups is found to be 1.16 ± 0.06 in females and 1.21 ± 0.07.

Rosenstein et al.,[9] collected 100 MRI knee to measure fAP, fML and fAP/fML ratio in 50 consecutive males and 50 consecutive females.

Pinskerova et al.,[10] studied 200 knee MRI of 100 males and 100 females to measure various parameters in femur. The results provided are in the format with sectioned parameters into different sizing criteria, thus direct values of fAP and fML are not provided. The aspect ratio is also calculated with the formula fAP/fML and the results are provided in terms of seven sizing groups.

Yazar et al.,[15] performed CT of 66 dry femur to measure different parameter in Caucasian origin dry bone. The author did not mentioned number of male and female samples. The value provided only corresponds to fML as 71.13 ± 5.24 mm.

Mensch et al.,[16] studied 30 (14 males and 16 females) cadaveric knees of Caucasian origin to measure fLAP, fMAP and fML. In males, fML is 81.1 ± 3.4 mm, fMAP is 29.9 ± 2.6 mm and fLAP is 31.4 ± 2.6 mm. In females, fML is 69.7 ± 2.7 mm, fMAP is 24.5 ± 1.5 mm and fLAP is 26.6 ± 1.5 mm.

Li et al.,[17] reconstructed 3D models from MRI images of 127 Caucasian samples (79 males and 48 females). The values found in males are fML 74.6 ± 3.9 mm, fAP 59.6 ± 3.2 mm and aspect ratio (fML/fAP) 1.25 ± 0.05. The corresponding values in females are fML 65.4 ± 1.4 mm, fAP 55.4 ± 2.8 mm and aspect ratio (fML/fAP) 1.18 ± 0.05.

Dupuis et al.,[18] measured 100 dry femur of Caucasian origin to obtain the following values. The data is differentiated in males and females. The values are fML is 70.3 ± 0.08 mm, fLAP is 64.4 ± 0.05 mm and fMAP is 61.4 ± 0.04 mm.

Mahfouz et al.,[20] collected cadaveric or skeletal knee CT of 840 Caucasians (500 males and 340 females). They developed virtual 3D model and measured fAP, fML and fML/fAP. The values obtained in males are fAP – 61.2 ± 3.6 mm, fML – 85.9 ± 4.7 mm and fML/fAP – 1.41 ± 0.06. Corresponding values in females are fAP – 55.9 ± 3.3 mm, fML – 75.8 ± 3.3 mm and fML/fAP – 1.36 ± 0.06.

3.6. Africans

Heever et al.,[3] directly scanned 18 male cadaveric specimens of black male origin using a 3D scanner. This generated a virtual 3D model of the distal femur that is further studied for measuring the fAPL, fAPM, fML and normalized aspect ratio (Fig. 1). The fML is 71.7 ± 3.25 mm and fAPL is 68.9 ± 4.55 mm. The normalized aspect ratio (fML/fAPL) is 103.5 ± 5.75.

Mahfouz et al.,[20] collected knee CT (cadaveric or skeletal)l of 80 African Americans (40 males and 40 females). The 3D model generation and measurements of model followed. The values obtained in males are fAP – 61.2 ± 2.9 mm, fML – 84.9 ± 4.7 mm and fML/fAP – 1.39 ± 0.07. Corresponding values in females are fAP – 57.4 ± 8.3 mm, fML – 76.8 ± 4.9 mm and fML/fAP – 1.38 ± 0.34.

3.7. Koreans

Kwak et al.,[4] obtained 88 cadaveric knee joints of Korean origin and performed computed tomography (CT). These images produced 3D reconstructed models in MIMICS and used them to determine representative dimensions parameter values (DPVs) for designing knee joint implants for the Korean population. The have not described about the fAP and fML in their study but certainly proposed sizing gradients for the population.

Lim et al.,[12] analyzed morphology of 56 males and 59 females knee MRI. The parameters taken into consideration are fML, fMAP, fLAP, aspect ratio (fMAP/fML, fLAP/fML). The values obtained in males are fML 81.5 ± 5.7 mm, fMAP 62.7 ± 4.1 mm, fLAP 59.0 ± 4.01 mm, fMAP/fML 0.85 ± 0.05 and fLAP/fML 0.84 ± 0.04. The values in females are fML 76.7 ± 3.71 mm, fMAP 56.8 ± 3.31 mm, fLAP 58.4 ± 3.10 mm, fMAP/fML 0.75 ± 0.03 and fLAP/fML 0.77 ± 0.03.

3.8. Caucasians, Africans and Orientals

Mensch et al.,[16] radiographed 53 knees of 38 Caucasians, 4 Africans and 11 Orientals. Out of 53, 30 males and 23 females were included. The combined values obtained are; in males fML is 82.1 ± 4.7 mm, fMAP is 29.2 ± 2.2 and fLAP is 31.4 ± 2.3 mm. In females, fML is 69.9 ± 2.6, fMAP is 24.5 ± 1.2 mm and fLAP is 26.5 ± 1.8 mm.

4. Discussion

All authors suggested surgical technique involved in TKA, proper sizing have the prosthetic implant, accurate tissue balancing and maximum coverage of components on the resected bone surface.[1] These important factors if considered carefully, the amount of stress applied to bone-implant interface can be minimized to improve implant longevity. All authors selected in this systematic review measured fAP and fML in samples with intact bone anatomy. It is found that the most common method used is measurement of 3D constructed bone and the most popular group studied is the Caucasian. 12 authors among 20 included Caucasian Samples and 3 authors Africans and 14 authors studied

Asian sub-populations with specified descent of origin. Irrespective of the method used by the author and calculative formula for aspect ratio it is proposed that subject of different origin have different dimension in bone. Therefore it is essential to consider this variation in depth to understand the larger requirement in dimension variety of the implants to cater different populations around the globe. Berger et al.,[21] studied 75 embalmed femurs and determined fML as 85.6 ± 5.1 mm for white males and 75.4 ± 2.3 mm for females; fAP is 68.1 ± 4.6 mm for white males and 60.2 ± 2.0 mm for females. Seedhom et al.,[22] reported fML 86 mm and 75 mm for white males and females, respectively in X-rays based measurements. Griffin et al.,[23] also provided similar femoral ML measurements using MRI, 84.1 ± 4.4 mm for white males and 74.1 ± 4.6 mm for females. These results are closely related to Yue et al.,[5] in our systematic review. Similar results for Caucasians were proposed by Poilvache et al.,[24] in terms of aspect ratio (fML/fAP). The values are 1.333 for Caucasian males and 1.299 for Caucasian females. Similarly Looner et al.,[25] reported aspect ratio (fML/fAP) as 1.235 for Caucasian males and 1.19 for Caucasian females and Chin et al.,[26] reported similar results, with femoral aspect ratio of 1.266 for Caucasian males and 1.22 for Caucasian females. Caucasians have larger and wider distal femur than their Asian counterparts. In terms of inter-Asian sub-populations there is a broader variety of values available. Heever et al.,[3] suggested that Caucasian males are not only larger than their counter females but also larger than Black males. They have wider knees. The similarity in Thai, Chinese and Japanese is well established by Chaichankul et al. Chinese are the next most popular subgroup among the authors in Asian sub-population.

5. Conclusion

Such studies are essential for incorporate designs applicable for concerned population.

Now a day people migrate and settle to different places and this settlement diversify the genetic makeup of the generations. This larger variation in the population implies to supports the need of implants customized for each patient. All 9 different ethnicities among Asian population are required to be considered as Asian knee sizes cannot be universally applied throughout the Asian population. There are significant differences observed between the different ethnicities within 9 the Asian population itself. Future implant designs may wish to incorporate this finding so as to be able to provide better implant fittings for use in the Asian population at a larger scale.

Conflict of interest

The authors have none to declare.

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Research paper

Quadriceps sparing (subvastus/midvastus) approach versus the conventional medial parapatellar approach in primary knee arthroplasty

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ABSTRACT

Introduction: Quadriceps-sparing (subvastus/midvastus) approach has emerged as an alternative to the classical medial parapatellar approach in total knee arthroplasty with the results claiming faster rehabilitation in the quadriceps sparing group. The present study was conducted to determine if the quadriceps sparing (subvastus/midvastus) approach offers any advantages over the classical medial parapatellar approach in primary knee replacements.

Material and methods: 55 patients undergoing unilateral TKA were randomized into two groups: the subvastus/midvastus group and the medial parapatellar group. The patients were assessed preoperatively and postoperatively at 7 days, 1 month, 3 months and finally at 6 months. Knee Society Scoring was used to compare the groups. Perioperative blood loss, duration of surgery and need for lateral release were also compared. The patient was kept on same pain management and postoperative rehabilitation protocol. Statistical analyses tested the null hypotheses of no differences in patients treated with either group at 95% significance level ($p < 0.05$).

Results: The difference between the two groups in terms of duration of surgery and perioperative blood loss were statistically not significant. Lateral release was required in 13.8% of patients in the parapatellar group compared to 3.8% of patients in the quadriceps-sparing group. On comparing the postoperative Knee Society Scores of the two groups at each follow up the difference was statistically significant at 7 days and 4 weeks postoperatively (p value < 0.05) but the difference between the two groups at 3 and 6 months was not significant statistically (p value > 0.05).

Conclusion: Quadriceps sparing approach (subvastus/midvastus) offers advantages over the standard medial parapatellar approach in terms of better pain relief and faster rehabilitation in the early postoperative period.

1. Introduction

Medial parapatellar approach is the most commonly used approach for total knee arthroplasty. This approach offers excellent exposure to knee joint for all aspects of total knee replacement. However the approach does violate a major portion of extensor mechanism.[1] Alternate approaches which do not violate the extensor mechanism have been described and include the subvastus and midvastus approaches. The reported advantages of these quadriceps sparing subvastus and midvastus approaches are quicker return of quadriceps function and reduced patellofemoral complications.[2,3] The subvastus approach[2] differs from medial parapatellar approach in the method of subluxating the extensor mechanism laterally for knee exposure. It involves stripping the vastus medialis muscle from its origin on the femur before dislocating patella Engh and Parks[3] described the midvastus approach in which vastus medialis muscle is split in line with its fibres rather than subluxated laterally in its entirety. These quadriceps sparing approaches does not violate quadriceps mechanism, reduces the need for lateral retinacular release, preserve the patellar blood supply and decrease postoperative

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pain.[2,3] We undertook a randomized case control study to evaluate the differences if any in the results of total knee replacement surgery using the classical parapatellar approach and the quadriceps sparing subvastus and midvastus approaches.

2. Material and methods

The study was conducted in a tertiary care setup on patients who underwent unilateral TKA between June 2013 and March 2015. Patients were randomized into 2 groups. Computer-generated randomization and closed envelopes were used to allocate patients to either the quadriceps sparing group (group 1) or the parapatellar group (group 2). 71 patients were assessed for eligibility out of which 55 met the criteria and were randomized into 2 groups with 26 patients in the quadriceps sparing group and 29 in the parapatellar group. All the patients admitted for unilateral TKR during the study period were assessed for eligibility. Exclusion criteria included individuals with BMI $> 30\ kg/m^2$, valgus or varus deformity of more than 20°, fixed flexion deformity of >30° and patients with previous knee surgery. All the patients were operated in the same settings. Same implant design was used in all the patients. All the patients followed the same rehabilitation protocol in the postoperative period. Patients in each group were evaluated both clinically and radiologically at a minimum of 6 months follow up. Statistical analysis tested the null hypotheses of no difference in the patient outcome in the subvastus/midvastus group and the parapatellar group at 95% significance level ($p < 0.05$).

3. Pre-operative evaluation and planning

Patients were assessed both clinically and radiologically. Detailed history of the patient was taken and general and local physical examination was done. Pre-op deformity was documented in all cases. Knee Society Score was documented.[4,5] Radiographs included antero-posterior weight-bearing view, lateral view and skyline view.

4. Surgical technique

All the patients were operated in laminar flow operation theatre. Pneumatic tourniquet was applied on upper thigh with the knee in full flexion.

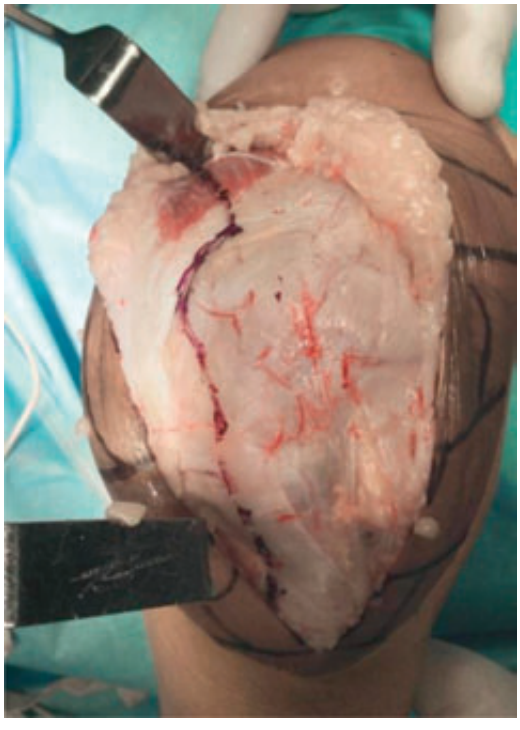
4.1. GROUP 1: (a) Subvatus approach: Technique[2]

With the knee flexed to 90° a straight anterior skin incision was made beginning 8 cm above the patella to 2 cm distal to the tibial tubercle. Superficial fascia was incised slightly medial to the patella and bluntly dissected from the vastus medialis muscle fascia down to the muscle insertion. Inferior edge of the vastus medialis was identified and bluntly dissected from the periosteum and intermuscular septum for a distance of 10 cm proximal to the adductor tubercle. Vastus medialis muscle was lifted anteriorly and L-shaped arthrotomy was performed beginning medially through the vastus insertion on the medial patellar retinaculum and carrying it along the medial edge of the patella. Medial edge of the patellar tendon was partially released and patella everted laterally with the knee extended (Picture 1).

4.2. GROUP 1: (b) Midvastus approach: Technique[3]

The midvastus approach commences with a standard anteromedial skin incision made with the knee in flexion. Dissection was carried directly down through the subcutaneous tissue. The superior medial corner of the patella was identified with the knee in flexion, and a parallel interval between the vastus medialis muscle fibres was created. This interval starts at the superior medial corner of the patella and extends obliquely in a superomedial direction approximately 4 cm through the full thickness of the muscle. The quadriceps tendon was not incised. Releasing the capsular folds of the suprapatellar pouch proximal to the patella was done to allow full patellar eversion. Distal dissection was carried along the medial side of the patella onto the proximal tibia just medial to the tibial tubercle. A cuff of soft tissue attached to the patella was normally preserved to aid in capsular repair at the conclusion of the procedure (Picture 2).

Picture 1. Operative photograph showing subvastus approach.



Picture 2. Operative photograph showing midvastus approach.

Picture 3. Picture showing median parapatellar approach.

4.3. GROUP 2: Medial parapatellar approach: Technique[4]

Incision was made at the medial border of the quadriceps tendon 7 to 10 cm proximal to the patella, curved around the medial border of the patella and back towards the midline, distally upto or distal to the tibial tuberosity. Superficial fascia was divided and retracted. Next, the dissection was deepened between the vastus medialis muscle and the medial border of the quadriceps tendon and the capsule and synovium were incised along the medial border of the patella and the patellar tendon. Retraction of the patella laterally and flexion of the knee was done to gain a good view of the anterior compartment of the joint and the suprapatellar bursa (Picture 3).

The femoral component was placed in 3° external rotation with respect to the epicondylar axis and further verified with reference to the anterior-posterior axis of the femur. Patelloplasty was done in all the cases, however patellar component was not used in any case. Patellar tracking was checked intra-operatively using the 'no-touch' and 'two-stitch' technique and lateral release was done as necessary.[5] Operative time, blood loss during the surgery and the need for lateral release were noted in all the cases.

5. Post-operative period and follow-up

Drain was removed after 48 h. Epidural opioids were administered for 48 h post-op and the dosage and frequency of oral opioid medication used was noted. I.V antibiotics were continued for 48 h and switched to oral antibiotics for 5 days. Oral anticoagulants were used for thromboembolism prophylaxis for 3 weeks. Static quadriceps exercises were started on day 1 post-op. Range of motion exercised were started on day 2 post-op. Full weight bearing using walker/crutch was allowed on post-op day 2. Mobilization with a walker/crutch was continued for 3 weeks, thereafter the type of support to be used if any was decided by the patient, according to his/her degree of comfort. Blood loss during the surgery and drain output were recorded. Pain score, extensor lag, range of motion, flexion deformity and walking ability were recorded in all the patients. Knee Society Score[6,7] was documented in the patients postoperatively on day 2, day 7 and then at 1 month, 3 months and finally at 6 months.

6. Statistical analysis

Continuous variables were presented as mean ± standard deviation. Normality of data was tested by Kolmogorov–Smirnov test. If the normality was rejected then non parametric test was used. Quantitative variables were compared using Unpaired *t*-test/Mann–Whitney test (when the data sets were not normally distributed) between the two groups. Qualitative variables were compared using Chi-Square test/Fisher's exact test. A p value of <0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

7. Results

The following observations were made during the study period.

The average age of the patients was 61.4 years (range 51–84 years) in the quadriceps sparing group and 59.8years (range 43–75 years) in the parapatellar group. The difference in the mean age between two groups is statistically not significant (p value >0.05). 48.78% of the patients belonged to the age group of 56–65 years. Majority of the patients were females (73.17%) in the whole study group. 58.54% of the operated knees were left sided and 41.46% of the operated knees were right sided.

7.1. Operative time and lateral release

1. The average operative time in the subvastus/midvastus group was 1 h 15 min and it was 1 h 4 min in the parapatellar group. The difference in the two groups is significant not statistically (p value > 0.05).
2. Lateral release was required in 1 (3.8%) patient in the quadriceps-sparing group and 4 (13.8%) patients in the parapatellar group.

7.2. Blood loss

Blood loss which included both the intra-operative losses and drain amount was measured in both the groups. The average blood loss in the subvastus/midvastus group was 418 ml and it was 426 ml in the parapatellar group. The difference in the two groups is not significant statistically (p value > 0.05).

7.3. Pain score

Table 1 gives the mean pain scores of patients in the preoperative and postoperative period measured using the Knee Society Score pain component. The difference in the pain scores between the two groups is statistically significant (p value < 0.005) at day 7 and 4 weeks with the quadriceps group having higher mean pain scores and thus less pain. However the difference between the two groups at 3 months and 6 months follow-up is statistically not significant (p values > 0.05).

7.4. Extension lag

1 patient (4%) in the subvastus/midvastus group and 6 patients (21%) in the parapatellar group had an extension lag of $<10°$ at

Table 1
Mean values (standard deviation) of pain score in the 2 groups in preoperative and post-operative period.

Pain Score	Category	Subvastus/midvastus group	Parapatellar group	*p* value
Preoperative		11.6 (8.5)	9.6 (6.76)	0.4674
Postoperative	7 Days	30.6 (9.05)	19.2 (8.62)	<.0005
	4 weeks	41.6 (7.18)	29.6 (6.76)	<.0005
	3 months	46.09 (4.76)	46.96 (3.28)	0.6716
	6 months	48.75 (2.22)	48.41 (2.84)	0.8049

7 days post-op. 1 patient in the parapatellar group had extension lag of 10° at the final follow-up of 6 months.

7.5. Flexion deformity

35% patients in the subvastus/midvastus group had a flexion deformity in the range of 10°–15° preoperatively. Postoperatively 3 knees had a flexion deformity of <5°, and the rest were fully corrected. In the parapatellar group 33.33% patients had a flexion deformity in the range of 10–15° preoperatively. Postoperatively 2 of the knees had flexion deformity of <5°, and the rest were fully corrected.

7.6. Alignment

Majority of the patients had varus alignment preoperatively (73% in Group-1 and 78% in Group-2). Postoperatively all knee were satisfactorily aligned at 0°–5° of valgus.

7.7. Range of motion (degrees)

Table 2 gives the mean values of range of motion of the involved knee in both the groups in the preoperative and postoperative period. On intergroup comparison between the two groups post-operatively the difference in the range of motion is statistically not significant (p value >0.05).

7.8. Walking

At 6 months follow up 95% of the patients in the subvastus/midvastus group could walk greater than 10 blocks. In the parapatellar group at 6 months 100% of the patients could walk greater than 10 blocks at 6 months follow-up. The difference in walking ability at 6 months follow-up is not significant statistically (p value > 0.05).

7.9. Knee Society Score (mean)

Table 3 gives the mean value of Knee Society Scores in the 2 groups in the preoperative and postoperative period. On comparing the postoperative Knee Society Scores of the two groups at each follow up the difference was statistically significant at 7 days and 4 weeks postoperatively (p value <0.05) but the difference between the two groups at 3 and 6 months was not significant statistically (p value >0.05).

7.10. Functional scores (mean)

Table 4 gives the comparison of mean functional scores in the preoperative and postoperative period in the two groups. The difference between the mean preoperative function score and the mean postoperative function score at the final follow-up are statistically significant in both the groups (p values < 0.05). On comparing the postoperative function score of the two groups at each follow up p values were not significant statistically (p value > 0.05).

7.11. Complications

No case of neurovascular injury or deep infection occurred in the study. Superficial wound complications occurred in a total of 4 patients in the study group which were managed on oral

Table 2
Mean values of range of motion in the preoperative and postoperative period.

Range of motion	Category	Subvastus/midvastus group	Parapatellar group	*p* value
Preoperative		84.2 ± 8.25	84.6 ± 7.06	0.9347
Postoperative	7 days	94 ± 4.08	94.2 ± 4.49	0.9670
	4 weeks	94.96 ± 2.89	95.2 ± 3.38	0.6989
	3 months	104.78 ± 4.39	105 ± 3.09	0.9605
	6 months	109.5 ± 3.59	110 ± 2.67	0.5803

Table 3
Mean values of Knee Society Score in the two groups.

Knee Score	Category	Subvastus/Midvastus group	Parapatellar group	*p* value
Preoperative		43.12 ± 3.73	43.12 ± 3.97	0.8053
Postoperative	7 days	68.08 ± 1.87	62.92 ± 1.85	<0.0005
	4 weeks	77.52 ± 2.4	72.6 ± 2.18	<0.0005
	3 months	90 ± 1.98	89.68 ± 1.62	0.6769
	6 months	90.1 ± 1.17	89.46 ± 1.4	0.2131

Table 4
Comparison of mean functional scores of the two groups.

Function	Category	Subvastus/midvastus group	Parapatellar group	*p* value
Preoperative		40.8 ± 4.93	40.6 ± 3.63	0.6825
Postoperative	3 months	70.22 ± 4.39	70.68 ± 5.19	0.6670
	6 months	81.25 ± 3.19	78.86 ± 4.06	0.0489

antibiotics and antiseptic dressings. One patient required secondary closure of the wound. No cases of component loosening were found at the final follow-up of 6 months.

8. Discussion

In our study a total of 55 primary total knee arthroplasties were done in 55 patients. No significant differences in the operative timing and amount of blood loss during the surgery were found between the two groups.

Lateral release was required in 13.8% of the cases in the parapatellar group as compared to 3.8% of patients in the quadriceps-sparing group to ensure proper patellar tracking intra-operatively. The differences between the two groups in the follow up were significant for pain relief at 7 days and 4 weeks postoperatively with the patients of the subvastus/midvastus group having less pain and therefore less requirement of analgesics. Extension lag was found in 21% patients in the parapatellar group compared to 4% patient in the quadriceps sparing group. The better pain relief combined with less of extension lag in the quadriceps sparing group allowed faster rehabilitation in the group quadriceps sparing group as compared to the patients in the parapatellar group. However the mean values of knee flexion range were comparable in both the groups when compared at post op day 7 and final follow up at 6 months.

There was statistically significant change in the knee society score in both the groups when the preoperative and the postoperative values were compared. Intergroup comparison of scores in the postoperative period showed statistically significant difference in the values at postoperative day 7 and 4 weeks postoperative with quadriceps sparing group showing better scores in comparison to the parapatellar group. However, the difference in the scores of two groups was statistically not significant when comparison was made at 3 months and 6 months postoperatively. The differences in Knee Society Scores were mainly due to the pain component of the score which tilted the results favourably towards the quadriceps sparing group.

Numerous studies have compared the results of traditional parapatellar and quadriceps sparing approaches used in knee replacement surgeries; however, the conclusions are conflicting.[8–16] Faure et al. (1993)[17] compared subvastus and medial parapatellar approach. One stage bilateral total knee replacement was done with one knee exposed using medial parapatellar approach and other knee exposed using subvastus approach and were evaluated in terms of quantitative strength testing and range of motion before surgery and at 1 week, 1 month and 3 months after surgery. There was no difference in range of motion but greater strength at 1 week and 1 month the subvastus group however, there was no difference in strength at 3 months between the two groups. Engh et al. (1997)[18] compared medial parapatellar approach and midvastus muscle splitting approach. The frequency of lateral reticular releases was recorded, patellar tilt and translation were measured and quadriceps strength was tested. The midvastus splitting approach provided excellent exposure to all knees. Patellar stability and quadriceps strength were equivalent for the two approaches. They concluded that the midvastus muscle splitting approach is an efficacious alternative to the medial parapatellar approach in primary total knee replacement. Parentis et al. (1999)[19] compared vastus splitting and median parapatellar approach in primary total knee arthroplasty. Clinical parameters and electromyography were evaluated preoperatively and post operatively at regular intervals. It was seen that there were significantly fewer lateral releases and lesser blood loss in vastus splitting group than the median parapatellar group but no significant differences regarding strength, range of motion, knee scores, tourniquet time, propioreception and patellar replacement.

Keating et al. (1999)[20] compared midvastus muscle splitting approach with medial parapatellar approach. They evaluated the difference in lateral release, postoperative rehabilitation, ease of approach and complications in total knee replacement. There was no difference in range of motion on day 2 or discharge, straight leg raise, terminal knee extension, extensor lag, lateral release or rehabilitation. There were post operative hematomas and manipulation on the muscle splitting side. They concluded that muscle splitting approach could not be recommended as being superior to the median parapatellar approach. White et al. (1999)[21] compared surgical and clinical parameters associated with midvastus and medial parapatellar approaches in primary total knee replacement. The comparison included the surgical parameters of difficulty of exposure, surgical time, incidence of lateral retinacular release and total blood loss. It was concluded that patients who have the midvastus surgical approach have less pain, earlier control of operative leg and may be discharged earlier. However the clinical result at six months based on the patient's pain relief, range of motion and ability to straight leg raise were identical between the two approaches. Roysam et al. (2001)[22] compared subvastus approach with medial parapatellar approach in primary total knee replacement. Assessment revealed earlier return of straight leg raise, lower consumption of opiates in the first week, less blood loss and greater knee flexion at first week in the group with subvastus approach. They concluded that subvastus approach offered early advantages over the standard parapatellar arthrotomy and preserves the integrity of the vastus medialis and peripatellar plexus of vessels.

Very few Indian studies have been done comparing the two approaches. In a recent study by Jain et al. (2013)[23] who compared the results of subvastus and parapatellar approaches in bilateral primary knee replacements concluded that subvastus approach produce appreciably less pain and faster mobilization as compared to parapatellar approach and shorter hospital stay, and more patient satisfaction.

The limitation of the present study is that the quadriceps power was not measured objectively which would have provided better assessment of the differences in the quadriceps strength between the two groups.

9. Conclusion

We conclude that quadriceps sparing approach (subvastus/midvastus) offers advantages over the standard medial parapatellar approach in terms of better pain relief and faster rehabilitation in the immediate post-operative period.

Conflicts of interest

The authors have none to declare.

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Research paper

Comparing gait analysis and functional outcomes of short femoral metaphyseal stem and high functional hip arthroplasty (resurfacing and big femoral head): A pilot study

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ABSTRACT

The purpose of this study is to evaluate and compare short term results (2 years post-operative), complications and functional outcomes (gait analysis) between short-metaphyseal hip arthroplasty and high functional total hip arthroplasties (resurfacing and big femoral head arthroplasties). Our patients were enrolled in three different groups, one comparing short-metaphyseal arthroplasties group and two high functional control groups. The first control group of resurfacing arthroplasties and a second of big femoral head arthroplasties. Each patient experienced a clinical examination and evaluated with Harris Hip Score, WOMAC, Sf-36, UCLA activity score, antero-posterior and lateral hip radiographies and were followed as outpatients for two years. At the last follow up all the patients perform a gait and static balance analysis. Statistical analysis have not revealed a significant difference between the three comparative groups regarding their demographic data nor a significant difference at the preoperative and the postoperative scores of each group. The radiographic evaluation revealed no differences and no complications. No one presented with cup or femoral loosening and no heterotopic ossification was observed. Also the comparing data of the three groups at the final 2 years postoperative control did not reveal any significant difference regarding their clinical scores and gait analysis results. The overall outcome of all three groups was similar and all the patients satisfied. We arrive at the conclusion that high functional resurfacing and big femoral head arthroplasties, present similar gait characteristics and functional outcome to the bone and soft preserving short-metaphyseal hip arthroplasties.

1. Introduction

Total hip arthroplasty is a common procedure in orthopedic surgery that is steadily increasing in young patients. Bone conserving and soft tissue sparing techniques and implants, offer to young patient's satisfactory functional outcome. Young patients with hip arthroplasty will receive at least one revision operation during the rest of their lives. If a standard stem can be used in a revision instead of a longer stem, this is as an advantage for both, younger and older patients. This advantage was a good reason for using resurfacing total hip arthroplasty in young patients.[1,2]

The advantages of bone preserving and soft tissue sparing techniques offers also biological and mechanical benefits that are well studied in young patients. The resurfacing and big femoral head hip arthroplasties provide almost physiological gait characteristics at early postoperative time (1–2 years). Especially in young patients and athletes was observed that they have successfully returned to preoperative everyday habits and sport activities.[3]

Gait analysis is an accurate study and vastly used to evaluate clinical and functional outcome of a hip replacement.[4] At the past gait analysis have been used to estimate, compare and correlate gait characteristics and functional outcome of different types of arthroplasties, from standard to resurfacing hip arthroplasties.[4–6] The combination of gait analysis results and those from clinical scores, WOMAC, SF36 gives extremely accurate picture of the functional status of the hip replacement.[5,7]

Short stem induced a proximal load transfer, with a primary metaphyseal anchorage, allowing a more physiologic load transfer and reduced stress-shielding. The mechanical and biological advantages from bone preserving and soft tissue sparing techniques, result to early clinical and functional outcomes.[8,9]

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2214-9635/

The purpose of this study is to evaluate the short term results (2 years post-operative), complications and functional (gait analysis) outcome of short-metaphyseal hip arthroplasty (SMH) and compare them with well-studied high functional resurfacing (RS) and big femoral head (BFH) arthroplasties. However, barely any data exist about gait analysis and functional outcomes of short metaphyseal stems.

2. Material and methods

Our study involving 55 patients undergoing THA. The first group (comparative study group-SMH) with 21 patients treated with short metaphyseal total hip arthroplasty. At the second group, resurfacing hip arthroplasties (controlled group-RS) were enrolled 18 patients and at the third group, big femoral head arthroplasties (controlled group-BFH), 16 patients. All the patients were treated in our department and the operations were performed by the same senior surgeon. Standard minimal invasive posterior surgical approach was used in all the operations.

For the SMH group (Fig. 1) the bearing surface was 36 mm oxynium head on high cross linked polyethylene in all 21 cases (SMF-Short Modular Femoral^{R}). All femoral stems and acetabular implants were uncemented. For the RS (Fig. 2) and BFH group (Fig. 3) (Wright^{R} Resurfacing and Wright^{R} Big Femoral Hip) the bearing surface were metal on metal with diameter of the femoral head at 52 mm (range 49–56 mm). All femoral stems and acetabular implants were uncemented at the BFH group and only the resurfacing femoral head implants were cemented at the resurfacing group. The patients of all the three studding groups were allowed to stand on the second postoperative day and then

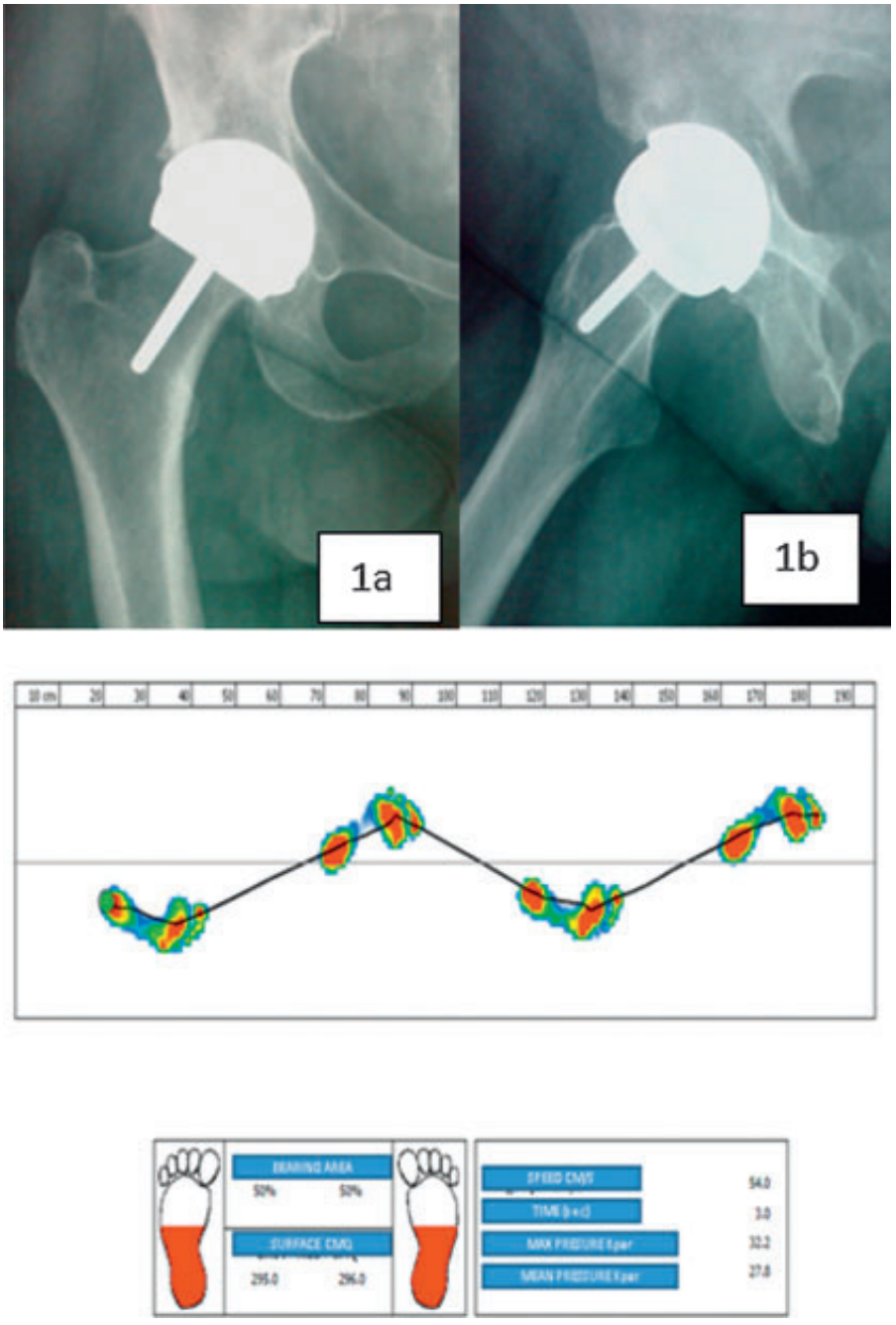

Fig. 1. Resurfacing hip arthroplasty radiographs: (a) AP, (b) lateral and postoperative gait analysis.

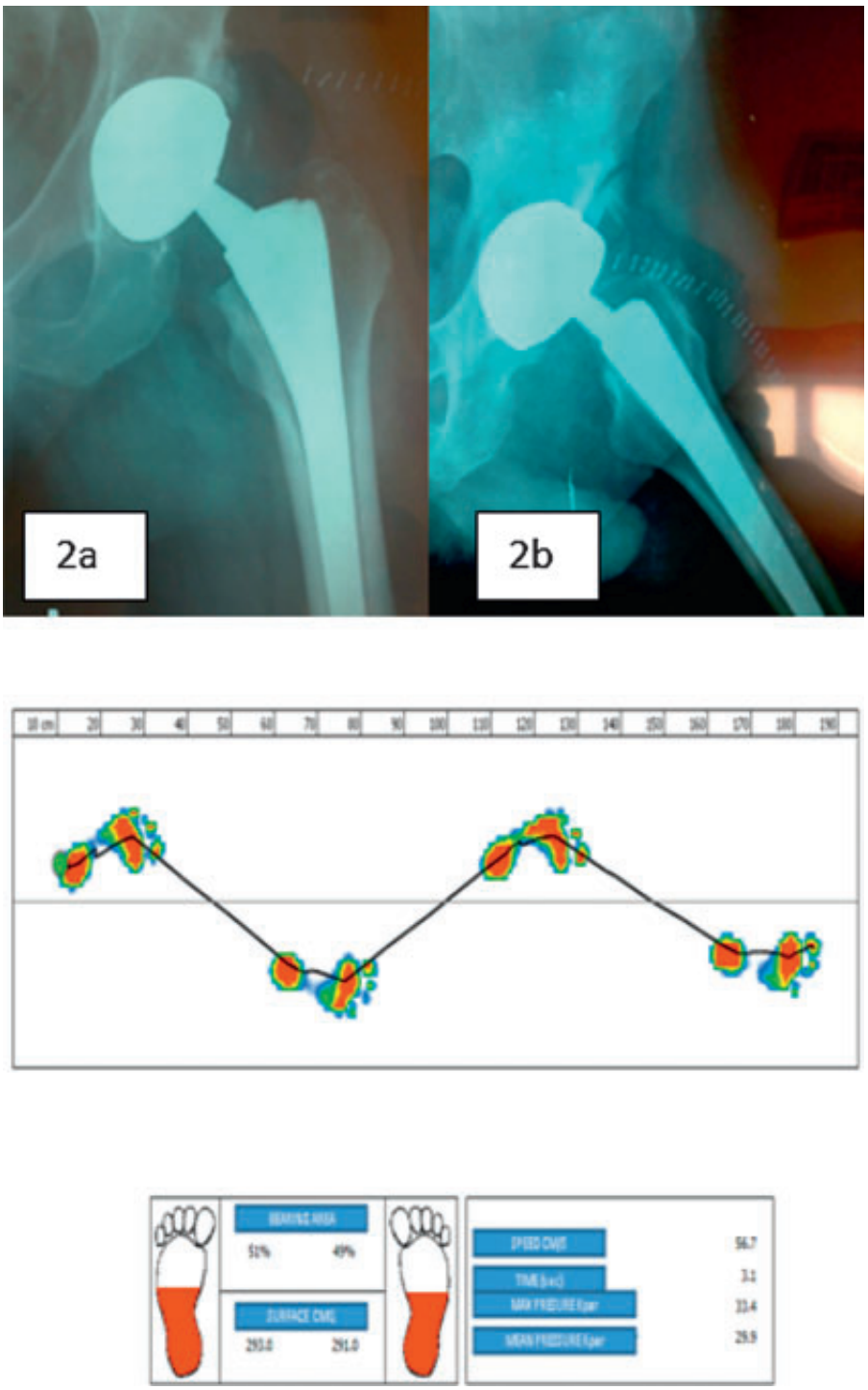

Fig. 2. Big femoral head arthtroplasty radiographs: (a) AP, (b) lateral and postoperative gait analysis.

progressed to full-weight-bearing activity with crutches as tolerated. They were advised to use crutches for six weeks and to use a cane thereafter as needed.

Preoperatively, each patient experienced a clinical examination that included detailed history, demographic data, hip's range of motion evaluation, Trendelenburg test, Harris Hip Score, WOMAC, Sf-36 (Physical-based component summary [PCS], Mental-component summary [MCS]), pain VAS (pain visual analog scale), UCLA activity score, anteroposterior and lateral hip radiographs. There was no need for further imaging evaluation.

All patients were followed prospectively after the operation as outpatients at regular intervals of one, six, 12 and 24 months. They were evaluated by clinical examination, with Harris Hip Score, WOMAC, Sf-36 (Physical-based component summary [PCS], Mental-component summary [MCS]), pain VAS, UCLA activity score, anteroposterior and lateral radiographs of their operated hip. Gait analysis was performed at second year post-operatively. Gait speed and postural balance performance results were analyzed. Stabilo pro system^{R} by Protec^{R} was used for estimation of gait analysis. The system is composed of three basic instruments: (i) a

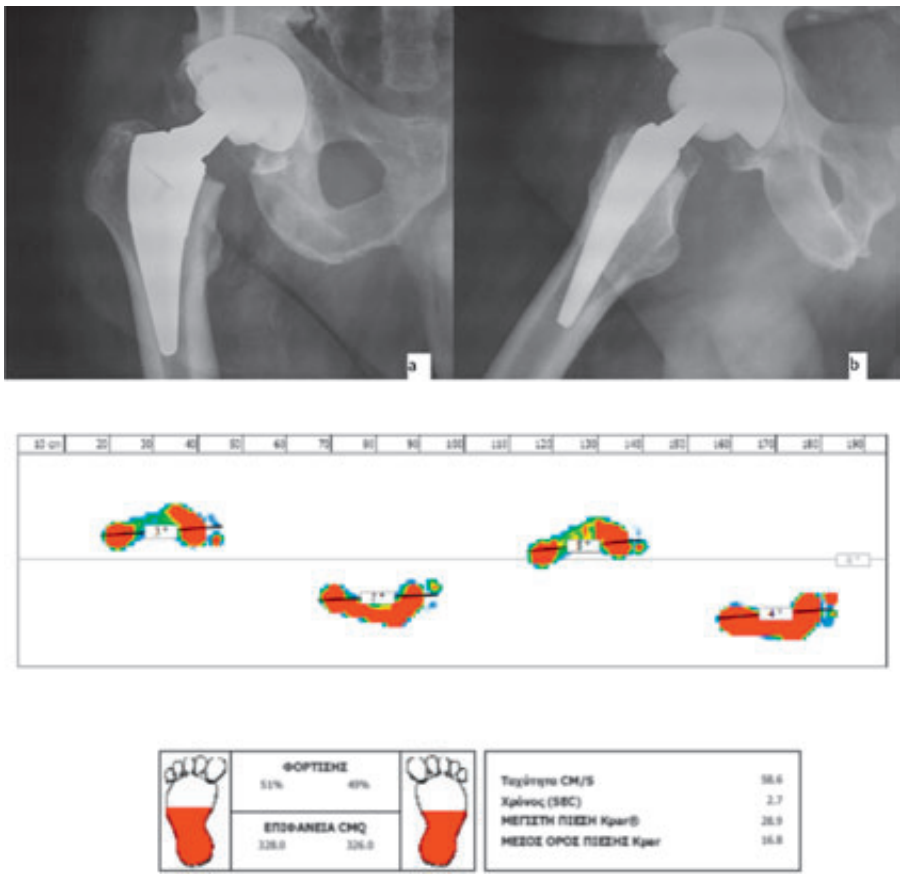

Fig. 3. Short metaphyseal hip arthtroplasty radiographs: (a) AP, (b) lateral and postoperative gait analysis.

48 cm × 48 cm basic barometric platform, the Basic Plana, with 2.304 sensors for the static and dynamic analysis of the limp, (ii) the Stabilometry and Linea plana, a 1.92 cm long pressure platform with 9.216 sensors that allows control of all gait characteristics as well as evaluation of the gravity center for the whole body and of each limp separately. Mean follow up time was 24 months.

The study was approved by our hospital institutional review board and all patients provided informed consent. For the statistical analysis we performed a paired *t*-test which is used to compare means on the same subject over time or in different circumstances. Analysis was performed by the Stata 11 (College Station, Texas, USA).

3. Results

Comparison of demographic characteristics regarding height, weight, age, BMI, between the three groups did not reveal any significant statistical difference (Table 1). There were no intraoperative deaths and no major complications related to the arthroplasty at any studied group and during the 2 year follow up.

At the SMF group the mean value for the HHS pre and post operatively were respectively 48.5 (range from 26.4 to 53.1) to 92.4 (range from 81.7 to 99.8). The mean values for the WOMAC and Sf36 scores respectively pre and post operatively were, 43.6 (range from 29.3 to 47.7) to 91.4 (range from 86.7 to 96.1) and PCS/MCS 35.8/46.3 to PCS/MCS 46.3/59.3. The UCLA activity score was relatively pre and post operatively 3.8/7.9. These results were compared with the corresponding values of the control groups (RS and BFH groups) (Table 2). We were not able to establish a statistically significant difference when comparing all the three groups (SMF vs RS, and SMF vs BFH). Statistical analysis revealed a statistical significant difference between the preoperative and the postoperative HHS (Harris Hip Score), WOMAC and UCLA scores for all the patients of the study. As far as Sf-36 there was statistical significant difference both in MCS and PCS between preoperative and postoperative values. All patients rated their clinical result as good and were able to return to daily habits and sport activities.

At the final follow up (2 years post operatively) gait analysis was performed in all three groups and their results were compared (Table 2). At the SMF group the data analyzed and compared were the following: velocity (cm/s), time (s), step length (cm), swing phase length (cm), pressure (Kpar mv), weight bearing area (%), weight bearing surface (cmq), external rotation (degrees) of the operated limp and modification of the gravity center (%). Statistical analysis of the gait analysis data could not reveal any significant difference regarding the gait characteristics of the two comparative studies, RS vs SMF, BFH vs SMF. Our SMF comparative group patients had similar gait characteristics with high functional resurfacing hip and big femoral head arthroplasties (Table 3).

The radiographic evaluation revealed no differences with the early postoperative X-rays. No evidence of cup or femoral

Table 1
Comparison of demographic characteristics between groups.

	BFH vs SMF *p* Value $p \leq 0.05$		RS vs SMF *p* Value $p \leq 0.05$	SMF
Age	0.4396		0.0805	57.3
BMI	0.1355		0.1058	31.3
		BFH	RS	SMF
Gender (male/female)		11/5	7/8	11/7
Cause (OA/other)		11/5	11/4	16/2
Foot (right/left)		12/4	12/3	15/3

Table 2
Comparison of clinical scores between groups.

	BFH	RS	SMF	BFH vs SMF p Value $p \leq 0.05$	RS vs SMF p Value $p \leq 0.05$
HSS pre/post operative	56.5/93.7	60.3/95.7	48.5/94.4	0.1866	0.1866
WOMAC pre/post operative	65.5/93.3	72.3/94.5	61.4/94.1	0.2473	0.6499
SF36 PCS pre/post operative	35.1/49.6	38.70/54.4	35.8/51.3	0.1058	0.0192
SF36 MCS pre/post operative	37.0/48.6	32.5/56.1	46.3/59.3	0.002	0.0173
UCLA activity	3.5/6.7	4.0/8.1	3.8/7.9	0.2156	0.8185
S VAS	3.7/7.2	5.6/9.7	4.3/9.5	0.0543	0.8093

loosening, or heterotopic ossification was observed. There was no report of hip dislocation cases.

4. Discussion

Uncemented metaphyseal-engaging short stems provides theoretically benefits compared to conventional stems similar to well-studied resurfacing and big femoral hip replacement. In this study our intention was to prove the functional efficiency of short metaphyseal arthroplasty in young patients and justify them as an interesting alternative to resurfacing hip arthroplasty.

The positive mid-term clinical and radiological results (4.9 years), do not show signs of loosening, that confirms the metaphyseal fixation concept of the short-stem (Metha) model.[10,11] Good results were reported for the CFP short-stem implant with a HHS of 93 after 2 years and a HHS of 96 after 7 years.[11] For the Mayo short-stem implant, a HHS of 93 was reported after 6.4 years.[12] The NANOS short stem demonstrated a satisfactory outcome at midterm follow-up (5.2 ± 0.7 years). The clinical and radiological results support the principle of metaphyseal anchorage of a short stem prosthesis.[13] Latest results in the literature for bone preserving short-stem implants are very encouraging. Despite an initial learning curve, short stems (Metha) have generated promising early clinical results (1 year), with low revision rates and high outcome scores.[14]

When using short-stems, neck preservation provides mechanical and biological advantages and offers superior tri-planar implant stability allowing more accurate restoration of the hip geometry and biomechanics.[15,16] Another advantage is that the short stem is cementless anchored to the femoral neck, the metaphysis or the upper diaphysis whilst keeping the trochanteric structures completely intact.[11] Experimental studies on short stems (Metha Aesculap) indicate influence of different femoral neck resection heights on stress shielding.[17] Studies in synthetic bone revealed that short stems induced a proximal load transfer, which supports that primary metaphyseal anchorage occurred allowing a more physiologic load transfer and therefore a reduction of stress-shielding.[16,18] Similar advantages were evaluated in the past regarding resurfacing hip arthroplasties. These advantages in addition to the good functional outcome, even in younger population were evaluated with gait analysis of the patients.[19,20] This study was undertaken to assess whether short metaphyseal arthroplasty with pure proximal fixation may provide high rates of satisfactory clinical and functional outcomes similar to high functional arthroplasties (RS, BFH).

It should be noted that the number of revision THA is steadily increasing as young patients with total hip arthroplasties multiplied and they face a higher risk of implant failure.[19] Wittenberg et al. presented 250 short hip stem prosthesis with an average of 4.9 years follow up resulting that short stem length and proximal fixation geometry support a bone-preserving and muscle-sparing implantation and should also allow for revision surgery with a standard hip stem.[21] Studies with Dual-energy X-ray absorptiometry (DXA) analysis, most commonly used protocol to evaluate bone remodeling after the implantation of femoral stems, have shown that progressive shortening of the femoral stem produces more proximal loading, which effectively preserves metaphyseal bone stock and increases periprosthetic BMD.[22,23] Bone preserving arthroplasties provide good bone stock and good functional outcome as well. We evaluate and compare gait analysis characteristics of short metaphyseal and resurfacing arthroplasties. The current study is the single to date on the evaluation and comparison of gait analysis and functional outcomes of short-metaphyseal hip arthroplasty and high functional total hip arthroplasties. Similar studies have been proposed at the past for different types of hip arthroplasty.[6,8]

Due to these advantages some authors believe that short stems might become an alternative to standard stems and hip resurfacing.[24,25] In our study we introduced the standard stems with high functional big femoral head (BFH) in a control group. The BFH are characterized by similar functional and gait characteristics to resurfacing.[4,5] Authors initiated a prospective clinical evaluation and conclude that short stem implants are stable and are associated with proximal bone remodeling closer to the metaphysis when compared with conventional stems. They also have comparable clinical performances. According to these results, they believe that short stem metaphyseal-engaging implants can meet the goals of a successful THR, including tolerating a high level of patient function, as well as durable fixation.[26,27] In our study we were able to prove also the success of good functional outcome in young patients using a 36 mm diameter of femoral head and simulate gait analysis similar to big femoral head and resurfacing arthroplasty.

Table 3
Comparison of gait and balancing results.

Parameter	BHF	RS	SMF	p Value (BFH/SMF) p Value $p \leq 0.05$	p Value (RS/SMF) p Value $p \leq 0.05$
Velocity (cm/s)	55.8	56.1	57.1	0.7319	0.2879
Time (s)	3.2	2.9	3.7	0.5734	0.5734
Step length (cm)	48.1	49	47.5	0.1338	0.1401
Swing phase (cm)	72.5	73.4	72.1	0.7376	0.0704
Step pressure (Kpar mv)	36	34.5	29.3	0.0012	0.0031
Step weight bearing (%)	51	50.6	49.6	0.1616	0.2879
Step surface (cmq)	313	298	327	0.1616	0.0238
External rotation	6.5	5.2	4.5	0.0705	0.4093

5. Conclusions

This study confirms the excellent early clinical and functional performance of short metaphyseal arthroplasty strongly suggesting not only an innovative, but also a reliable alternative in total hip replacement for young active patients. The short-term results

are encouraging, but nevertheless long-term results must be further observed on a prospective basis.

Conflicts of interest

The authors have none to declare.

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Research paper

Functional outcome of arthroscopic repair of full-thickness degenerative rotator cuff tears

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ABSTRACT

Background: In the past decade, in spite of the advancement in the clinical knowledge, imaging modalities for precise diagnosis and minimally invasive surgeries, the ideal management for degenerative rotator cuff tears is still a matter of debate.
Methods: This prospective study was conducted from January 2013 to August 2016, involved 16 patients (09 males, 07 females) with the mean age of 62.81 ± 7.24 years (range 54–80 years), who had the full-thickness degenerative tear of the rotator cuff. Arthroscopic repair using single row technique was performed in all the patients. The outcome was assessed using ASES questionnaire; pain score by visual analogue scale (VAS) and range of motion of the shoulder joint at presentation, 24 weeks and at final follow-up.
Results: At the mean follow-up of 24.68 ± 3.17 months (range 20–29 months), the mean ASES score and pain score (VAS) improved significantly from 31.16 ± 5.57 to 71.79 ± 3.92 (p-value <0.001) and 5.63 ± 0.72 to 1.9 ± 0.92 (p-value <0.001) respectively. There was significant improvement in all the movements of the shoulder joint. 14 patients were satisfied with the final functional outcome.
Conclusion: Arthroscopic repair of a full thickness degenerative tear of the rotator cuff using single row repair technique leads to satisfactory functional outcome in terms of activities of daily living, pain scores and range of motion.

1. Introduction

Rotator cuff tears (RCT) are the common cause of shoulder complaints in the elderly population. Management options for the RCT include conservative and surgical (open/arthroscopic) repair of the tear. But debate about the best treatment option has not been resolved and controversy still persists about the optimal management of the degenerative RCT, as the acceptable results have been achieved with both conservative as well as surgical intervention in the past.[1,2]

The proponents of surgical intervention of the degenerative tears of rotator cuff feel that RCT has limited ability to heal without repair. Furthermore, conservative management leads to the progression of the tear which can be disabling later in life in the terms of pain and functional outcome.[3–5] While the proponents of conservative management feel that results of the functional outcome even after the surgical intervention are similar to the conservative management and re-tear rates after the surgical repair are also very high. Furthermore, surgical intervention has inherent risks of surgery.[6–8]

In our search on the pubmed database, we could find only one original article from the Indian subcontinent about the management of degenerative RCT using the arthroscopic technique.[9] The present study was conducted to assess the functional outcomes after arthroscopic management of degenerative RCT in terms of the pain score and activities of daily living in patients aged >50 years.

2. Materials and methods

2.1. Study design

This was a prospective study of 16 patients with full thickness degenerative rotator cuff tear, who met the inclusion criteria. All the patients were operated between January 2013 and December

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2014 at our centre by arthroscopic repair of RCT using single row repair technique. The patients were advised surgery based on chronic shoulder pain with inability or difficulty in elevating arm and patients who have not improved with the conservative trial of at least six months duration.

Inclusion criteria
1. Age >50 years.
2. Full thickness degenerative RCT confirmed on preoperative MRI.
3. No, or minimal improvement after conservative management of at least 6 months.

Exclusion criteria
4. Partial thickness rotator cuff tears.
5. Traumatic rotator cuff tears.
6. Preoperative MRI showing significant pathology requiring surgical intervention other than rotator cuff tears.
7. Re-tears of the repaired rotator cuff tears.

2.2. Preoperative evaluation

Preoperative evaluation included comprehensive history, physical examination, MRI of the shoulder joint. Preoperative range of motion of shoulder joint was assessed. The American Shoulder and Elbow Surgeons (ASES) questionnaire was filled.[10]

ASES is a 100 point scoring system in which 50 points were derived from the patient's report of pain on Visual analogue scale (VAS).[11] The cumulative score of 10 activities of daily leaving on 4-point ordinal scale accounts for the remaining 50 points.

2.3. Surgical technique

All the patients were operated under combined inter-scalene block and general anaesthesia in lateral decubitus position with torso rolled 25–30° posterior and arm in 45° abduction and 15° forward flexion with 10 pounds traction weight. The posterior portal was made at soft spot 2 cm inferior and 1 cm medial to the posterolateral border of the acromion and diagnostic arthroscopy was performed to confirm degenerative complete tear and to exclude pathologies like biceps tendon tear, Bankart or Hill Sach's lesions. The articular surface of the cuff was inspected, and partial or full thickness tears were identified (Fig. 1a). After the complete gleno-humeral arthroscopy, the posterior border of the acromion was palpated. The trocar was then placed underneath the acromion and inserted in an anterior direction to enter the sub-acromial space. The bursal tissue was cleared and adhesiolysis was performed using radiofrequency soft tissue ablation device through lateral portal. The medial and lateral extents of acromion were identified, along with the coracoacromial ligament. Sub-acromial decompression in the form of bursal debridement and acromioplasty was performed. We aimed to create adequate space for rotator cuff tendon with the acromioplasty. As all of the patients in our study had the chronic degenerative tear, so impingement was also considered to be part of the disease and removal of osteophytes and adequate decompression of subacromial space was done in every case.

After the decompression, the tear margins were debrided. Cuff mobility was assessed for the approximation of cuff to its footprint. An anterior and superior-lateral portals were made for anchor placement and suture shuttling. The bone bed, just off articular margin on humerus was prepared, using a shaver and radio frequency ablator (Fig. 1b). For fixation of the rotator cuff to the bone, 5.5 mm bio-corkscrew suture anchors (Depuy Mitek, Raynham, MA, USA) were inserted (Fig. 1c) at roughly 1-cm intervals, 4–5 mm off the articular surface and at an angle of approximately 45° to bone surface to increase anchor's resistance to pull-out. The sutures were passed through tendon after the anchors were placed. The number of anchors used varied depending upon the size of the tear. After placing all the sutures in the cuff, traction was applied to reduce the tendon to bone. We used three half hitches sliding knot, followed by three consecutive half hitches on alternating posts for the repair of the cuff to the bone (Fig. 1d). The portal sites were closed and the sterile dressing was done after the repair.

2.4. Postoperative care

Immobilization with an abduction pillow for four weeks was advised. The range of motion exercises of hand, wrist and elbow were started from day 1. All the stretching exercises of the shoulder were avoided. From 4 to 12 weeks, the passive and active-assisted range of motion exercises were encouraged in all planes. However, external rotation with abduction of the arm in 90° was avoided for 12 weeks. Active followed by strengthening exercises were started after 12–16 weeks.

2.5. Postoperative assessment

All patients were followed up regularly at 4 weeks, 24 weeks, at the final follow-up. A comprehensive evaluation including a physical examination, assessment of the range of motion and completion of ASES questionnaire was done.

2.6. Statistical analysis

The pre and postoperative outcomes of the range of motion of shoulder joint and ASES questionnaire which include VAS scores and activities of daily living were compared by unpaired *t*-tests (*p* values of <0.05 were considered significant).

2.7. Ethical clearance and informed consent

Ethical clearance was obtained from the institutional ethics committee of the hospital before the start of the study. Written informed consent was obtained from each patient before the conduct of the study.

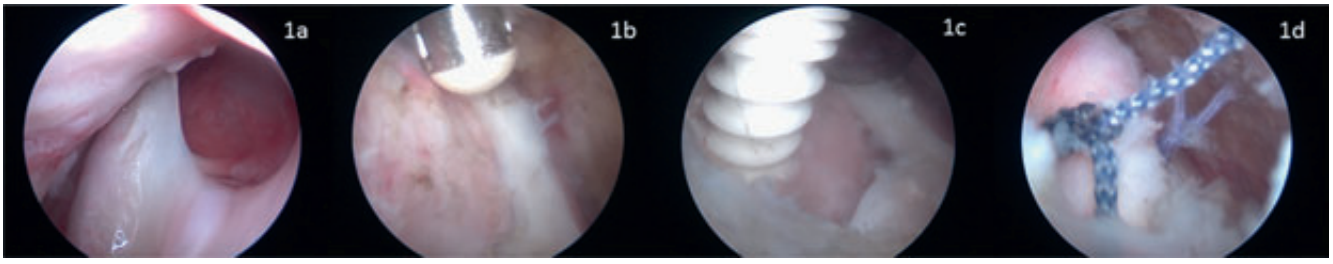

Fig. 1. Arthroscopic view of (a) crescent shaped full thickness rotator cuff tear as seen from glenohumeral joint, (b) preparation of bone footprint by electrocautery, (c) bio-absorbable anchor at the prepared site, (d) cuff secured at desired footprint of rotator cuff.

3. Results

The pre-operative demographic data and anatomic configuration of lesions were as per Table 1 All the patients were operated using arthroscopic single-row repair technique. The mean number of suture anchors used were 2.68 (range 2–4). Mean surgery time was 2.1 h (range 1–3.5 h). No complications were observed during intra-operative or in the post-operative period. There was no re-tear at the time of final follow-up.

The ASES Society questionnaire scores improved from 31.16 ± 5.57 preoperatively to 71.49 ± 3.91 at the final follow-up (p-value <0.001). The pain score on the 10 point VAS improved from 5.63 ± 0.72 preoperatively to 1.9 ± 0.92 at the final follow-up (p-value <0.001).

The mean forward elevation improved from $51.25 \pm 11.47^\circ$ pre-operatively to $139 \pm 18.45^\circ$ at the time of final follow-up (p-value <0.001). The mean external rotation was $25 \pm 4.08^\circ$ pre-operatively and it improved to $66.25 \pm 12.71^\circ$ at the final follow-up (p-value <0.001). The mean preoperative abduction was $35.31 \pm 5.61^\circ$ and it improved $142 \pm 18.52^\circ$ at the time of final follow-up (p-value <0.001). The mean preoperative internal rotation was at L3 level and the majority of the patients (14 out of 16) could reach at T8 level at the final follow-up. The mean preoperative cross body adduction was $18.12 \pm 5.43^\circ$ and it improved to $48.43 \pm 7.23^\circ$ at the final follow-up (p-value <0.001).

14 patients were able to perform activities of daily living and were satisfied subjectively with the final outcome while two patients were having difficulty in performing activities of daily living because of pain and restriction of movements (Table 2).

Table 1
Preoperative demographic data and anatomic configuration of the lesions.

Factor	Finding
Mean age	62.81 ± 7.24 years (range 54–80 years)
Gender	
Male	9 (56%)
Female	7 (44%)
Smoking/tobacco use	3 (18%)
Alcohol consumption	3 (18%)
Dominant side involvement	10 (62%)
Duration of symptoms	9.37 ± 2.18 months (range 6–12 months)
Mean follow up	24.68 ± 3.17 months (range 20–29 months)
Full thickness rotator cuff tear	16 (100)
Configuration of tear	
L shaped	6 (38%)
U shaped	2 (12%)
Crescent shaped	8 (50%)

4. Discussion

The present study was a prospective evaluation of the patients, aged more than 50 years, to assess functional outcomes after primary all arthroscopic single-row repair of degenerative, full thickness rotator cuff tear. The study also aimed at assessing the relief of pain and the ease achieved in the activities of daily living in older population after the surgery.

Although several studies have found no significant difference between conservative and operative management of the degenerative rotator cuff tear.[2,6] But at the same time, various other studies have recommended operative intervention in patients who fail to respond to the conservative trial of 3–6 months.[1,12] In the present study, the sample size of 16 patients was selected who did not show improvement after a minimum of six months of conservative management.

Out of the 16 patients, nine (56%) were males and seven (44%) were females with mean age of 62.81 years. Ten (62%) had dominant (right) side involvement. Various other studies also have the similar demographic pattern as shown in the present study. Verma et al.[13] operated 39 patients with mean age of 75.3 ± 4.2 years while Gladstone and Bishop[14] operated 26 patients with mean age of 62. The mean follow-up in present case series was 24.68 months while it was 36.1 ± 9.9 months in a study by Verma et al.[13] and 12 months in a study by Gladstone and Bishop.[14]

All the patients were operated using arthroscopic single-row repair technique. In recent years trend is shifting towards

Table 2
Mean ASES score, VAS, range of motion of the shoulder joint.

	Preoperative	24 weeks	Final follow-up
ASES score	31.16 ± 5.57	69.75 ± 4.21	71.49 ± 3.91
VAS	5.63 ± 0.72	2.75 ± 0.58	1.9 ± 0.92
Flexion	51.25 ± 11.47	104.37 ± 16.31	139 ± 18.45
External rotation	25.00 ± 4.08	63.43 ± 14.80	66.25 ± 12.71
Abduction	35.31 ± 5.61	106.56 ± 17.00	142.5 ± 18.52
Adduction	18.46 ± 5.43	41.25 ± 10.08	48.43 ± 7.23

Fig. 2. (a,b) Pre-operative, (c,d) post-operative overhead abduction and arm lift off.

arthroscopic double-row repair, especially in degenerative type. However, various studies document similar functional results with both single and double row repair technique.[15,16] Furthermore, double row repair has its own disadvantages like increased stress on the repair because of excessive lateralization of the repair, increased surgical time and increased cost of the implant.

We have used ASES Society questionnaire scores for the functional evaluation of the surgical intervention. Various studies have used different scoring systems like Simple shoulder test, DASH score, Constant score, ASES, UCLA score for the evaluation of the rotator cuff after the repair. However, none of the scoring systems is considered as better than other scoring systems in the evaluation rotator cuff pathologies of the shoulder.[17]

The majority of the patients {85% (14 out of 16)} showed significant improvement at the final follow-up (Fig. 2a–d). The mean ASES Society questionnaire scores improved from 31.16 ± 5.57 preoperatively to 75.76 ± 5.04 at the final follow-up ($p < 0.001$). The pain score on the VAS improved significantly from 5.63 ± 0.72 preoperatively to 1.9 ± 0.48 at the final follow-up ($p < 0.001$).

14 out 16 patients were able to perform activities of the daily routine at the time of final follow-up which they were not able to perform prior to the surgery. We feel that adequate sub-acromial decompression with the removal of osteophytes and other subacromial bony prominences to increase the space should be performed in every patient, as these osteophytes are the major cause of pain and hindering factor in the return of functions even after the satisfactory rotator cuff repair.

5. Conclusion

Arthroscopic single row repair technique provides significant improvement in pain and function in carefully selected patients with degenerative rotator cuff tear.

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Conflicts of interest

The authors have none to declare.

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Short communication

Functional outcome of partial arthroscopic repair for massive rotator cuff tears

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ABSTRACT

Background: Despite advancement in arthroscopic techniques, surgical management of massive, irreparable rotator cuff can be difficult and demanding. Hence different surgical options like debridement, cuff augmentation, partial repair, tendon transfer, reverse shoulder arthroplasty or in space balloon spacer following failure of non-operative treatment have been described in literature.
Aim: To evaluate functional outcome following arthroscopic partial repair in patients with pseudo paralysis as result of massive irreparable rotator cuff.
Material and Methods: Retrospective review 19 patients with arthroscopic partial repair for massive rotator cuff tear performed. The diagnosis of massive cuff tear was confirmed in all patients during arthroscopic evaluation. Arthroscopic partial cuff repair was performed if watertight repair not possible in all cases to restore the insertion of the cuff above the equator. The postoperative scores were recorded by a postal questionnaire.
Results: There were 13 male and 6 female in this group with an average age of 60.4 years. Average follow up was 10.42 months (3–24 months). At follow up 14/19 (73%) had more than 900 forward flexion, abduction and 4/19 had external rotation greater than 450. Postop scoring was available in 11 patients with average oxford score 33.3 (19–44) and Quick DASH score of 22.16 (2.3–63.6). Pain levels were improved in all 11 patients who completed the questionnaire. Preoperative pseudo paralysis was improved in 82.3% patients (14/17). We had 2 patients presenting with re rupture 8 and 20 months respectively. None of the patients had reoperation within 2 years of primary procedure.
Conclusion: Functional partial repair can restore the shoulder biomechanics. The Partial cuff repair along with robust deltoid rehabilitation is a reliable procedure with good functional outcome.

1. Introduction

The aim of rotator cuff repair is to re-establish the attachment of the torn tendon to the humeral tuberosity. When this is achieved via a complete repair, favorable outcomes have been documented.[1–5] However even with a complete repair, some series report failure occurring in up to 90% of cases.[6,7]

Approximately 1 in 25 patients undergoing rotator cuff repair surgery undergo revision surgery in the following year.[8] Despite this potentially high number of failed repairs, several studies have found that patient reported outcome were improved whether or not the repair successfully maintained the integrity of the rotator cuff.[9–13]

The demonstration of improved pain and function despite lack of cuff integrity is an important factor to consider when managing patients with large, irreparable tears. According to literature several treatment options including simple debridement, partial repair, tendon transfer, biologic augmentation and reverse shoulder arthroplasty have been widely used for an irreparable large to massive cuff tear. Management options take into account the patient's age, comorbidities, activity level, and general physical demand. Massive tears, severe retraction combined with poor tendon quality and fatty infiltration occasionally preclude complete repair of the torn tendon to its native footprint. Attempting to mobilise laterally and repair the apex of a retracted tear to a lateral bone bed will often result in high tensile overload and subsequent failure.[14] Hence if complete watertight repair cannot be accomplished then a functional partial repair may be possible.[2,15–18]

Burkhart coined the phrase 'functional rotator cuff tear' which describes a tear that is anatomically deficient yet biomechanically

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intact, resulting in a more balanced shoulder with resultant improved function.[15] He described the biomechanical rationale of the 'suspension bridge system'. This model describes how partial rotator cuff repair attempts to re-create the transverse force couple of the rotator cuff through the concept of margin convergence. This can reduce the overall tension of the anterior and posterior tear leaves and provide a stable fulcrum for the glenohumeral joint. Thus patients with functional rotator cuff tears may have near normal function despite persistent defects in the rotator cuff.[14,15]

2. Materials and methods

In this retrospective study, we included 19 consecutive patients treated with arthroscopic partial repair for massive cuff tear. All the procedures were performed under supervision of the senior author over a period of three years (2011–2014). Following approval by trust audit committee, we retrieved patient information from electronic database, hospital records. Preoperative scores in the form of Quick DASH and Oxford were available for six patients while postoperative scores were obtained from ten patients. Pre and postoperative ROM were recorded from clinic records. Preoperative radiographs were assessed to identify any element of gleno-humeral arthritis. Pre-op MR scans were available in fourteen patients while five had an ultrasound scan to identify the nature of tear. Massive cuff tears with absence of arthritis who failed three months of pre-operative rehabilitation and were unable to forward flex and abduct beyond 90° were listed for arthroscopic cuff repair. We used postal questionnaire to evaluate the satisfaction and functional outcome following partial repair.

2.1. Surgical technique

All patients underwent arthroscopic procedure in a beach chair position under the care of the senior author. Following assessment of cuff tear, thorough mobilisation of cuff was performed including release of adhesions and appropriate dermal slides. Standard preparation of footprint was performed with the help of shaver (Fig. 1). The partial repair was performed only if tension free watertight repair could not be achieved. The partial repair was performed to get the anterior and posterior cuff above the equator (Fig. 2 and 3).

2.2. Post-operative rehabilitation

Patients were discharged on the same day with a sling for comfort. Early mobilisation was carried out with closed chain exercises commenced on the same day and a deltoid rehabilitation programme.

3. Results

There were thirteen male and six female patients in this cohort with an average age of 60.4 years (42–81). Dominant side was involved in 71% of patients. Out of those, fourteen patients with pre-operative MR scan, Goutellier stage IV was identified in eight and III in six patients.

At a mean 10.42 months follow up fourteen of nineteen (73%) patients had more than 90^{00} forward flexion and abduction and of these five (36%) achieved abduction and forward flexion beyond 145°. Four patients (21%) achieved external rotation greater than 45^{00}. Pre-operative pseudo paralysis improved in 82.3%. The average oxford score was 33.3 (19–44) and Quick DASH 22.16 (2.3–63.6). Pain levels were improved in all eleven patients who completed the questionnaire. All patients felt better than the pre-operative state, 16% returned to the same occupation and 67% had no pain at night. There were no repair related complications recorded. None of these patients had further procedure within the follow-up period. Two patients presented with re-rupture 8 and 20

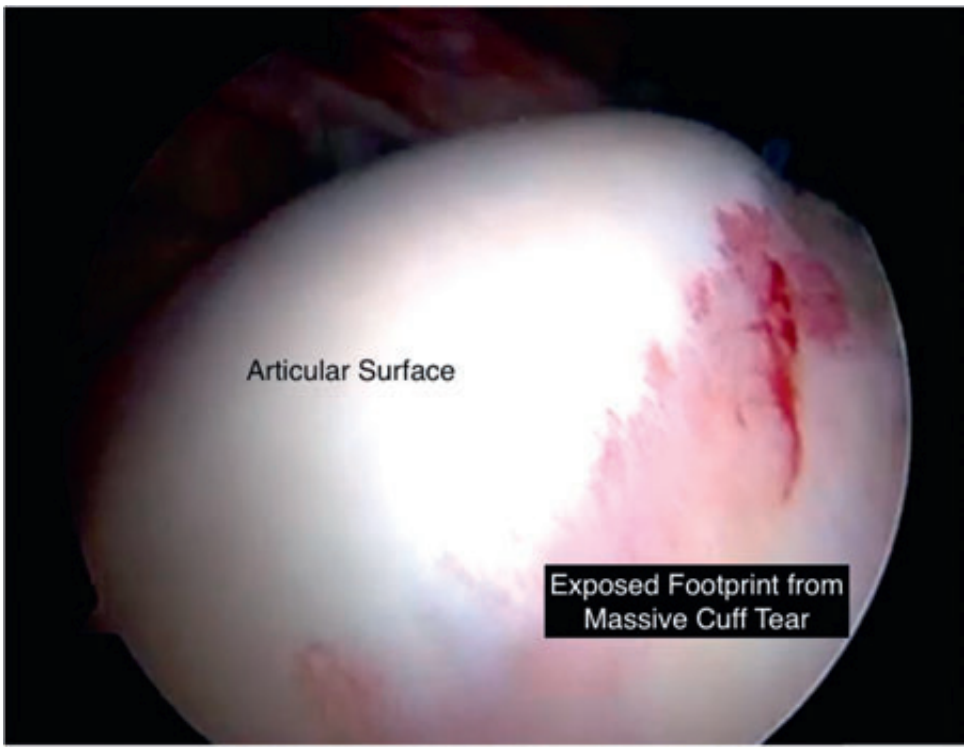

Fig. 1. Intra-op Arthroscopic view of massive cuff tear with exposed footprint.

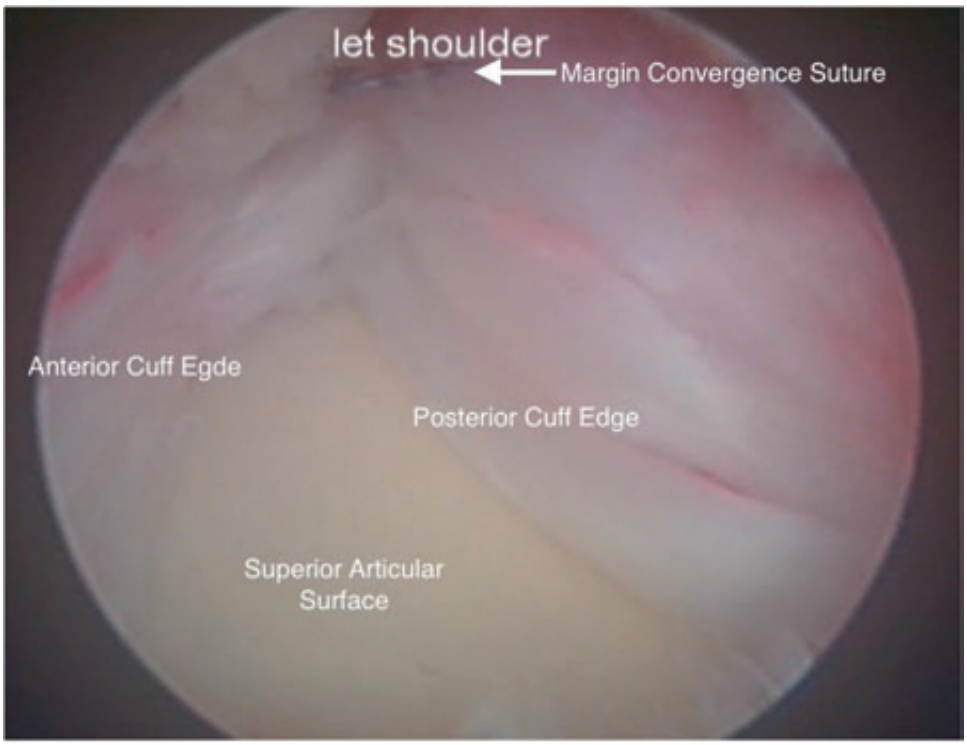

Fig. 2. Margin Convergence for partial repair.

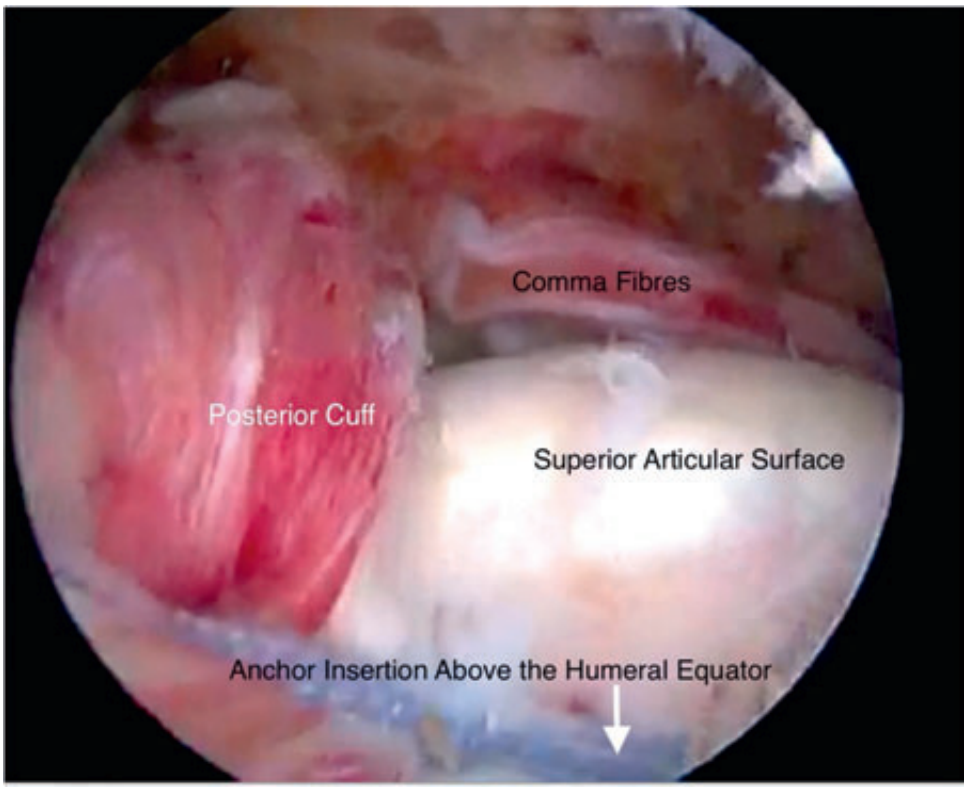

Fig. 3. Partial Repair of cuff above equator.

months but did not require surgical intervention at the point of most recent follow-up.

4. Discussion

The management of irreparable rotator cuff tears is a complex problem. Multiple factors influence decision-making and each patient must be counseled as to their likely respective outcomes. Poor cuff quality on pre-operative MRI gives an indication as to the likelihood of successful repair with fatty infiltration of the infraspinatus being a significant influencing factor toward healing failure.[13] However, even with grade 3 and 4 fatty degeneration of the cuff, repair can provide significant functional improvements.[19]

Massive tears however can be severely retracted as well as having poor tissue quality. Extensive soft tissue and capsular releases can help mobilise retraced rotator cuffs, but there remain occasions when the lateral tendon edge is unable to be completely re-approximated to the footprint. Short term and mid term results of simple arthroscopic cuff debridement for these cases have shown promising results. However longer term follow up shows that these initial results deteriorate significantly with time.[17,20–22]

In a prospective, randomised trial of 42 patients with massive rotator cuff tears, Berth et al., report that at two years there was no difference between those undergoing arthroscopic partial repair or arthroscopic debridement.[17] Regardless of the treatment group, post-operative results demonstrated highly significant improvements compared with pre-operative values in most parameters including pain relief. Arthroscopic partial rotator cuff repair demonstrated slightly better functional outcome than debridement however. Despite this, ultrasonography revealed structural failure of the partial rotator cuff repair in 52% at final follow-up. In our series all patients felt better than their pre-operative status with similar pain relief and improved function was observed

In Iagulli's series of 93 massive tears, complete repair was achieved in 52 cases and partial repair was accomplished in 41 cases.[23] No rotator cuff tear was found to be completely irreparable, and no tear was treated with debridement alone. At a mean follow up of 24 months no significant difference was demonstrated in UCLA score between the two groups. Both improved from pre-operative scores. Partial repair of massive cuff tears yielded outcomes comparable with complete repair of massive tears at medium length follow-up.

Porcellini has shown that this improvement in function may indeed last longer than most current studies have been able to demonstrate. They report that at a mean five years post partial repair, good results were seen through improved Constant and Simple shoulder score and in restoring the acromion-humeral head distance.[24]

Although a key component to repair is avoiding excess tension, every attempt should be made to limit the size of the residual defect. Kim et al., report on 27 cases of massive irreparable cuff tear treated with partial repair. They note that the mean residual defect size was 12 mm and that there is a relatively strong inverse correlation between the residual defect size and post-operative Constant and UCLA functional shoulder score. In their series all patients demonstrated significant improvement in Constant, UCLA and Simple shoulder score at a mean 41 months. Overall 81% of patients were satisfied with their results.[25]

In a series of 24 patients undergoing partial repair of massive rotator cuff tear, Duralde and Bair report a larger mean size of the residual defect at 17 mm. However similar to our series, satisfactory pain relief was achieved in 83% with 67% of patients demonstrating good to excellent results with increased active elevation (from 114° to 154°). Over 90% of patients were satisfied with the results of surgery.[16]

These findings support the earlier work by Burkhart et al., who describes the benefits of partial repair over tendon transposition for irreparable cuff tears. In 14 cases they demonstrated improved active elevation by a mean 90.8 degrees. Importantly for this group, strength improved on average 2.3 grades on a 0–5 point. UCLA score improved from 9.8 to 27.6 and all but one patient was very satisfied.[15]

4.1. Limitations

This was a retrospective review with small number of cases. Not All patients had preoperative scoring done.

5. Conclusion

Functional partial repair by maintaining cuff cable can restore the shoulder biomechanics. The partial cuff repair along with robust deltoid rehabilitation is a reliable, cost effective procedure with good functional outcome. Therefore partial repair to maintain the force couple can produce satisfactory results in patients with irreparable massive cuff tears.

Contributions

Ravi Badge: Data Collection, Literature Review, Manuscript Writing.

Jon Baxter: Literature Review, manuscript Writing.

Puneet Monga: Literature Review, Manuscript editing, Senior Author.

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Technical note

A method of avoiding skin irritation from outside-in suture knots in wrist scope surgery

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ABSTRACT

Wrist arthroscopy is helpful in treating many wrist problems. Suture repair is a commonly used method. One of the complications of suture repair is skin irritation by the knot. An irritating knot is more likely to occur with the conventional outside-in suture repair technique. We present a simple method to minimized skin irritation from a subcutaneous knot.

1. Introduction

Wrist arthroscopy is helpful in treating many wrist problems. Suture repair is the method commonly used in treating torn or loose structures. One of the complications of suture repair is skin irritation by the knot. It more frequently occurs in cases of surgery around the wrist, such as repair of the peripheral triangular fibrocartilage complex, due to the lesser amount of soft tissue around this area.[1] An irritating knot is more likely to occur with the conventional outside-in suture repair technique if the knots is not well buried at the end of the surgery. We offer a simple method to prevent skin irritation from a subcutaneous knots.

1.1. Surgical technique

This technique is suitable for outside-in suture repair technique around the wrist area. It is also suitable for the knee area or other parts with lesser amount of soft tissue.

In securing a repaired suture in wrist arthroscopic surgery, surgeons prefer to tie a knot with 4 or 5 throws and cut the suture end to a certain length, based on the suture materials and the tying methods. Untying the knot is a problem if the length of the suture end is not long enough; but, skin irritation is the problem if the length of the suture end is long enough.[2] With our method, we just cut the suture end to a length of 1.5–2 cm to leave a longer suture thread. Then, curved forceps can be used for subcutaneous dissection to create a space. The thread at the suture end can be grasped by the forceps and buried in the subcutaneous space (Fig. 1). With long suture threads, the knots can lay flat in the subcutaneous layer without any skin irritation. Using this method, skin irritation due to the short length of the suture can be prevented, and the length of the suture end is long enough to prevent the knots from untying.

2. Results

Our series of two surgeon's experience, from January 2008 to December 2015, there were 130 patients (79 female, 51 male) underwent arthroscopic triangular fibrocartilage complex repair with this outside-in suture technique. The 2-0 polydiaxanone (PDS II; Ethicon) was used for all the suture repair. In the follow-ups during the postoperative 3 months, there were only 5 patients (4 female, 1 male) complaining of the local foreign body sensation around the area of suture knots. But the complained discomfort of all the patients did not exist in the postoperative 1-year follow-up.

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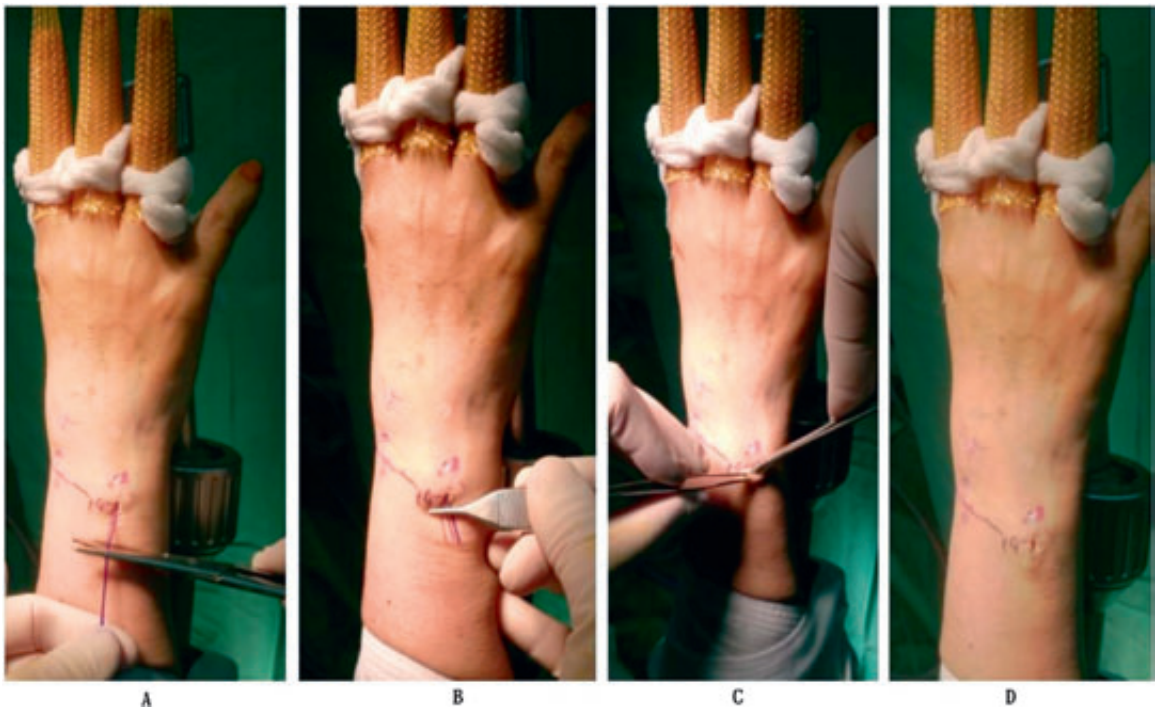

Fig. 1. (A,B) Cut the suture end to a length of 1.5–2 cm. (C) Creat a subcutaneous space. (D) Bury the suture ends in the subcutaneous space. The knots can be turned to lie parallel to the skin.

3. Discussion

The all inside suture technique is popular now and the problem of skin irritation can be avoided.[3] But for the institutions without all-inside suture instruments or surgeons familiar with the outside-in technique, this method could be helpful for decreasing the skin irritation by the suture knots. This method can also work in other parts (e.g., knee) if skin irritation due to the knots would be a problem.

There are still some limitations for this technique due to we did not have the comparative results from the conventional outside-in suture knots. Also the appropriate "long-length" of the suture thread in different suture materials still needs further study.

Conflict of interest

The authors have none to declare.

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Case report

Dermal burn: An unusual complication of radio frequency probe in shoulder arthroscopy

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ABSTRACT

Radiofrequency ablation probes have gained popularity in arthroscopic surgeries. We report an unusual complication associated with prolonged radiofrequency use in a shoulder arthroscopy case. A 55 year old male patient suffered a second degree burn around shoulder during rotator cuff repair. Long duration of radiofrequency probe use compounded by absence of suction outlet led to high temperature fluid coming in direct contact with the surrounding skin resulting in second degree burns around the shoulder region. Burns were managed conservatively, and went on to heal with hypopigmented scar at six month follow-up. Although a safe device, caution should be maintained while using radiofrequency probe and outflow should not be allowed to come in direct contact with the surrounding skin.

1. Introduction

Radiofrequency ablation probes have gained popularity in arthroscopic procedures in recent times, their ability to effectively ablate the soft tissue and maintain hemostasis have made their place inevitable in today's arthroscopic surgeons armamentarium.[1]

While these devices are simple to operate, their use is associated with various complications which mainly stem from increased temperature of the irrigating fluid. Various factors contribute to overheating namely the outflow rate, duration and pattern of usage of RF device.[2] These variables alter the extent of temperature rise of irrigating fluid, if ignored this can lead to various complications by direct damage to the cartilage, surrounding capsular attachments, tendons and nerves.[3–5] Dermal burns have also been reported due to extravasation of overheated fluid from outlet port of RF device.[6,7]

This case report highlights the fact that dermal burns are not so uncommon with RF use and simple, inexpensive measures can help in avoiding such complications.

2. Case report

A 50 year old male, policeman by profession presented to our clinic with complains of pain in left shoulder region with difficulty in overhead activities. History revealed an injury to left shoulder four months back, which was initially managed with rest and analgesics. Four months later, although the intensity of pain decreased but he continued to experience chronic dull aching pain accompanied with difficulty in using his shoulder for overhead activities.

Clinical examination revealed tenderness localized to acromioclavicular region with weakness in supra-spinatous and infra-spinatous while teres minor appeared to be uninvolved. Radiographs revealed Bigliani Grade 3 acromion, MRI demonstrated partial tear of supraspinatous and infraspinatious on the articular side.

In view of the symptomatology and corroborative radiographic findings patient was planned for arthroscopic acromioplasty and mini-open rotator cuff repair.

Under general anaesthesia patient was positioned in lateral decubitus with lateral traction apparatus applied to the left upper limb using 10 lb weights. After standard skin preparation and draping, diagnostic arthroscopy was done which revealed a U shaped tear of rotator cuff in its anterior two-third. Mobilization of the ends of tear was done with use of shaver and radio frequency probe (VAPR electrode, DePuyMitekInc,Raynham,MA).

During the procedure we found difficulty in visualization of sub-acromial space,therefore, the suction attached to RF probe was

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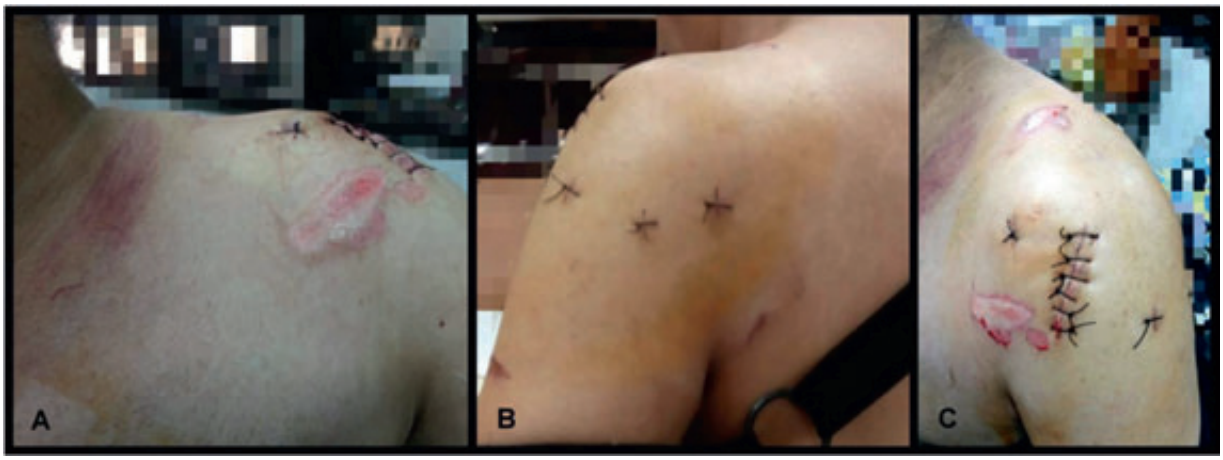

Fig. 1. Second degree dermal burns in anterior(A) and posterior chest region(B); extending to axillary region(C).

disconnected in an attempt to control the outflow of fluid to produce an intra articular tamponade effect thereby facilitating better visualisation. Extensive bursitis was found in the sub-acromial region which was cleared with RF probe, coraco-acromial ligament release and acromioplasty were done with the use of RF probe and acromionizer. This was followed by side to side, single row repair with modified Mason-Allen stitches using a mini-open approach was done.[8]

Before concluding the procedure some blisters were noted on anterior and posterior aspect of the chest extending into axillary region (Fig. 1). We concluded that as the suction was removed from the RF probe outlet, overheated irrigation fluid dripping continuously from that outlet had caused scalded burns.

Fig. 2. Six month post-operative clinical picture showing areas of burn healed by secondary scarring.

Post-operatively, standard rehabilitation protocol was followed; blisters were managed conservatively with local application of soframycin ointment.

Six months postoperatively the rotator cuff repair had an uneventful recovery while the blisters healed with secondary scarring leaving an unsightly cosmetic appearance (Fig. 2).

3. Discussion

Use of radiofrequency devices in shoulder arthroscopy has increased in recent times as constrained sub-acromial space and associated bursitis make visualization difficult. RF probes are excellent in soft tissue ablation and hemostasis thereby improving visualization and aiding in release of cuff lesions.[1]

Their use is infrequently associated with complications; these arise primarily due the overheated irrigation fluid which causes either direct damage to nerves,tendon, capsule or even chondrolysis.[3–5] An unusual complication in form of dermal burns has also described, till date only six cases of dermal burns have been reported in English literature during shoulder arthroscopy attributed to RF probe.[6,7,9]

SN Kouk et al. [6] reported a single case of second degree burns of shoulder girdle while using RF probe, while CR Troxell et al. [7] reported a case series of four patients with dermal burns around shoulder during sub acromial arthroscopy, both articles attributed the leaking irrigation fluid from the RF probe outlet as the cause of burns. RK Talati et al. [9] reported cutaneous burn secondary to contact between RF device and spinal needle used in identifying structures during an arthroscopic acromioplasty.

Similar cases of dermal burns after extensive use of RF probe have also been reported during hip arthroscopy.[10]

Arthroscopic procedures in sub-acromial region invariably present with difficulty in visualization, Burkhart SS et al. [11] observed that constrained space and bleeding pose a challenge in identifying structures. Standard procedures of maintaining hemostasis directly by using electro-cautery or via hypotensive anaesthesia and arthroscopic pumps have shown variable results.They proposed the application of Bernoulli's principle by occlusion of leaking portals by digital pressure thereby increasing pressure inside the joint aiding in hemostasis.

RF probe has an outlet port which is meant to suction out the overheated irrigation fluid, but this continuous suction creates a low pressure condition in the joint leading to bleeding and turbulence thereby blurring the arthroscopic vision.

In line with these principles, most surgeons use suction intermittently with the shaver device to maintain high pressure

by restricting outflow. These measures undoubtedly enhance vision, but the application of same principle with RF devices; by using suction intermittently leads to overheating of the joint environment.

Duration and pattern of use of RF device also contribute to the rise in temperature of irrigating fluids. Zoric et al. [12] found that bipolar RF probes, even when used for five seconds in a non stop flow mode can result in fluid temperature rising upto 50°, while usage for two minutes can raise the temperature to 80°. Improper control of these variables can lead to rise in temperature to unsafe levels.

High temperature can cause damage to surrounding structures within the joint .This overheated fluid can also cause scalding burns when it comes in contact with the surrounding skin areas. Burns are governed by both the temperature of the fluid and the duration of its contact with the skin, while 15 s of contact at 59° can cause third degree scalding, temperature as high as 68° is capable of causing such burns with a contact time as short as one second.[13]

We believe that complication in our case resulted from a series of events.

During sub acromial decompression and debridement of extensive bursitis, there was excessive and continuous use of RF probe which had increased the temperature of irrigating fluid within the joint. As this was accompanied by bleeding and turbulence, suction tubing was detached from RF probe in an attempt to create tamponade effect. Although this provided a better arthroscopic vision but we did not realize that the overheated fluid dripping out from the small outlet tubing of RF probe and from other portals had collected at the edges of draped area, resulting in scalding burns over anterior and posterior chest wall extending upto the axillary region.

We conclude that a cautious approach to debridement should be maintained. Use of RF probe should be intermittent and limited to prevent the overheating of irrigating fluid within the joint. Moreover, while using RF probe the irrigating fluid flow rate should be cautiously monitered to prevent the overheating of fluid. Also, the length of outlet tubing can be increased in a simple and inexpensive manner by attaching part of suction tube to it, thereby draining the leaking fluid away from skin.[14]

Conflict of interest

None.

Source of support

None.

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Case report

Recurrent intraarticular knee hemangiomas: A case report☆

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ABSTRACT

Intra-articular hemangioma is a rare condition with only around 200 cases reported in the literature. MRI is the investigation of choice and arthroscopy has got a definitive role in the treatment. Arthroscopy may have to be combined with open surgery if the feeder blood vessels are extra-articular. We performed a complete resection, after arthroscopic examination in an 18-year-old girl presented with a recurrent intra-articular hemangioma. At 18 months follow up there was no evidence of recurrence.

Key messages

High degree of suspicion is needed in the timely diagnosis and treatment of intra-articular hemangioma. Delay in diagnosis can lead to the destruction of the joint and secondary arthrosis. Incomplete excision of the lesion can lead to recurrence.

1. Introduction

Intra-articular hemangiomas are rare neoplasms. It is a benign condition and is thought to be due to a hamartomatous vascular malformation rather than a true neoplasm. It is often misdiagnosed or missed altogether and so the natural course and treatment options are not well described. The most common joint to be involved is the knee. If they are inadequately excised they are prone to recurrence and therefore should not be taken lightly. We report a case of recurrent intra-articular hemangioma of the knee joint which preoperative MRI had assessed as highly suspect and which resection and subsequent histological examination confirmed to be an intra-articular synovial hemangioma.

2. Case history

An 18-year-old girl presented with complaints of pain in the right knee for almost 8 years which she noticed after a trivial fall with associated swelling on the medial aspect of the knee. The pain was aggravated by walking on uneven surfaces and on running. She did not notice any episode of locking of her knee. She had undergone surgery previously, 7 years before and again one year after the first surgery for a recurrent swelling.

On physical examination, there was a 10 cm long scar on the lateral aspect of her right knee healed primarily. Her knee alignment was normal. An ill-defined cystic swelling was noted on the anteromedial aspect of the knee along the joint line which increased on flexion and became less prominent on extension. The swelling was mildly tender but not warm or pulsatile. There were a few small dilated subcutaneous veins noted overlying the swelling. There was no significant synovitis or effusion. Mild wasting of quadriceps muscle was present on the affected side.

Plain radiographs of the knee were essentially normal (Fig. 1). Magnetic resonance imaging revealed a lobulated, multi-septate T2 hyper intense lesion with multiple hypo intense septae predominantly within Hoffa's fat pad in favor of slow flow vascular malformation. There were associated discrete T2 hyper intense foci within the lesion that were thought likely to represent phleboliths. The lesion occupied Hoffa's fat pad with extension into the subcutaneous plane along lateral aspect of the patellar tendon (Fig. 2). There was bony remodeling along the inferior aspect of medial and lateral patellar facets with corresponding articular cartilage loss. There was evidence of previous surgical scar along the lateral aspect of the knee and infrapatellar region. A smaller, similar appearing hyper intense lesion in the subcutaneous plane, along with the posterolateral aspect of the right leg, at the junction of mid and lower third which also appeared suggestive of a second asymptomatic slow flow vascular malformation.

Focused USG-Doppler screening showed few small hypo echoic spaces demonstrating vascularity of venous pattern. Some mobile

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Fig. 1. Lateral and anteroposterior plain radiographs of the knee were essentially normal though on retrospect increased infra patellar soft tissue shadow.

internal echoes are seen which could be related to recent bleed. Hyperechoic areas are likely to represent calcific foci – phleboliths (Fig. 3). Similar vascularity is seen within lesion in the posterior aspect of the right leg.

The patient underwent arthroscopy of the right knee with standard anterior medial and lateral portals and an accessory superolateral portal at which the intra-articular hemangioma was clearly identified in the anteromedial space anterior to the medial joint line abutting the Hoffa's fat pad (Fig. 4). The initial plan had been to perform an arthroscopic ablation of the feeder vessels and excise the hemangioma arthroscopically; however in view of the fact that she had already had two surgeries in the past, combined with the fact that the origin of the feeder vessels was evidently extra-articular, it was decided to proceed with a mini-open en-bloc resection of the lesion.

Histopathologic examination showed fibro-adipose tissue and skeletal muscle with parts of a lesion composed of closely packed congested, ectatic thick and thin walled blood vessels. The adjacent stroma showed fibroblastic proliferation, numerous thick walled congested blood vessels and mild infiltrates of lymphocytes, plasma cells and a few foamy macrophages suggestive of benign angiomatous lesion with no evidence of malignancy.

The patient was followed up clinically and radiologically at 18 months. She had no surgery related complications, full pain-free range of motion and was able to perform all her daily activities and academics with no restriction. Her Oxford knee score improved

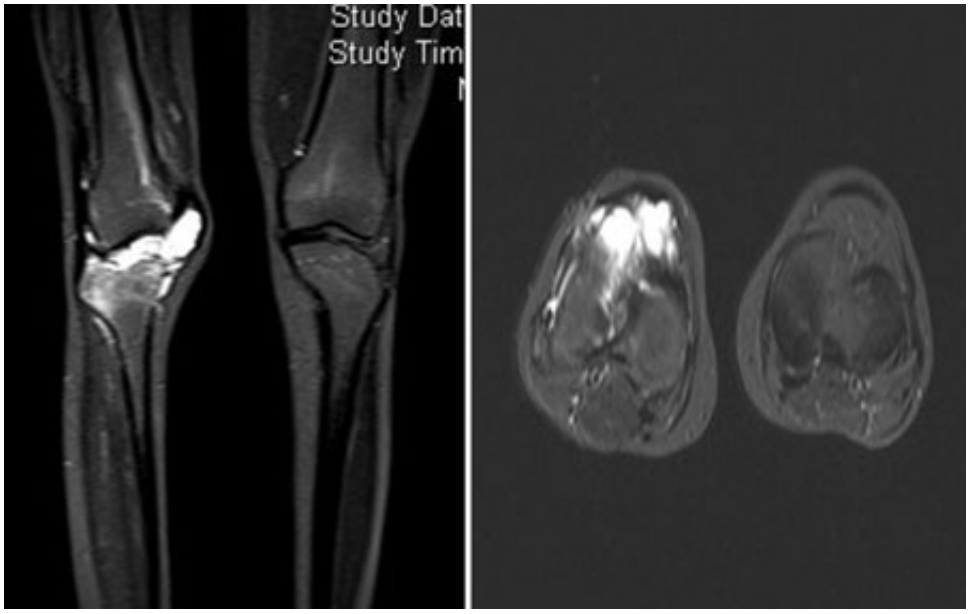

Fig. 2. MRI T2 hyper intense lesion with multiple hypo intense septae predominantly within Hoffa's fat pad in favor of slow flow vascular malformation.

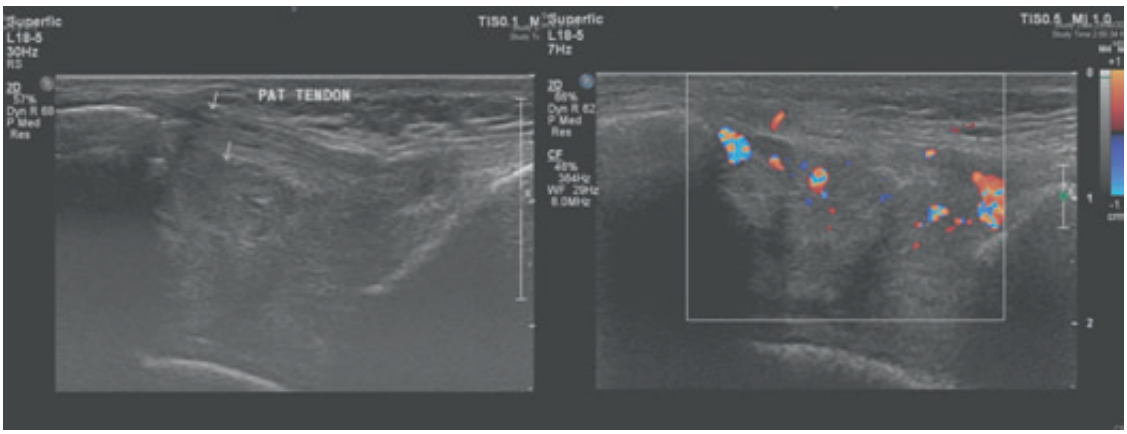

Fig. 3. Focused USG Doppler screening showed hypoechoic spaces demonstrating venous pattern vascularity.

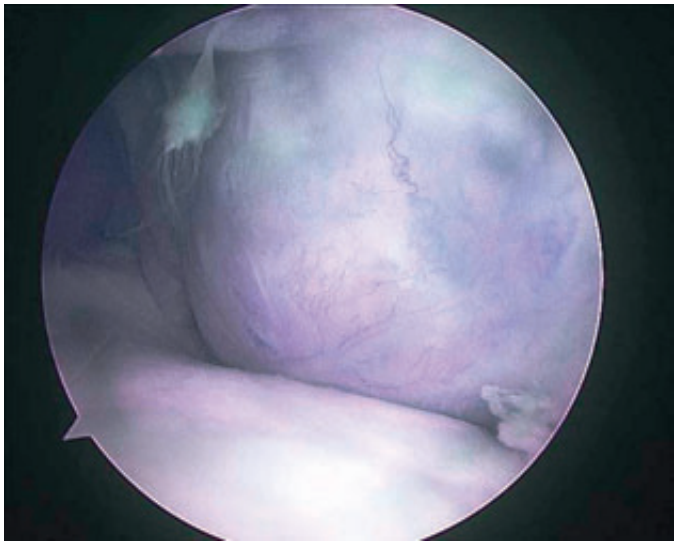

Fig. 4. Arthroscopic view of the lesion situated in the anteromedial space anterior to the medial joint line (view from the superolateral portal).

from 28 to 52 at follow-up and she was extremely satisfied with the outcome.

3. Discussion

There is scant literature on this uncommon condition and far fewer on recurrent cases of intra-articular hemangiomas. 75% intra-articular hemangiomas occur during childhood, but it may develop in young adults and sometimes at advanced ages.[1] Incidence is more in girls.[2] Usually, a patient presents in childhood with a history of recurrent atraumatic painful bloody knee effusions. Discoid meniscus, meniscal cyst, meniscal tears, osteochondritis dissecans, pigmented villonodular synovitis, synovial sarcoma, hemophilia, sickle cell disease and its variants and juvenile rheumatoid arthritis can be the differential diagnosis.[3–5] Plain radiograph in most of the time will be normal.[6] MRI is the most useful diagnostic tool, especially T2-weighted images, on which the lesion exhibits a high signal due to blood in vascular spaces.[7] In less than 5% of patients, periosteal reaction, cortical destruction, discrepancy in leg length may be seen.[8] In symptomatic cases, excision of the lesion is the treatment of choice and can be done either arthroscopically or arthrotomy and excision.[9–11] In cases of pure synovial hemangioma, selective embolization of feeder vessels might also be an alternative to surgery. The recommended treatment options in the literature include sclerotherapy, arthroscopic excision, and open excision. In this particular case, we considered arthroscopy as a primary treatment modality and it did allow us to identify the extent of the lesion and the potential pitfalls. Extra-articular feeder blood vessels could be identified as a probable cause of multiple recurrences as they had not been addressed previously. By opting for arthroscopy proceed open surgery we could identify the issue arthroscopically but then had more freedom to catch the feeder vessels and excision of the lesion in toto leaving less chance for recurrence.

Authors' contribution

Dr. George M. Srampickal was a major contributor to writing the manuscript.

Dr. Korula Mani Jacob was the orthopedic surgeon involved in arthroscopy proceed open surgery.

Dr. Koyeli M. Mahata done the image interpretation.

Disclosure

The work for this article was not supported by any external or internal funding sources.

Conflicts of interest

The authors have none to declare.

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Case report

Spontaneous bilateral quadriceps rupture – A case report

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ABSTRACT

Bilateral simultaneous quadriceps rupture is a rare entity. Its occurrence without associated aetiology is even rarer. It has a bimodal age distribution, with majority of cases occurring in population older than 50 years. Its occurrence in younger population is unusual. Aetiology is trauma, long term steroid usage, fluoroquinolone injections at local site or associated co-morbidities such as chronic renal failure, diabetes, obesity, hyperparathyroidism, endocrine disorders and gout, which via different mechanism lead to weakening of tendon thereby predisposing it to rupture. Surgical repair is the treatment of choice; it ranges from direct repair using Bunnel or Krackow sutures in acute cases to repair via lengthening procedures in chronic cases as described by Scuderi and Codivilla. Distal fixation to patella is a matter of debate in today's time as suture anchors have emerged as an alternative to trans-osseous repair. Although various studies have demonstrated good outcomes with suture anchors, biomechanical studies comparing the two techniques have shown conflicting results. We present a case of spontaneous bilateral quadriceps rupture in a young female without associated identifiable pathology. Also, we attempt to describe the Codivilla repair technique and discuss recent trends in quadriceps repair.

1. Introduction

Bilateral simultaneous quadriceps rupture is a rare entity. Several case reports and studies describing the similar condition that have been reported in the literature have occurred in patients with predisposing factors to tendinopathy. However, Tarazi et al.[1] has reported a case of bilateral patellar tendon rupture sustained by a patient following minimal trauma with no predisposing medical conditions. Its occurrence without any associated aetiology is even rarer.[2] It has a bimodal age distribution, with majority of cases occurring in population older than 50 years. Its occurrence in younger population is unusual.[3–6] Aetiology is trauma, long term steroid usage, fluoroquinolone injections at local site or associated co-morbidities such as chronic renal failure, diabetes, obesity, hyperparathyroidism, endocrine disorders and gout, which via different mechanism lead to weakening of tendon thereby predisposing it to rupture.[4,7,8]

Surgical repair is the treatment of choice; it ranges from direct repair[9] using Bunnel or Krackow sutures in acute cases to repair via lengthening procedures in chronic cases as described by Scuderi and Codivilla.[10] Distal fixation to patella is a matter of debate in today's time as suture anchors have emerged as an alternative to trans-osseous repair.[11,12] Although various studies have demonstrated good outcomes with suture anchors, biomechanical studies comparing the two techniques have shown conflicting results.[13–15]

We present a case of spontaneous bilateral quadriceps rupture in a young female without associated identifiable pathology. Also, we attempt to describe the Codivilla repair technique and discuss recent trends in quadriceps repair.

2. Case report

A 21-year-old woman presented with difficulty in walking and pain in both knee for one year. There was history of sudden give way feeling at both knees while descending stairs one year back. No history of trauma was present. No history of long term steroid usage and fluoroquinolone injections at local site. Following the incident, an osteopath prescribed her treatment in form of bed rest and analgesics for one month after which she started ambulating on her own. Although she was ambulating independently, she had pain and difficulty while walking with inability to extend the knees completely.

Clinical examination revealed a palpable gap in supra-patellar region with some continuity of extensor mechanism maintained

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Fig. 1. Clinical photograph demonstrating the visible defect in supra-patellar region of both knees.

via lateral retinaculum (Fig. 1). She had antalgic gait with extensor lag of 30° and active range of motion 30–130° although passive extension was possible.

Plain radiograph of both the knees revealed patella baja with loss of soft tissue contour in supra-patellar region (Fig. 2). Magnetic resonance imaging showed loss of continuity of quadriceps tendon in T2 weighted images (Fig. 3) confirming the clinical diagnosis of bilateral quadriceps tendon rupture.

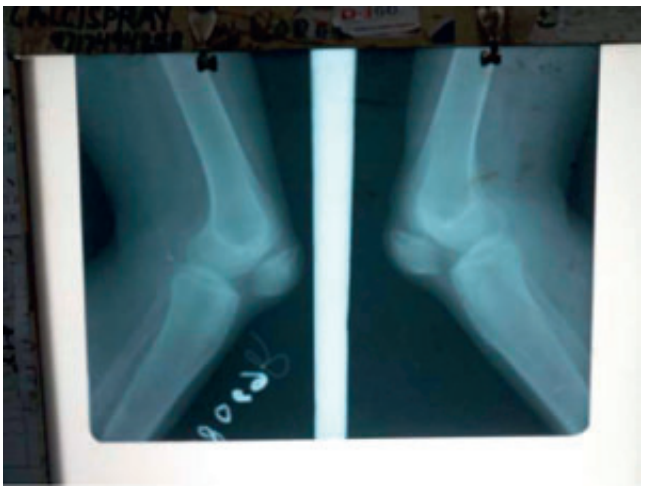


Fig. 2. Plain radiograph – lateral view of both knees showing patella baja.

Patient was thoroughly evaluated preoperatively with blood sugar level, renal function test, thyroid function test, serum parathyroid level, RA factor, anti-CCP, HLA B-27 level and serum uric acid level to rule out all predisposing medical conditions responsible for tendinopathy. However, no aetiology was found causing the pathology. As the patient had extensor lag and difficulty in walking she was planned for bilateral quadriceps repair.

3. Surgical technique

Patient was laid in supine position. After combined spinal epidural anaesthesia, part preparation and draping was done as per standard protocol. A 15 cm long midline, longitudinal incision was given over the anterior aspect of knee extending up to tibial tuberosity (Fig. 4a). Full thickness flaps were elevated on both

Fig. 3. MR imaging – T2 weighted images showing discontinuity at quadriceps insertion.

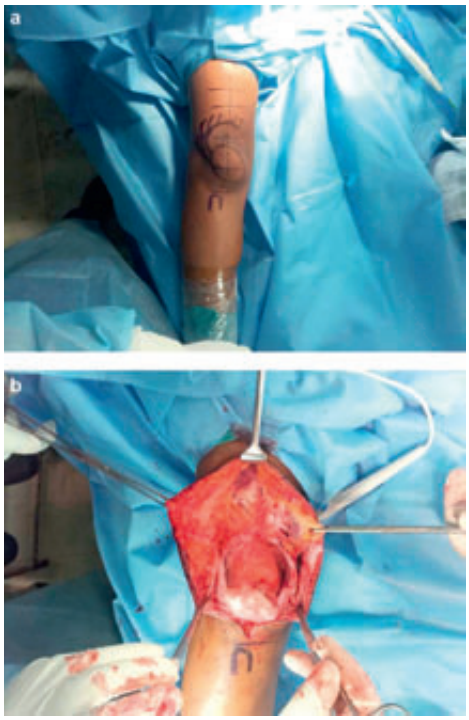


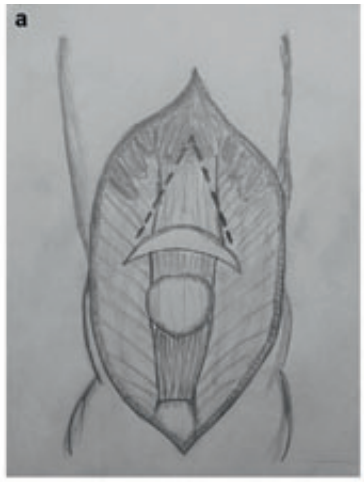
Fig. 4. (a) Surface marking of 15 cm long, anterior, midline incision extending up to tibial tuberosity, partial continuity by fibres of vastus lateralis. (b) Showing rupture with retraction of proximal stump and white, fibrous tissue at superior pole of patella.

medial and lateral aspects. Torn ends of ruptured quadriceps tendon were identified; rupture was identified at bone–tendon interface at the superior pole of patella.

The margins were surrounded by thick, whitish fibrous tissue, akin to pseudoarthosis (Fig. 4b). Margins were debrided with curette till the appearance of bleeding cancellous bone at superior pole of patella; caution was maintained during curettage as patella is usually osteoporotic due to chronic nature of such injuries.

An inverted V was marked over the proximal part of quadriceps mass, full thickness flap was elevated through the proximal quadriceps mass as marked in inverted V fashion leaving adequate cuff of tendon both on medial and lateral aspects of flap. This step gained the length of proximal stump and was adequate enough for repair (Fig. 5a–c). Mattress sutures were placed in proximal stump with fibre wire, three drill holes were made in patella in cephalo-caudal direction using a 1.5 mm drill bit, an arthroscopic suture passer was used to pass suture shuttles, leaving loops on the superior pole of patella (Fig. 6a). Four ends of mattress sutures placed in proximal stump were passed through the three loops in a manner that lateral one passed through lateral drill hole. Middle two suture ends passed through middle drill hole, while the medial suture end passed through the medial drill hole (Fig. 6b).

This was followed by tightening the knots of both suture ends over inferior pole patella while maintaining the knee in complete extension. The inverted V flap was turned 180° and sutured over the repaired quadriceps-patella construct (Fig. 7a). The crater resulting from the inverted V flap was closed partially by medio-lateral sutures as much permissible. The integrity of the repair was tested by taking the knee into 90° of flexion. Wound was closed over drain and post-operatively limb was immobilized in above



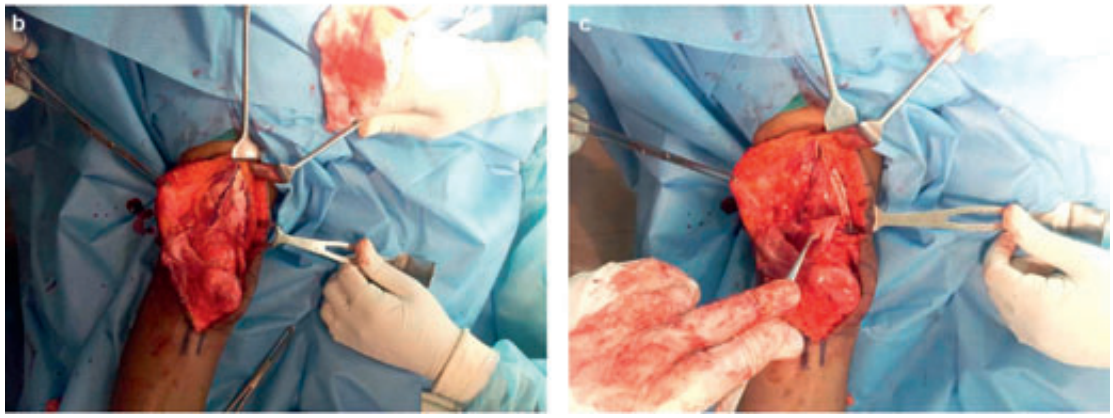


Fig. 5. (a) Illustration of tear in quadriceps tendon with inverted V marked over the proximal stump. (b) Intra-operative photograph showing complete tear with inverted V marked over proximal stump. (c) Full thickness flap elevated from proximal stump along the marking.

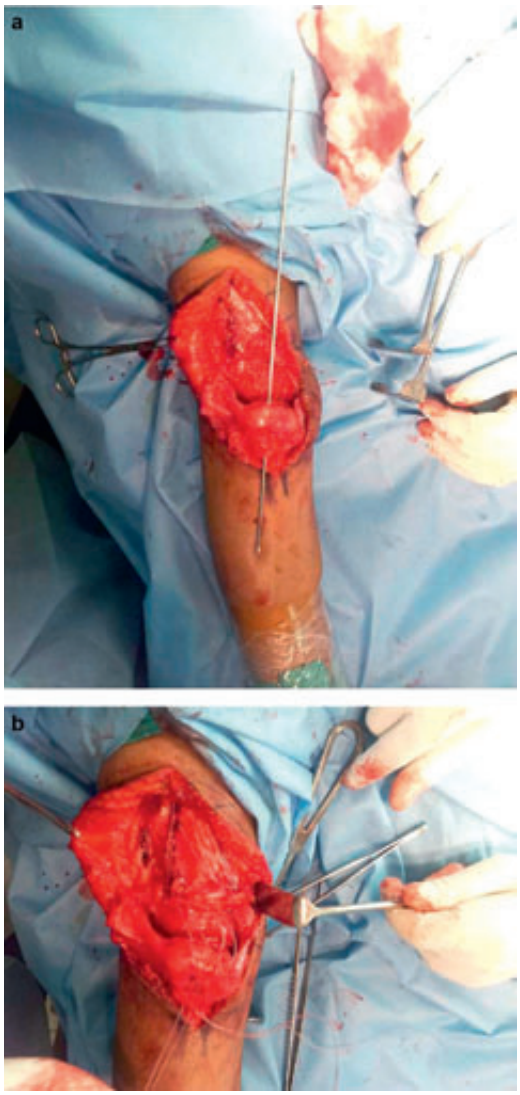


Fig. 6. (a) Arthroscopic suture passer used to pass vicryl loops through drill holes made in patella. (b) Open fibre wire ends delivered through vicryl loops to exit from inferior pole of patella.

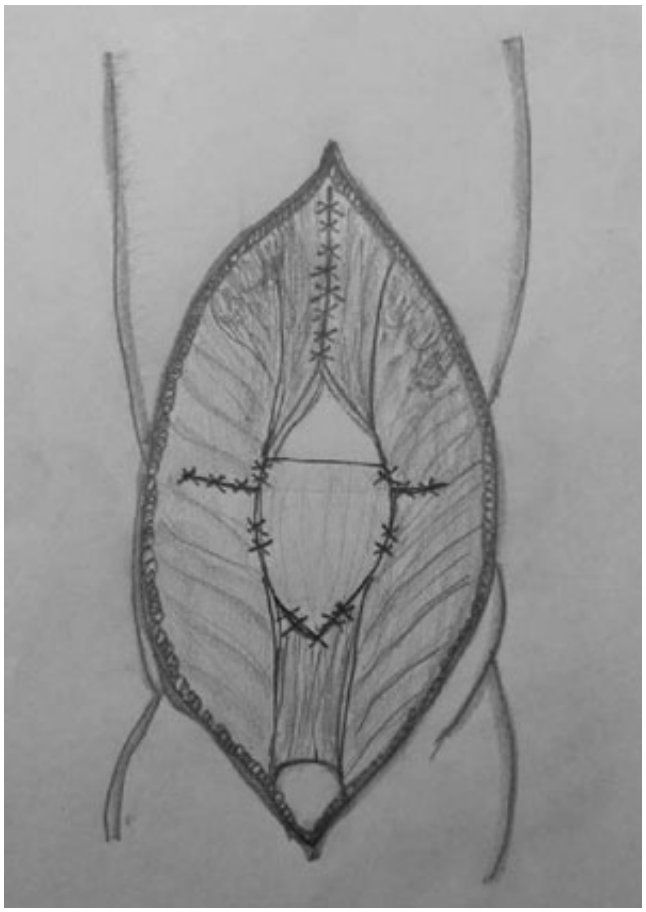


Fig. 7. (a) Illustration of V shaped full thickness flap being turned 180° and sutured over quadriceps repair construct.

knee cast in extension. Knee range of motion was started at two weeks with continuous passive machine (CPM) and 90° of flexion was achieved at three weeks. The patient walked with knee ROM brace locked in extension with weight bearing as tolerated. Strengthening closed chain exercises were also initiated and continued till 10 weeks.

Full range of motion without any extensor lag could be obtained after three months. The other side was operated after three months with the same technique and had an uneventful recovery.

4. Discussion

Simultaneous rupture of both quadriceps tendons is uncommon. In several previously reported studies and case reports it is most commonly described in older age group patients and usually in association with diabetes mellitus, chronic renal failure, spondylo-arthropathies, hyperparathyroidism or long term steroid therapy, quinolone use or some kind of predisposing medical pathology.[4–8] Bilateral quadriceps ruptures are often misdiagnosed or missed as the patients are mostly elderly with associated co-morbidities and also as the presenting symptoms are mostly confounded by weakness either due to old age or as sequelae to stroke.

These ruptures are postulated to result from a sudden, violent contraction of Quadriceps unit in a semi flexed position of knee. McMaster et al. demonstrated that even 40–50% fibres of tendon are adequate enough to prevent rupture under physiologic load transmission, thereby consolidating role of associated co-morbidities in making the tendon prone to rupture.[16] Neubaeur et al. in a meta-analysis of 105 patients concluded that 67.9% ruptures were associated with trauma. They found an associated co-morbidity in 64.3% of cases.[2]

Various associated pathologies weaken the tendon either by change in the collagen-architecture or by affecting its vascularity.[3,5,7] Histopathological studies of ruptured tendons revealed alteration in collagen micro-architecture with associated hypoxic degenerative changes.[16,17] Usually hypo-vascular zone is found 1–2 cm above the patella which is found to be most common site of quadriceps rupture.[9,16]

Tarazi et al.[1] however has reported the similar case of bilateral patellar tendon rupture in a 45 year old man following minimal trauma with no predisposing conditions. Our case was unique as the patient was of a younger age group (21 year) which is uncommon, and also no identifiable co-morbidity was found even after extensive diagnostic workup. Once the diagnosis is established, surgical repair is the treatment of choice. Repair may be in form of direct end to end repair, or its augmentation as described by Scuderi turndown flap. Puranik et al.[18] evaluated the outcomes comparing various suture techniques.

Using the Rougraff scoring system[19] to evaluate results, they found that direct repair of the tendon using the Bunnell technique had lower Rougraff scores than transosseous repair.

Chronic ruptures are commonly associated with retraction of proximal stump thereby making end to end repair non-feasible. Such cases are managed with Codivilla technique of quadriceps lengthening supplemented with turndown flap.[10] Although Codivilla technique has stood the test of time for chronic ruptures, complications in form of re-rupture and residual extensor lag have prompted the surgeons to experiment with various modes of distal fixation.

Schmidle and Smekal[20] have shown good results with trans-patellar repair by utilizing a transverse, central trough in superior pole of patella. Various authors[11,12,21] have advocated use of suture anchors in quadriceps repair owing to their success in shoulder surgery. Also the suture anchor technique does not require exposure of distal pole of patella and patellar tendon, thereby avoiding complications of patellar tendon irritation by non-absorbable sutures. Although promising, suture anchors are expensive and are associated with complications of patellar fracture and failure in form of pullout or suture rupture at eyelets.[13] Various biomechanical cadaveric studies[13,15] have been done in recent times to establish the tensile strength of repair via suture anchors and transosseous tunnels. While Lighthart et al.[13] found no significant difference between the two groups, Hart et al.[14] concluded that although repair in both group was sufficiently strong, the transosseous group had high ultimate tensile strength ($p < 0.05$). In contrast Petri et al.[15] have shown better biomechanical properties of suture anchors in comparison to trans-osseous tunnels.

Our patient was managed with Codivilla technique and turn down flap with trans-osseous patellar tunnels. The patient obtained full range of motion at three months with no extensor lag. As the cadaveric reports regarding distal fixation mechanism are still of conflicting nature, we believe that transosseous tunnel method is a prudent approach, especially in developing countries with cost sensitive health care. Appropriate fixation with augmentation by flap followed by early rehabilitation is the key to good functional outcome in such patients.

Conflict of interest

The authors have none to declare.

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Case report

Total hip arthroplasty in neglected, obturator type, hip dislocation in a young adult – an unusual case and literature review

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ABSTRACT

Neglected obturator dislocation of the hip is extremely rare and most cases are reported from rural areas of developing countries. We present the case of a 30-year old male who presented with pain in the left hip for 2 years with and with a fixed deformity of the hip. He gave a history of fall from a tree 15 years ago. Radiographs revealed an obturator dislocation of the hip with a well-formed pseudo-acetabulum around the dislocated femur head. Uncemented total hip arthroplasty was done and at 2-year-follow-up the patient was able to walk pain-free and unaided.

1. Introduction

Anterior dislocation of the hip is relatively rare compared to posterior dislocation accounting for less than 5–10% of all hip dislocation cases.[1] Neglected or missed or mismanaged hip dislocation is still a major concern in developing countries like India, especially in the rural areas, although the incidence has certainly come down.[2,3] We report a case of neglected obturator hip dislocation which presented to us 15 years after injury with features of secondary osteoarthritis of a well-formed pseudo hip joint. This is to date, the longest period of presentation of a neglected anterior hip dislocation case; it was managed by uncemented total hip arthroplasty (THA).

2. Case details

A 30-year-old man from a rural background presented to our hospital with the chief complaint of pain in the left hip for the past 2 years which was insidious in onset and had gradually progressed in intensity with time. He also complained of a limp and difficulty in performing activities of daily living such as squatting and cross legged sitting. On further questioning, the patient revealed that he suffered a fall from a tree when he was 15 years old landing directly on the buttocks on a tree branch. Following the fall, the patient had sustained multiple injuries and was unable to stand; he was taken to a quack for treatment by his parents who were illiterate and poor. He was subjected to 3 months of immobilization and massage by the quack following which the patient was mobilized with a stick. The patient reported that gradually the pain had subsided completely; although he walked with a limp, he coped up and was able to work and carry out his daily activities until the onset of pain and worsening of the limp since the last 2 years.

On clinical examination, it was noted that the hip joint was fixed in 30° of flexion and 20° each of abduction and external rotation. He had an apparent lengthening of 3 cm and a true lengthening of 2 cm. Plain radiographs showed that the hip was dislocated antero-inferiorly with a well-formed pseudo-acetabulum around the dislocated femur head and the femur head was locked in the obturator foramen (Fig. 1).

3. Surgical technique

We decided to do an uncemented total hip replacement via the posterior approach. Intra-operatively, the femoral head was found lying antero-inferiorly in the obturator foramen; the native acetabulum was filled with fibrous tissue which was cleared meticulously. Both the femur head and acetabulum cavity were devoid of articular cartilage. We were unable to deliver the head out of the pseudo-acetabulum due to excessive fibrosis and also as

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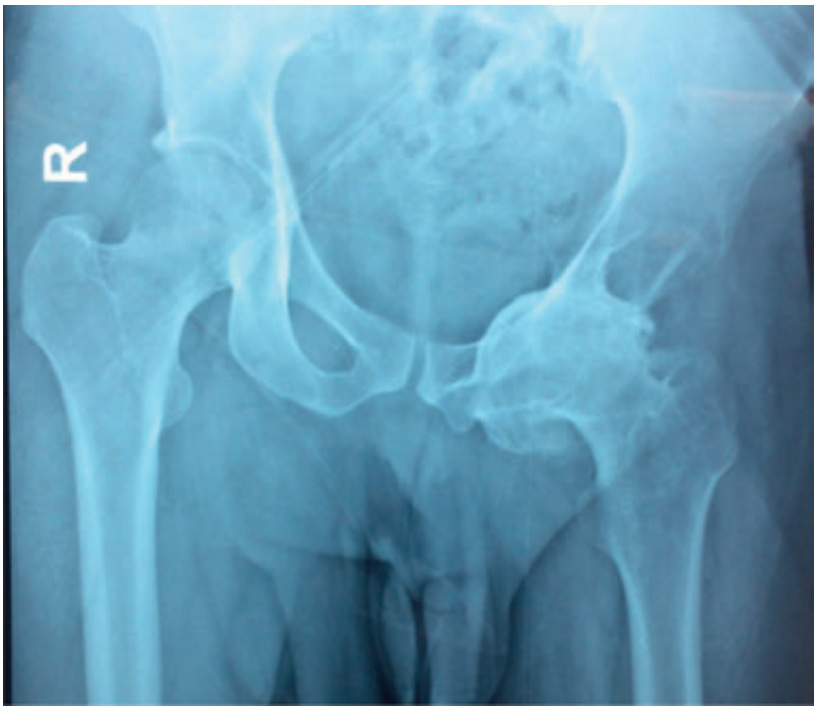

Fig. 1. Pre-operative radiograph of pelvis with both hip joints in antero-posterior view showing the antero-inferiorly dislocated left hip joint with pseudo-acetabulum formation all around the dislocated femur head.

the head was locked in the obturator foramen. Therefore, a neck cut was given at the subcapital level and the femoral head was extracted using a cork screw extractor. Both the native acetabulum cavity and the femoral canal were prepared adequately; an uncemented cup (*Size 54*) and stem were inserted respectively (*Stryker, USA*) after trials. Due to the long duration of presentation after the initial injury, we had expected a loose hip after placing the acetabulum cup in the native acetabulum as the hip abductors would be stretched and lengthened. Intra-operatively, the hip was loose after hip re-location as expected in the pre-operative planning. Therefore, we aimed to increase the horizontal offset by placing a 127° neck shaft angle femur stem and a +4 mm femur head. The vertical offset was increased by making the neck cut at a slightly higher level compared to our level of routine neck cut. Post-reduction, the hip was stable and a true shortening of 1 cm was noted.

Post-operative radiograph showed well placed femoral and acetabular components (Fig. 2). Post operatively, there was limb

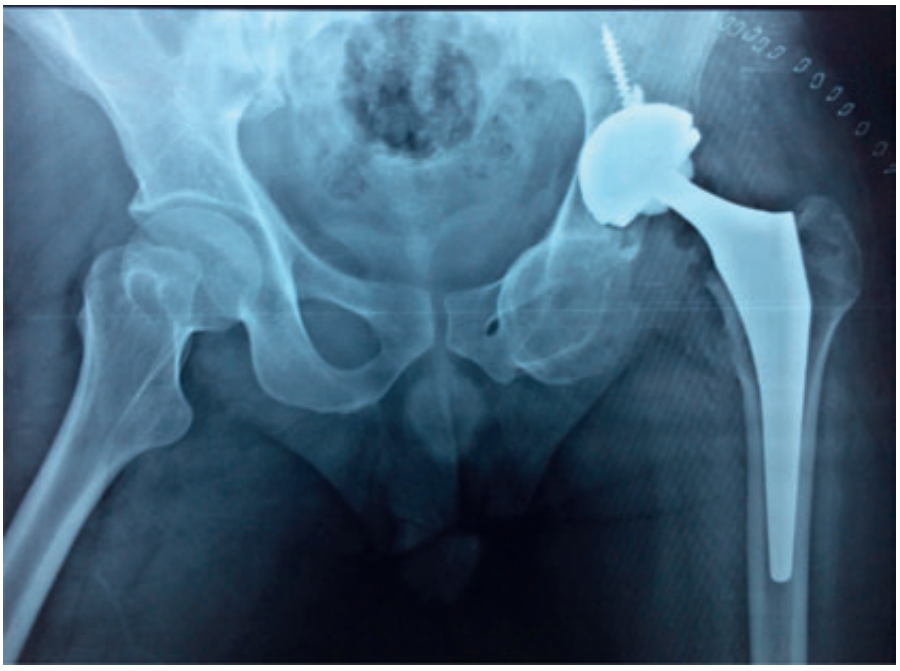

Fig. 2. Immediate post-operative radiograph of pelvis with both hips in anteroposterior view showing well-placed femur and acetabular components.

lengthening of 1 cm. Patient was mobilized gradually from the 2nd post-operative day with weight bearing as tolerated with the assistance of a walker. The post-operative period was uneventful; sutures were removed 2 weeks later and the patient was discharged. At 2 years follow-up, the patient was completely pain free and able to walk and carry out all activities of daily living without any difficulty (Fig. 3).

4. Discussion

Hip dislocation has been classified with reference to the plane of acetabulum as anterior and posterior according to the position of the dislocated femur head. Anterior hip dislocation can be one of 2 types – obturator (inferior) and pubic (superior) type.[4,5] In an obturator type of anterior hip dislocation, the mechanism of injury involves a force applied to an abducted hip, which is then flexed and externally rotated to dislocate the femoral head to lie anterior and inferior to the obturator foramen.[6] In our case, the patient who was sitting on a tree branch accidentally slipped and fell with his hips still in flexed, abducted and externally rotated position; during his descent, his thigh was struck by another branch which probably lead to the obturator type of hip dislocation.

A careful review of the English literature revealed a total of 25 other cases of neglected anterior hip dislocations with the duration of presentation ranging from 1.5 months to 12 years.[7–17] It is striking to note that all these 25 cases have been reported from developing countries with 80% of the cases being reported from India (20 out of 25 cases (see Table 1).

In our case, the dislocation was entirely missed by the quack who immobilized the patient. When the patient was gradually mobilized after 3 months of immobilization, and as the dislocation was neglected for such a long period of time (15 years), heterotropic ossification occurred around the femur head leading to a well-formed pseudo-acetabulum which was almost congruous to the head. Another probable reason for the long duration of presentation after injury may be that the pseudo hip joint was inherently stable as the femur head was locked in the obturator foramen allowing the patient to walk and carry out his activities of daily living. The fact that the patient was relatively pain-free for a period of 13 years with development of gradually progressive pain in the last 2 years suggests that he developed secondary osteoarthritis of the pseudoacetabulum; this caused the onset and progression of hip pain, the worsening of the limp and the gradually increasing limitations in the range of motion of the hip joint leading eventually to a fixed hip deformity.

Although cases of neglected inferior hip dislocations have been reported in the literature, albeit infrequently, our case is unique as in no other case has there been such a long duration of presentation (15 years, i.e. 180 months) after the injury. Hamada reported 1 case in 1957 which had a neglect period of 12 years which was treated by a corrective trochanteric osteotomy.[7] Apart from this case, all other 24 cases reported are less than 18 months old in duration of neglect.[8–17]

A well-formed pseudoacetabulum had formed in this case due to the long period of neglect; in no other neglected case has such a well formed pseudoacetabulum been reported. Secondary osteoarthritis of the pseudo hip joint, as seen in our case, is a very interesting phenomenon and hitherto has never been described in the English literature.

Total hip arthroplasty has remarkably transformed the management of neglected anterior hip dislocation. In the literature, cases reported before the turn of the 20th century have been managed mainly by corrective intertrochanteric osteotomy, open reduction or Girdlestone arthroplasty ([7–12]; Table 1). However, in the 5 cases reported in the modern era, 3 cases have been managed with THA, 1 case with Girdlestone arthroplasty and another case treated by open reduction as the duration of presentation in that case was only 4 months.[13–17] This reflects

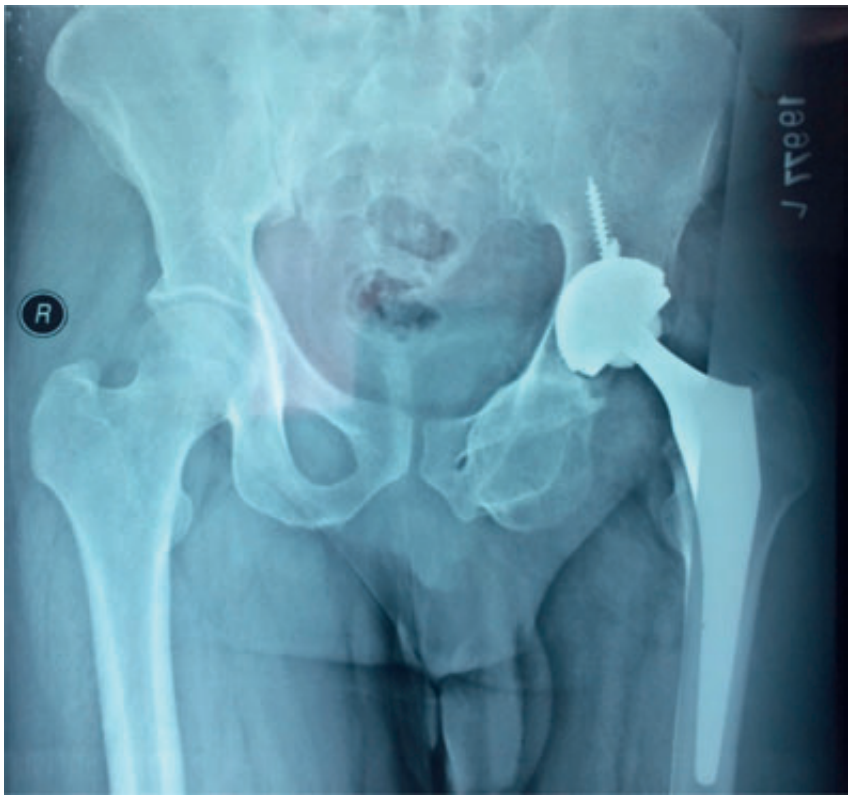

Fig. 3. Plain radiograph at 2 years follow-up showing a well-fixed implant with no signs of implant loosening.

Table 1
Summary of all publications reporting neglected anterior dislocation of the hip joint in the English literature.

Sl. no.	Authors	Year	No. of cases reported	Country	Duration before presentation	Treatment
1	Hamada[7]	1957	4	Egypt	5 months to 144 months	Corrective inter-trochanteric osteotomy for deformity
2	Aggarwal et al.[8]	1967	7	India	1.5–16 months	Trochanteric osteotomy (5) Open reduction (1) Fascial interposition arthroplasty (1)
3	Scadden and Dennyson[9]	1978	1	South Africa	1 month	Open reduction
4	Rai et al.[10]	1983	1	India	–	–
5	Nagi et al.[11]	1992	4	India	2–11 months	Open reduction (1) Valgus/derotation osteotomy (1) Modified excision arthroplasty (2)
6	Pai[12]	1992	3	India	3 weeks to 12 months	Girdlestone arthroplasty (1) Heavy traction in abduction + open reduction (1) Closed reduction (1)
7	Pankaj et al.[13]	2010	1	India	6 months	Uncemented THA
8	Singaravadivelu et al.[14]	2010	1	India	3 months	Cemented THA
9	Alva et al.[15]	2013	1	India	5 months	Girdlestone arthroplasty
10	Patil et al.[16]	2013	1	India	12months	Hybrid THA
11	Joshi et al.[17]	2014	1	India	4 months	Open reduction
12	*Our case*	*2016*	*1*	India	*180 months*	*Uncemented THA*

the change in the surgical thinking and the increasing use of THA in these challenging cases. The functional outcome after THA in this subset of cases has been good with excellent patient satisfaction being reported.[13,14,16]

5. Conclusions

Inferior dislocation of the hip is rare and neglected or missed cases of inferior dislocation of the hip are extremely rare, especially in the modern era. Yet, such cases are still sporadically being reported from rural areas of developing countries; this is due to the lack of trained personnel, facilities in these areas combined with the illiteracy, superstitious beliefs and ignorance of people in such areas. A high index of suspicion must be maintained to diagnose these dislocations and should be promptly reduced to avoid complications. THA is the gold standard of management in these cases in the modern era with good functional outcomes being reported consistently. Girdlestone arthroplasty also provides good results if facilities for performing a THA are unavailable.[15]

Conflicts of interest

The authors have none to declare.

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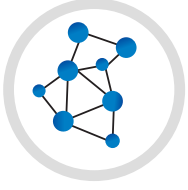

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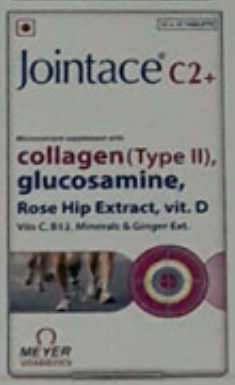

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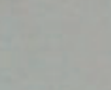

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