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Efficacy of Viscosupplementation in Hip Osteoarthritis by Using Clinical Gait Analysis

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Abstract

Osteoarthritis is the most common cause of disability in elderly people. Hip osteoarthritis is the second most frequent form affecting joints and its socioeconomic impact on society related disability is expected to increase. Hip osteoarthritis is characterized by pain and impaired movement. Intra-articular joint infiltration of hyaluronic acid (HA) as a line of treatment to restore the biologic properties of synovial fluid in the joint. To assess hip OA by ultrasonography and hip performance using qualitative gait analysis pre and post intraarticular hip injection of (HA).

40 patients with unilateral painful OA hip (Kellgren-Lawrence II-III) were treated from October 2019 to October 2021 with HA guided by US. Patients were evaluated before injection, after 1 and 3 months through the visual analog scale (VAS) scale, Lequesne Index and the spatiotemporal parameters of gait analysis. Pain as measured with visual analog scale (VAS) significantly decreased after the intraarticular injections 1 and 3 months ($P<0.0001$). A significant improvement was noted regarding disability ($P<0.0001$), as measured by Lequesne Index. As regards gait analysis, patients walked with higher cadence and stride length compared to baseline. A significant increase in gait speed was noted after 1 and 3 months follow up, no significant importance noted regarding step width. Patients display improvement 3 months after injection of (HA), accompanied by changes in walking pattern, as measured by spatiotemporal parameters of gait analysis. The improvement observed may be the consequence of the therapeutic effect of intra-articular injections of (HA).

Keywords: Hip osteoarthritis, Visco supplementation, Gait analysis.

1. Introduction

Osteoarthritis (OA) is one of the most common diseases of our era. It is not simply a loss of articular cartilage leading to joint pain but is increasingly being shown to be a disorder of the “joint organ”, affecting the cartilage along with the underlying bone, surrounding muscles and ligaments. The hip is exposed to static and dynamic forces while standing, walking and running. These forces predispose the articular surfaces of the hip joint to chronic wear and damage [1]. Hip osteoarthritis (OA) causes pain during movement then at rest. Its management is complex and

requires an understanding of the symptoms and functional limitations. The primary goals are to minimize pain, maximize function, and limit the rate of structural disease progression. Given that walking is an integral and frequent activity of daily living and an exercise commonly prescribed to people with hip OA, it is important to understand how hip OA influences gait characteristics to inform effective management of the disease [2].

As hips are crucial for locomotion, hip OA is one of the leading causes of gait impairment in the elderly population. There is consistency in reporting that hip OA patients reveal some form of gait alterations. The most frequently reported deviations are reduced stride length, cadence and gait velocity [3]. Use of hyaluronic acid (HA) intra-articular injections (IA) for symptomatic hip OA had broadly expanded. IA injections were performed "blindily" with higher failure rate and complications due to the proximity of important anatomical structures [4]. nUltrasound guidance has implemented the use of hip viscosupplementation with HA, making it secure and effective. It presents benefits as no need for contrast and an increased sensitivity [4]. HA is a high-molecular-weight glycosaminoglycan composed of continuously repeating molecular sequences of glucuronic acid and N-acetyl-glucosamine. The concentration and molecular weight of HA are decreased by 33% to 50% in OA, limiting its role in maintaining normal joint biomechanics [5]. The purpose of IA injections is to replace the lost HA and potentially stimulate the production of endogenous HA within the joint [6]. Gait analysis can be used for evaluating improvements after an intervention to improve walking. Spatial-temporal gait parameters are a simple way of objectively assessing gait dysfunction and monitoring treatment progress in a clinical setting. Spatial-temporal gait parameters can be measured using motion-capture systems as 3 D gait analysis [2]. The aim of this study was to assess hip osteoarthritis by ultrasonography and lequesne functional index, and to assess hip performance by using qualitative gait analysis pre and post HA intra-articular hip injection.

2. Patients and Methods

This study included (40) patients with primary unilateral hip osteoarthritis of both genders diagnosed according to the American College of Rheumatology (ACR) Clinical Criteria for Classification and Reporting of OA of the hip [7], they attended to the out-patient clinic of Rheumatology and Rehabilitation Department, at Al Zahraa Hospital Al-Azhar University between October 2019 and October 2021.Patients were informed about the study and written informed consent was obtained from all patients.

2.1 Inclusion Criteria

- Age ≥ 45 years.
- Patients with symptomatic hip osteoarthritis (pain and/or stiffness).
- Grades II or III on Kellgren and Lawrence scale [8].

2.2 Exclusion Criteria

- Inflammatory arthropathy is Rheumatoid arthritis.
- History of any lower extremity joint replacement, trauma, avascular necrosis and/or surgery to either hip or knee.
- Recent history of previous IA injections.
- Diabetes or neurological diseases.
- Contraindications to intra-articular injections as use of anticoagulant therapy.

2.3 Materials

2.3.1 Hyaluronic acid (sodium hyaluronate):

The injected material was highly purified sodium salt of HA with a defined molecular chain length 2500 to 3500 saccharide units

and molecular weight average from (800-1200 KDa. The injected material was of bacterial origin and not chemically modified so it was not antigenic. Each injection has 2 ml of 20 mg sodium hyaluronate as thriple injections one week interval.

2.3.2 Ultrasonography:

Xario 200, Toshiba ultrasound machine, multi frequency linear probe with frequency 7 MH in B-mode**.**

2.3.3 Gait analysis lab:

composing of; 10 motion capture cameras, model Bonita 10 with one megapixel Resolution and 250 frame per second. One Bonita video camera. Three force platform, model AMTI, OR6-7. These were connected to an IBM computer with printer, software vicon nexus version 2.11.0 [9]. The spatiotemporal gait parameters are as follows: Stride length (cm): anterior-posterior distance between the heel strikes of two successive placements of the same foot, Stride width (cm): lateral distance between the midlines of the right and left heels, Cadence: steps/minutes.

2.4 Methods

Patients were subjected to the following:

- History taking, examination and routine laboratory investigations. Hip Plain x ray and Ultrasonography.

- Clinical assessment at baseline, 1 and 3 months follow up of hip injection by HA along.

2.4.1 Pain intensity on visual analogue scale (VAS):

A 10-cm VAS with 0 labeled “no pain” and 10 labeled “the worst pain you have ever had” was used to assess pain. The patient answered the question “with respect to the worst pain you have experienced in your life.

2.4.2 Liquesce functional index:

Represent the functional level of the OA patient and is based on a 24-point scale, which includes: pain or discomfort, maximum distance walked and activities of daily living.

2.4.3 Gait analysis using a 3-dimensional computerized gait analysis system:

Gait analysis was performed at the National institute of neuromotor system [9].

2.5 Statistical analysis:

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Paired sample t-test of significance was used when comparing between related samples. Repeated measures ANOVA tests for whether there are any differences between related means. Post hock comparisons using Bonferroni correction. Pearson's correlation coefficient (r) test was used to assess the degree of association between two sets of variables: Value of “r” ranges from -1 to 1. 0 = no linear correlation. 1=perfect positive correlation. -1=perfect negative correlation. Positive = Increase in independent variables leads to increase in the dependent variable. Negative= Increase in the independent variable leads to decrease in the dependent. The confidence interval was set at 95% and the margin of error accepted was set to 5%. P value < 0.05 was considered significant.

3. Results

As shown in table 1 the study was conducted on 40 patients with symptomatic unilateral primary hip osteoarthritis. There were 24 females (60%) and 16 males (40%), with a mean age (62.73±7.11 years) ranged from (49 – 82 years). Their mean weight (79.90±9.68 kg) ranged from (65–99 kg), mean height (163.65±8.25 cm) ranged from (147–175 cm) and mean BMI (29.85±3.24) kg/m^2 ranged from (25.8–38.3) kg/m^2.As show in table 2 regarding

plain x ray, the majority of patients (n = 28) (70%) had a K L grade II and 12 patients (30%) had a K L grade III .Regarding ultrasonography evaluation at baseline: Bone capsular distance (BCD) mean was (5.83±0.85) mm ranged from (4.1–7.5) mm. femoral osteophyte and femoral head scores. As show in table 3 regarding VAS there was significant reduction after 1 month (3.80±0.87) and after 3 months (3.09±0.73) in relation to baseline (7.03±1.86), P<0.001. There was significant reduction regarding Lequesne index after 1 month (9.10±2.72), and after 3 months (7.91±2.36) in relation to baseline (16.44±3.16), P <0.001 that indicates an improvement of functional state. There is significant difference between post 1 and post 3 months of injection by Bonferroni test that indicates maintenance of improvement. As shown in table 4 patients walked with higher cadence and gait speed with a significant difference between pre, Post 1 and post 3 months of injection. Also, there was a significant improvement at stride length, there is no significant difference in step width at post 1 month and at post 3 months. Regarding hip extension angle, it was significantly increased at post 1 month and at post 3 months; (P<0.001).

Table 1: Demographic data distribution among all patients (n=40).

Demographic data	Total (n=40)
Sex	
Female	24 (60%)
Male	16 (40%)
Age (years)	
Range	49-82
Mean ±SD	62.73±7.11
Weight (kg)	
Range	65–99
Mean±SD	79.90±9.68
Height (cm)	
Range	147–175
Mean±SD	163.65±8.25
BMI) kg/m^2)	
Range	25.8–38.3
Mean±SD	29.85±3.24

Table 2: Radiological finding distribution among study group (n=40):

Radiological finding	Total (n=40)
K L grade	
II	28 (70.0%)
III	12 (30.0%)
Ultrasound assessment	
BCD mm	
Range	4.1–7.5
Mean±SD	5.83±0.85
Femoral osteophyte score	
0	5 (12.5%)
1	19 (47.5%)
2	13 (32.5%)
3	3 (7.5%)
Femoral head score	
0	2 (5.0%)
1	23 (57.5%)
2	14 (35.0%)
3	1 (2.5%)

Table 3: Comparison between Pre-treatment VAS score and Lequesne and those of post 1 and 3 months".

	Pre-Treatment	Post 1 months	Post 3 months	ANOVA	p-value
VAS Score	7.03±1.86A	3.80±0.87B	3.09±0.73C	24.04	<0.001**
Lequesne	16.44±3.16A	9.10±2.72B	7.91±2.36C	46.91	<0.001**

Table 4: Comparison between Pre-treatment Clinical Gait Analysis and other measurements of post 1 and 3 months".

Clinical Gait Analysis	Pre-Treatment	Post 1 months	Post 3 months	ANOVA	p-value
Spatio-temporal characteristics of Gait					
Cadence	76.27±12.05C	89.35±8.34B	95.30±9.95A	-11.67	<0.001**
Gait speed	0.52±0.15C	0.72±0.14B	0.77±0.15A	-13.83	<0.001**
Stride time	1.58±0.26A	1.30±0.16B	1.22±0.16C	11.03	<0.001**
Step time	0.80±0.14A	0.69±0.09B	0.60±0.09C	7.88	<0.001**
Single support	0.56±0.08A	0.51±0.07B	0.47±0.06C	5.37	<0.001**
Stride length	0.77±0.17C	0.90±0.11B	0.94±0.12A	-8.36	<0.001**
Step length	0.40±0.08C	0.44±0.06B	0.48±0.06A	-5.28	<0.001**
Step width	0.193±0.05	0.190±0.05	0.189±0.05	1.71	0.249

Using: Repeated measures ANOVA tests p-value >0.05 NS; **p-value <001 highly significant, Values in each row which have different letters are significantly different at (P<0.05), at Bonferroni test.

4. Discussion

Lurati et al. [10] studied the effects of HA on peripheral T cells in hip OA and showed that HA injection results in a decrease in proinflammatory T cells concentrations. HA reduces synovial inflammation and restores synovial fluid rheological properties. Several studies such as De Lucia et al. [11], Migliore A et al. [12] and Tikiz et al. [13] investigated hip articular capacity after and before pharmacological treatments, but few investigated gait performances. Clinical gait analysis offers an objective documentation of the patient's status can help in treatment planning and assist in the pre/post-treatment comparison. A study conducted by Qvistgaard et al. [14] addressed these concerns and successfully showed that US could be a reproducible method for the assessment of changes in the osseous surface and synovium-related inflammation, they studied parameters such as the Bone Capsular Distance (BCD), osteophyte score and femoral head score. Results agreed with Abraham et al. [15] who found that hip joints were classified as having OA if there was presence of either osteophytes or femoral head abnormality. Moller et al. [16] concluded that US is valuable in the early detection of OA and is helpful in defining the type and extent of bone and cartilage damage, also it is an excellent tool for the detection of synovitis. Sudula [17] documented that ultrasonography has been demonstrated to be a valuable imaging technique in the diagnosis and management of OA of hip joint. Showing different changes resulting from inflammation and structural damage. These changes mainly consist of the appearance of joint effusion and synovial hypertrophy in the presence of inflammation and osteophytes. There was agreement with Brocq et al. [18] who found deterioration of Lequesne Index for 22 hip OA patients before injection of HA. Also, Basaran et al. [19]. Regarding the Spatiotemporal parameters of the gait analysis, there was in agreement with Watelain et al. [20] and Kubota et al. [21] who found walking of hip OA patients was significantly slower than normal subjects,

with significantly shorter step length compared to normal subjects, and lower cadence than normal subjects. Reduction in gait speed in our patients was in agreement with Constantinou et al. [2] who explained this secondary to the reduction of the stride length of the affected limb. In turn, the shorter stride length in hip OA appears to be explained by reductions in step length on the affected side. Di Lorenzo [22] stated that OA patients walk with a longer double support time, tending to avoid extreme positions of the joints. They attempt to avoid pain by walking slowly to control the speed of heel strike and toe-off.

Eitzen et al. [3], documented that abnormal joint loading has been shown to contribute to detrimental shear stresses as well as disruption and loss of cartilage, and is considered to be an important mechanism of lower limb OA pathogenesis. Accumulated inadequate loads may further play a role in disease progression, as they can facilitate enlargement of the joint surface that is worn down. After 3 months of injection, regarding VAS and Lequesne hip OA severity index for all patient groups, there was sustained effect of IA injection of HA indicating maintenance of improvement. Paoloni et al. [23] studied 20 hip OA patients observing the clinical effects of 3 weekly intra-articular injections of 2 mL of hyaluronic acid in the hip in terms of pain and function at 1, 3 and 6-months follow-ups. Reporting that pain significantly improved after this procedure, ($P \leq 0.0001$). Lanzotti et al. [24] performed HA injections to 30 hip OA patients and evaluated the clinical response by pain VAS. They found significant improvements in mobility and pain then concluded that HA injection is safe and efficient treatment for OA of the hip. Balazs and Denlinger [25] reported significant reductions in pain and discomfort in osteoarthritic joints. Because the molecular weight and the amount of HA is reduced and eventually its protective effect is mostly lost in OA, it seems logical to replace the HA from outside sources to reverse the pathological process.

5. Conclusion

Hip OA patients display clinical and functional performance improvement during walking 1 and 3 months after IA injections of HA. Also, we found that IA Visco supplementation are effective and safe not only in relieving pain but also in altering natural history of hip OA by improving joint mobility and improvement in spatiotemporal parameters of gait analysis, also improvement of hip extension angle of hip. This report proved the efficacy of ultrasound guided IA HA injection for hip osteoarthritic patient treatment**.**

6. Recommendation

We recommend that the use of intraarticular HA Visco supplementation as an effective treatment in hip osteoarthritic patients who have functional impairment of activity of daily life. Also recommend that the use of gait analysis as a quick screening tool and excellent predictor not only in detection of functional impairment and performance in patients with hip osteoarthritis but also to evaluate effectiveness of follow up.

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