Does Patient Sex Influence Cartilage Surgery Outcome?: Analysis of Results at 5-Year Follow-up in a Large Cohort of Patients Treated With Matrix-Assisted Autologous Chondrocyte Transplantation

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Does Patient Sex Influence Cartilage Surgery Outcome?

Analysis of Results at 5-Year Follow-up in a Large Cohort of Patients Treated With Matrix-Assisted Autologous Chondrocyte Transplantation

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Background: Sexual dimorphism in humans has already been documented at different levels, and preliminary findings also suggest the importance of patient sex on clinical outcome in the treatment of cartilage lesions.

Purpose: To document and analyze the influence of sex on clinical outcome in a large cohort of patients treated with a cartilage regenerative procedure for knee chondral lesions and prospectively followed at midterm follow-up.

Study Design: Cohort study; Level of evidence, 3.

Methods: A total of 250 knees were treated with matrix-assisted autologous chondrocyte transplantation (MACT) and prospectively evaluated with International Knee Documentation Committee (IKDC), EuroQol visual analog scale (EQ-VAS), and Tegner scores at 1-, 2-, and minimum 5-year follow-ups to compare results obtained in men and women. The lesions were focal International Cartilage Repair Society grade III-IV chondral knee defects involving femoral condyles, trochleae, and patellae. Two homogeneous groups of 56 male patients and 56 female patients were then selected by a blinded statistician for a matched-pair analysis.

Results: A statistically significant improvement in all the scores in both men and women was observed in the general population. The IKDC subjective score showed better results for men at all follow-up times: at 5 years, the mean IKDC subjective score was 79.5 $\pm$ 18.6 versus 64.3 $\pm$ 20.2 for men and women, respectively ($P < .0005$), and the same trend was confirmed with the EQ-VAS and Tegner scores. The matched-pair analysis confirmed the difference of final results achieved (74.1 $\pm$ 19.8 vs 63.7 $\pm$ 20.2, respectively; $P = .006$). However, men and women started with different preoperative levels, and the analysis of the improvement obtained was not significantly different. Finally, when scores were standardized for each patient, according to the mean score typical for the corresponding age and sex category in a healthy population, a sex-related difference was not confirmed at any of the follow-ups. Etiological factors, lesion site, and preinjury activity level differed in women and men of the general population and were the confounding factors responsible for the different outcome not confirmed by the analysis of homogeneous cohorts of patients.

Conclusion: Women have a different knee chondral lesion pattern and more often have unfavorable conditions related to the cause of injury, site, and activity level, and they also have lower raw, not standardized, scores. However, a matched-pair analysis with data standardized for the specific patient categories showed that, on equal terms, women have the same possibilities for successful outcome as men after surgical treatment for knee cartilage regeneration.

Keywords: sex; gender; cartilage regeneration; knee; matrix-assisted autologous chondrocyte transplantation

The importance of looking for possible sexual dimorphism when analyzing the results of medical studies should not be underestimated.[41] Sexual dimorphism in humans has already been documented at different levels, ranging from susceptibility[39] or response to concussion[15] to the risk of knee injury[9] or anterior cruciate ligament (ACL) injury.[7] The same might be true for other pathological conditions, and cartilage lesions might also present different characteristics between women and men, both from the point of view of the clinical presentation and the outcome after surgical treatment.[43,47]

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Articular chondral lesions are hard to treat and remain a challenging problem for orthopaedic surgeons because of their inherent limited healing potential.[8] Regenerative techniques, such as autologous chondrocyte implantation, have emerged as a potential therapeutic option that aim at re-creating a hyaline-like tissue in the damaged articular surface.[5,40] The recent development of scaffold-based procedures has further improved the potential of these techniques, thus dispelling concerns related to the first-generation procedure both from biological and surgical points of view.[35,38] The clinical application of the regenerative approach has been well documented for different techniques, and the results are good.[23,37] However, published studies present mostly an evaluation of the clinical outcome at short-term follow-up and focus on small cohorts of patients; thus, results and treatment indications are still controversial. Nonetheless, some recent findings seem to suggest a role of sex in determining the clinical outcome also in patients affected by knee cartilage lesions and treated with surgical regenerative procedures.

Gille et al[25] evaluated 27 patients at a mean 37 months' follow-up treated with autologous matrix-induced chondrogenesis for localized full-thickness cartilage defects by combining the well-known microfracture procedure with collagen scaffolds and fibrin glue. Besides the overall positive outcome, they also reported significantly higher values in the International Cartilage Repair Society (ICRS) score in men compared to their female counterparts. Vanlauwe et al[46] compared characterized chondrocyte implantation versus microfracture and found a higher percentage of failures in women of both groups. Gobbi et al[26] evaluated patellofemoral full-thickness chondral defects treated with matrix-assisted autologous chondrocyte transplantation (MACT) at 5 years' follow-up: even though objective International Knee Documentation Committee (IKDC) scores were not influenced by sex, significantly poorer results were obtained in female patients with the IKDC subjective score. The group of Filardo et al[21] also showed the influence of sex in different cohorts of patients treated with MACT and reported better results for men. This trend was confirmed by a further analysis of 3 more specific patient groups: those affected by degenerative lesions,[22] those with osteochondritis dissecans,[20] and those older than 40 years.[36]

However, even though these findings suggest the importance of sex for the clinical outcome, the available results are just preliminary indications based on a subanalysis of small groups of patients primarily evaluated for other aspects. The main purpose of the present study was therefore to document and analyze the influence of sex on the clinical outcome in a large cohort of patients, who were treated with a cartilage regenerative procedure (MACT) for knee chondral lesions and prospectively followed at midterm follow-up.

MATERIALS AND METHODS

Patient Selection

Clinical experimentation was approved by the Hospital Ethics Committee and Internal Review Board, and informed consent of all patients was obtained. Hyaluronic acid–based MACT has been used at the authors' institute since 2000, and 250 knees have been treated and prospectively evaluated for a minimum of 5 years' follow-up (38 other patients underwent surgery but were lost to follow-up, for a total of 13.2% dropouts).

The treatment was indicated in patients with focal grade III-IV (ICRS evaluation)[6] chondral knee defects involving femoral condyles, trochleae, and patellae, who complained of clinical symptoms: pain, swelling, locking, and giving way. Exclusion criteria were untreated tibiofemoral or patellofemoral misalignment or instability, diffused arthritis, previous intra-articular fractures, and other general medical conditions (diabetes, rheumatoid arthritis, etc). Patients who presented with an ACL lesion at the time of surgery underwent a combined surgical procedure of ACL reconstruction during the same surgical session with cartilage harvesting.

There were 182 lesions in men and 68 in women. The characteristics of these 2 groups are reported in detail in Table 1. Among these patients, 2 cohorts of male and female patients were selected to have homogeneous groups for a matched-pair comparative analysis: the selection was performed by an independent statistician, blinded to the clinical outcome, who selected 2 groups of 56 patients each from the general database, with comparable lesion sites, previous and combined surgery, cause, age, and defect size (Table 1). The body mass index (BMI) was less than 2 points higher in the group of men, which is in line with the different average values reported for women and men.[48]

Treatment Procedure and Follow-up Evaluation

The procedure was performed in 2 surgical steps. The first one consisted of a 150- to 200-mg healthy cartilage biopsy sample taken from a nonweightbearing knee area for chondrocyte cell culture and subsequent seeding onto the hyaluronan-based scaffold Hyaff 11 (Fidia Advanced Biopolymers Laboratories, Padua, Italy). The second one consisted of implanting the bioengineered tissue Hyalograft C (Fidia Advanced Biopolymers Laboratories), according to the arthroscopic technique described by the group of Marcacci[37] or a miniarthrotomy approach, based on the lesion location and the surgeon's preference.[26]

All patients underwent a prospective evaluation at 1-, 2-, and minimum 5-year follow-ups, and the mean final follow-up was 8.4 ± 1.5 years. The clinical outcome was analyzed using the cartilage standard evaluation form as proposed by the ICRS.[31] In particular, patients were evaluated with IKDC subjective and EuroQol visual analog scale (EQ-VAS) scores. Activity level was evaluated with the Tegner score relative to preoperative and preinjury levels.[45] The surgery was considered to have failed if the patient needed a reoperation because of symptoms related to the primary defect. For retreated patients, the last clinical evaluation before reoperation was considered at every further follow-up.

Statistical Analysis

All continuous data were expressed in terms of the mean ± standard deviation. One-way ANOVA with the Scheffé post

TABLE 1
Characteristics of the Total and Matched-Pair Groups[a]

	Total Group (n = 250)			Matched-Pair Group (n = 112)		
	Men (n = 182)	Women (n = 68)	*P* Value	Men (n = 56)	Women (n = 56)	*P* Value
Age, mean ± SD, y	30.7 ± 10.9	33.0 ± 12.3	NS	33.2 ± 11.6	34.0 ± 11.9	NS
BMI, mean ± SD	24.8 ± 2.8	23.0 ± 3.8	<.0005	24.6 ± 2.5	23.4 ± 3.8	.025
Mechanism of injury, %			.059			NS
Degenerative	48.4	61.8		64.3	64.3	
Nondegenerative	51.6	38.2		35.7	35.7	
Traumatic/OCD	26.9/24.7	19.1/19.1		14.3/21.4	19.6/16.1	
Lesion site, %			.001			NS
Condyles	80.2	67.7		73.2	73.2	
Patella	11.0	29.4		23.2	23.2	
Trochlea	8.8	2.9		3.6	3.6	
Defect size, mean ± SD, cm^2	2.9 ± 1.6	3.2 ± 1.6	NS	2.8 ± 1.2	3.2 ± 1.5	NS
Previous surgery, %	60.4	63.2	NS	67.9	69.6	NS
Combined surgery, %	41.8	33.8	NS	42.9	28.6	NS
Tegner preinjury score, mean ± SD	6.7 ± 1.9	4.8 ± 2.0	<.0005	6.3 ± 2.1	4.5 ± 1.9	<.0005

[a]The selection process produced 2 homogeneous groups, with the only difference being the higher activity level in men (the BMI difference was reduced to a level in line with the physiological difference reported between women and men of the general population). BMI, body mass index; NS, not significant; OCD, osteochondritis dissecans.

hoc pairwise analysis was performed to assess differences among groups when the Levene test for homogeneity of variances was not significant ($P < .05$); otherwise, the Mann-Whitney test (2 groups) or the Kruskal-Wallis test with the nonparametric post hoc pairwise least significant difference test was used. The Spearman rank correlation was used to assess the correlation between continuous variables and the scores. The Kaplan-Meier survival analysis was used to estimate the failure rate; the log-rank test was used to assess the influence of sex on survival. The subgroup for the matched-pair analysis was composed using propensity score matching (factors considered were chosen using logistic regression and weighted according to the following equation):

$$w_i = \frac{\min(1-e_i, e_i)}{Z_i e_i + (1-Z_i)(1-e_i)},$$

where Z_i was the factor and e_i the odds ratio of the logistic regression. The chosen factors were then site, cause, previous surgery, associated surgery, age, and size.[1,42] Multivariate regression was performed to assess the factors predicting the outcome.

For all tests, $P < .05$ was considered significant. Statistical analysis was carried out by SPSS software version 15.0 (SPSS Inc, Chicago, Illinois).

RESULTS

A statistically significant improvement in all the scores in both men and women was observed after treatment in the general population. The IKDC subjective score showed better results for men versus women at all follow-up times: at 1 year, 74.4 ± 16.7 versus 60.4 ± 18.3, respectively ($P < .0005$); at 2 years, 78.4 ± 17.4 versus 66.9 ± 19.5, respectively ($P < .0005$); and at 5 years, 79.5 ± 18.6 versus 64.3 ± 20.2, respectively ($P < .0005$). Because men started with higher scores (42.2 ± 14.2 vs 33.2 ± 14.7, respectively; $P < .0005$), the analysis of the improvement obtained was performed, confirming that they not only achieved final better results because they started with higher baseline scores but also actually presented a higher final improvement ($P < .0005$) (Figure 1).

The EQ-VAS also showed significantly higher results in men versus women at all follow-up times: at 1 year, 83.2 ± 13.1 versus 75.4 ± 16.7, respectively ($P = .001$); at 2 years, 84.3 ± 12.4 versus 79.8 ± 14.9, respectively ($P = .04$); and at 5 years, 86.0 ± 13.7 versus 78.6 ± 15.2, respectively ($P < .0005$). The activity level, evaluated by the Tegner score, confirmed the higher scores in men versus women at all evaluation points: before injury, 6.7 ± 1.9 versus 4.8 ± 2.0, respectively ($P < .0005$); preoperatively, 2.1 ± 1.5 versus 1.4 ± 1.1, respectively ($P < .0005$); at 1 year, 4.7 ± 2.0 versus 2.8 ± 1.4, respectively ($P < .0005$); at 2 years, 5.2 ± 2.3 versus 3.1 ± 1.6, respectively ($P < .0005$); and at 5 years, 5.2 ± 2.2 versus 3.0 ± 1.5, respectively ($P < .0005$) (Figure 2). The cumulative survival analysis, considering the latest follow-up available of a mean 8.4 years, also showed worse results in women ($P < .0005$) (Figure 3).

Because the literature shows that healthy patients present different IKDC subjective scores depending on sex and age,[2] study group comparisons were repeated after standardizing[2] the scores of each patient according to the mean score obtainable for the corresponding sex and age category: despite a decrease in the difference observed in the score comparison between groups, women still had lower scores at the 5-year evaluation ($P = .005$) (Figure 4).

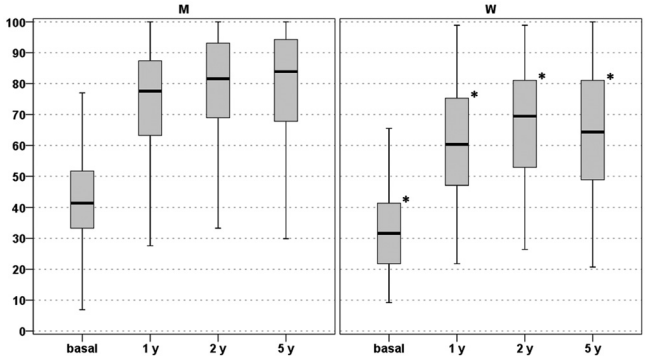

Figure 1. International Knee Documentation Committee subjective score in women and men of the general population at baseline level and at 1, 2, and 5 years of follow-up (*women had significantly lower scores).

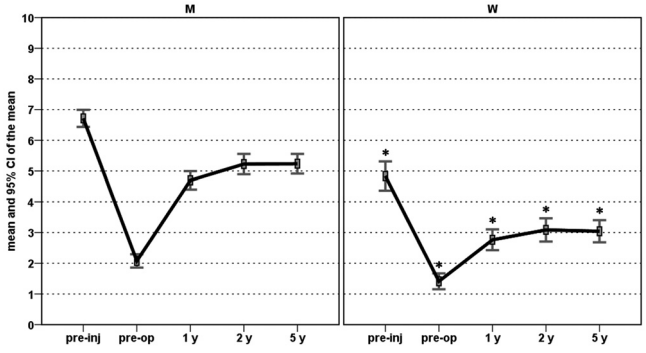

Figure 2. Tegner score in women and men of the general population before injury and preoperatively and at 1, 2, and 5 years of follow-up (*women had significantly lower scores).

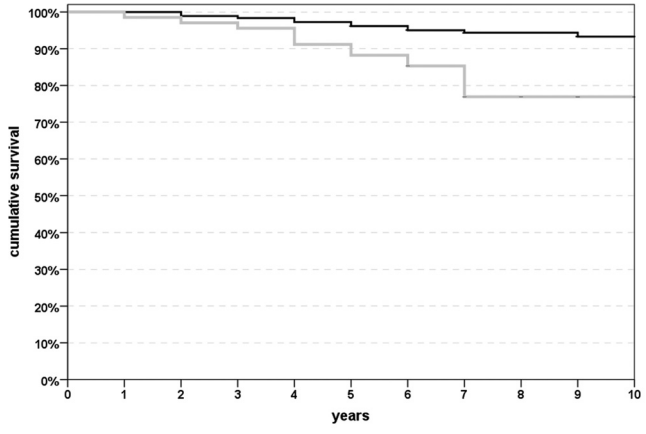

Figure 3. Cumulative survival curve of women (bottom line) and men (top line): women had a significantly higher number of failures.

The matched-pair analysis entailed the comparison of 2 groups of 56 patients each, who were selected to have the most homogeneous characteristics possible to limit biases and better assess the real role of sex in determining the

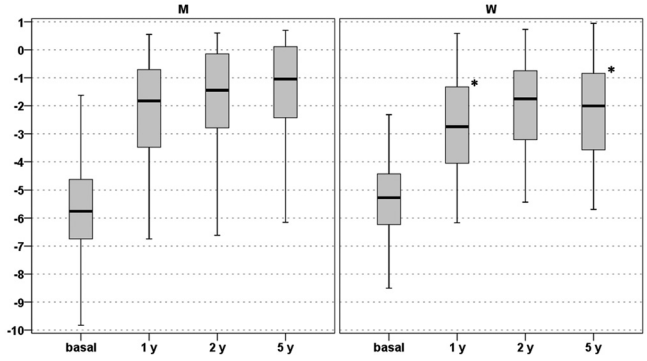

Figure 4. International Knee Documentation Committee subjective score in women and men of the general population at baseline level and at 1, 2, and 5 years of follow-up after score standardization according to the mean score obtainable for each specific healthy patient category (*women had significantly lower scores).

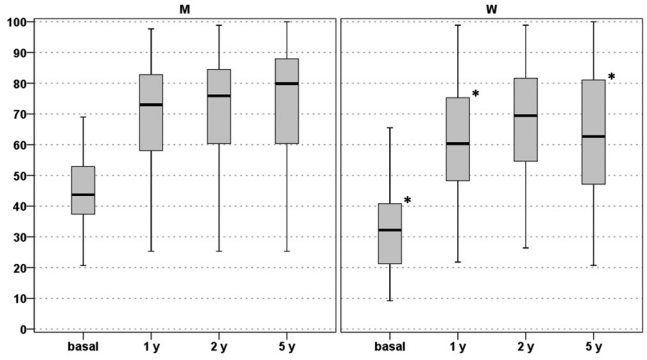

Figure 5. International Knee Documentation Committee subjective score in women and men of the matched-pair groups at baseline level and at 1, 2, and 5 years of follow-up (*women had significantly lower scores).

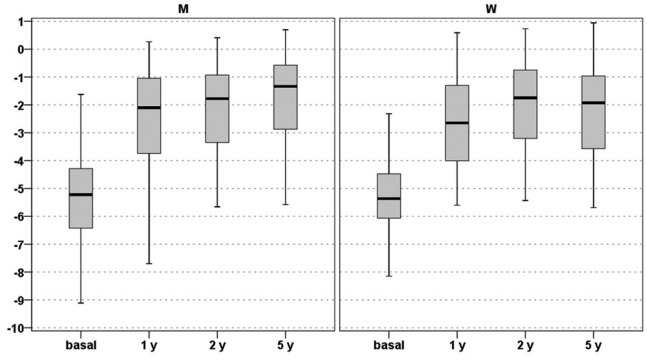

Figure 6. International Knee Documentation Committee subjective score in women and men of the matched-pair groups at baseline level and at 1, 2, and 5 years of follow-up after score standardization according to the mean score obtainable for each specific healthy patient category (no statistical differences were found).

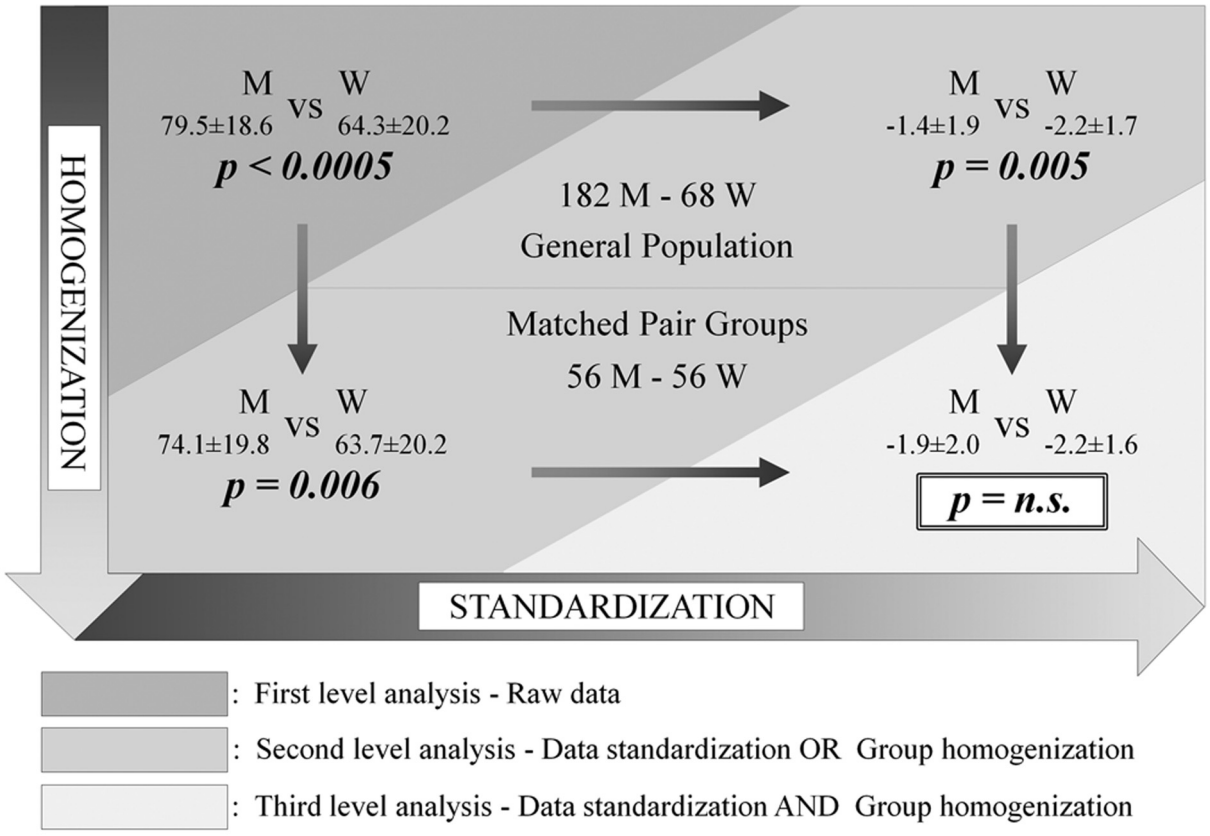

Figure 7. International Knee Documentation Committee subjective scores of the different male and female cohorts analyzed at 5-year follow-up and *P* values of the comparison performed at different analysis levels according to data standardization and homogenization of patient groups.

clinical outcome. In this patient selection, the group of men increased in subjective IKDC values from 44.9 ± 11.8 preoperatively to 70.2 ± 17.2 at 1 year, 73.1 ± 17.2 at 2 years, and 74.1 ± 19.8 at 5 years, whereas the group of women increased in subjective IKDC values from 33.0 ± 14.9 preoperatively to 60.8 ± 18.1 at 1 year, 66.5 ± 20.2 at 2 years, and 63.7 ± 20.2 at 5 years (men vs women: $P = .006$ at 1 year, $P = .09$ at 2 years, and $P = .006$ at 5 years) (Figure 5). However, men and women started with significantly different preoperative levels ($P < .0005$); thus, we analyzed the improvement obtained at final follow-up and that on the contrary did not show any statistical difference.

Finally, also for the matched-pair analysis, the scores of each patient were standardized according to the mean score typical of the corresponding sex and age category of the healthy population: after standardization, the matched-pair analysis did not show any significant differences between women and men at any of the follow-ups (Figure 6).

Further analysis was performed to understand the different results obtained when comparing the general groups and the matched-pair groups in terms of sex-related differences. Conversely to the homogeneously selected matched-pair groups, the general groups were heterogeneous (Table 1): the multivariate analysis of the characteristics differing between these groups of women and men confirmed the role of some factors—cause, lesion site, and preinjury activity level ($P = .01$, .004, and .002, respectively; $\eta^2 = .027$, .045, and .06, respectively)—in determining the final outcome.

DISCUSSION

As recently underlined, it is not possible to tell the relevance of sex in clinical outcomes unless an appropriate analysis is performed.[41] This study focused on the role of sex in cartilage surgery, in particular by analyzing the midterm results of a wide cohort of patients treated with a cartilage regenerative procedure and prospectively followed over time. The analysis was performed at different levels (Figure 7), evaluating the different characteristics of female and male populations affected by cartilage lesions in the present series and the different results obtained, but also comparing those groups after standardizing the scores for specific patient categories (which have different scores also in healthy patients) and after selection of homogeneous groups for a matched-pair analysis. The present study showed different results in the general female and male populations, but this difference was not confirmed by the analysis of standardized scores in matched-pair groups.

To better interpret these findings, it is important to specify what "sex" is and what "gender" is. In fact, because of the sometimes salacious connotations of this short but powerful 3-letter word, there is a recent tendency to substitute the word *sex* with the much more genteel-sounding *gender*, and sometimes, it is hard to understand exactly how the terms differ. However, they are 2 specific terms defining different aspects: *sex* refers to the biological and physiological characteristics that define women and men, while *gender* refers to the socially constructed roles, behaviors, activities, and attributes that a given society considers appropriate for women and men. To put it another way, *male* and *female* are sex categories, while *masculine* and *feminine* are gender categories. Aspects of sex will not vary substantially between different human societies, while aspects of gender may vary greatly.[49]

Many sex-based differences have already been documented in the biology of cartilage and the effect of sex hormones on both chondral health and disease.[14] Key sex hormone biosynthesis enzymes have been found in different species, and endogenous synthesis has been confirmed in human chondrocytes.[10,14,50] Sex hormone receptors for 17β-estradiol, progesterone, and testosterone have also been identified in human chondrocytes,[3,13] and even though little is known to date regarding the metabolic pathways by which the sex hormones influence cartilage metabolism, a large body of experimental studies describe their importance and the complex interaction with other serum factors to exert their regulatory function and mediate pathological processes.[14,27,30] This complexity in the network of countless factors is reflected by the sexual dimorphism even at the cellular level with different responses to the same hormone: 17β-estradiol stimulates human articular chondrocytes from female, but not from male, donors to increase DNA synthesis, sulfate incorporation, and alkaline phosphatase activity.[34] On the other hand, androgens can also stimulate human chondrocyte proliferation as well as collagen and proteoglycan synthesis,[24] and testosterone levels can also explain up to 8% of variation in medial tibial cartilage volume in men.[12]

Studies of chondral volume also showed significant differences, and the noninvasive nature of magnetic resonance imaging allowed it to be proven by several studies in the last decade.[§] These differences are evident from an early age, as shown by a cartilage development study in children: boys gained articular cartilage much faster than did girls at all sites.[32] Evaluation in adults confirmed the significantly larger cartilage volume in men.[11] There are a number of possible mechanisms for this difference in cartilage volume: different dynamic forces across the knee joint because of differences in physical activity between women and men might partly explain this distinction.[28] In fact, physical activity has been found to be a significant explanatory factor for cartilage volume at all sites,[33] and part of the difference between women and men might be therefore "gender" related. However, a further evaluation on a larger cohort of patients showed that, although diminished from 8% to 18%, the volume difference remained significant after adjusting for body height, weight, bone size, and physical activity.[19] Thus, cartilage volume seems related not only to different habits between women and men but also to "sex" differences: the variations in sex hormones, growth factors, or other factors remain a likely candidate for the unexplained component of the documented difference.

Important differences have been also documented in the pathological processes. The natural history of knee cartilage lesions shows an increase in cartilage defects of 3.1 to 3.6 times higher in women than in men,[18] and women have substantially greater knee cartilage loss than do men: these sex differences first appear at the age of 40 years and become more marked with increasing age,[17] both in adults without clinical knee osteoarthritis (OA) and in patients with knee OA.[4,29] A recent systematic review confirmed the sex-related differences in OA, with evidence of an association between endogenous estrogen, cartilage turnover, and radiographic degeneration and between testosterone and cartilage volume.[44] Osteoarthritis offers a clear demonstration of the role of sex in cartilage degeneration: while the occurrence of OA in men increases at the age of 30 years, women are protected from OA before menopause, and changes in hormones, in particular estrogens and androgens, contribute to the subsequent disease outbreak.[14] However, although differences in women and men affected by OA are recognized, and the influence of sex-related hormones on tissue development and homeostasis appears to be obvious, the role of sex in the biology of cartilage defects and in the chondral regenerative processes in a younger population is far from being understood.

In the present study, a population of 250 patients affected by knee cartilage lesions, treated surgically with a chondrocyte scaffold–based regenerative procedure, and prospectively evaluated at a minimum 5 years' follow-up was analyzed. When evaluating the entire patient population, a significantly greater improvement in men was observed in all the scores. Also, the cumulative survival analysis at a mean of 8.4 years' follow-up showed poorer results in women. However, it has to be pointed out that scores vary between women and men, as well as at different ages, also in healthy patients.[2] This clearly shows that at least a large part of the reported difference is gender related because the different activities and lifestyles between women and men are responsible for a significant difference in their raw scores. Thus, because the comparison of women and men was the focus of the present study, the scores were standardized according to the mean score obtainable for each specific patient category to evaluate whether, besides the gender-related difference, there was also a sex-related difference. This analysis showed again poorer results for women.

Because the female and male groups were heterogeneous, we then performed a matched-pair analysis. A statistician, blinded from the clinical outcome, selected 2 homogeneous groups of patients to eliminate the influence of other factors and isolate the role of sex in determining the clinical outcome. This confirmed the difference of the final results achieved. However, men and women started with significantly different preoperative levels; thus, we analyzed the improvement obtained at final follow-up and that on the

[§]References 4, 11, 17-19, 28, 29, 32, 33.

contrary did not show any statistical difference. Finally, when the scores were also standardized for each patient, according to the mean score typical for the corresponding age and sex category in a healthy population, the sex-related difference was not confirmed at any of the follow-ups.

This might be a straightforward indication that results of cartilage regeneration procedures are not only affected by sex. When data are adjusted for the real score achievable by each patient, and homogeneous groups are compared, sex does not have a significant influence on the midterm outcome. Therefore, the reported difference in our general patient population, as well as in other studies in the literature, is mainly caused by gender-related differences. Women are generally involved in less challenging physical activities, and this might imply various important aspects worthy of consideration besides the lower score achievable also in healthy patients. Sport participation is lower and thus also the percentage of traumatic/microtraumatic lesions, which have been shown to have a better outcome, whereas patellar lesions and degenerative causes, characterized by lower improvement, are more frequent. Another aspect related to sport activity level is the postoperative phase: top athletes are more motivated to follow the difficult and long physical therapy course, which has been shown to play a key role in the speed of recovery, and they also have a better environment to manage this phase, with more money and better equipped facilities.[16] Further multivariate analysis of the characteristics differing between women and men in the general population (mechanism of injury, lesion site, and preinjury activity level) confirmed their role in determining the observed differences.

However, it should be underlined that, although the present results suggest a predominant role of gender, it is likely that sex is still an important factor. The comparison of homogeneous groups shows similar results, but sex might explain the different lesion patterns observed and therefore the poorer results in women of the general population (more degenerative lesions, more patellofemoral abnormalities, etc). Moreover, because of the young age of the present population, the analysis might not be applicable for older patients, and sex may play a greater role in cartilage regeneration in an older patient population, as suggested also by the literature that demonstrates that sex differences first appear at age 40 years and become more marked with increasing age.[17]

Another limitation of the present study is the not so absolute homogeneity of the matched-pair study group. Concerning this, the BMI difference is low and corresponds to the physiological difference reported for the normal general population. More important is the activity level, as previously discussed, and even though the groups were as homogeneous as possible, it cannot be excluded that other factors (social, psychological, but also biomechanical, metabolic, etc) that were not considered for this study might play an important role in determining the outcome after a cartilage regeneration procedure. The surgeons themselves might also have introduced biases by using different treatment strategies when managing lesions in men or women (less aggressive surgical approach, attempt to avoid ugly scars, etc). Moreover, a longer term follow-up might allow differences in the duration of the improvement, the need for reinterventions, and the failure rate to be detected. Nonetheless, a high number of patients were evaluated at midterm follow-up, and a robust methodology specifically aimed at evaluating differences between women and men was applied.

This study allows some important conclusions to be made. In a young population, on equal terms, women have the same chance of success as men after a surgical treatment for knee cartilage regeneration. However, women have a different lesion pattern, often presenting more unfavorable conditions, and they also have lower raw, not standardized, scores; these gender-related aspects have to be considered both for the clinical management and the planning and evaluation of cartilage-related clinical trials.

CONCLUSION

Women have a different knee chondral lesion pattern, often having more unfavorable conditions related to the cause of injury, site, and activity level, and they also have lower raw, not standardized, scores. However, a matched-pair analysis showed that, on equal terms and with data standardized for the specific patient categories, women have the same chance of success at midterm follow-up as men after a surgical treatment for knee cartilage regeneration.

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