Research Article

Rehabilitation Effect of Exercise Therapy on Knee Osteoarthritis Evaluated by Computed Tomography Image under Optimized Reconstruction Algorithm

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The aim of this study was to explore the treatment of knee osteoarthritis (KOA) with combined exercise therapy and to evaluate the curative effect through CT imaging technology based on optimized reconstruction algorithms. A total of 60 patients with osteoarthritis admitted to our hospital from September 2020 to March 2021 were randomly recruited as the research objects. Patients were rolled into the routine treatment group and exercise group (routine treatment + targeted exercise therapy) according to different treatments they received, with 30 cases in each group. Then, the CT imaging results of the two groups were compared after treatment. The positive rates of peripheral osteogenesis, joint space narrowing, cartilage lesions, and synovial lesions in the exercise group were inferior to those in the routine group, and the difference was statistically significant ($P < 0.05$). However, the change rate of positive indicators before and after treatment was not statistically significant ($P > 0.05$). The change range of digital pain score and Lysholm knee function score in the exercise group was significantly superior to that in the routine group, and the difference was statistically significant ($P < 0.05$). CT images with optimized reconstruction algorithms still had certain limiting factors in the evaluation of the curative effect of KOA and still needed to be improved. It was also proved that exercise therapy had good application value in the treatment of KOA through other methods.

1. Introduction

Knee osteoarthritis (KOA) is a very common clinical joint degenerative disease, also known as osteoarthritis disease, degenerative arthritis, etc. [1]. KOA has a high incidence in China, mainly in the elderly, and most of the patients below the age of 50 are male. However, over the age of 50, most of them are women, especially those in postmenopausal period [2]. The main causes of KOA are trauma, cold, strain, osteoporosis, and congenital abnormalities of bones and joints [3]. The pathogenesis of KOA is complex, and it will bring about great inconvenience to patients' life when it is serious. KOA has always been one of the focuses of clinical research.

The treatment of KOA is varied and is classified into two main categories: surgical treatment and conservative treatment. Conservative treatment is classified into drug

treatment and nondrug treatment, the physical therapy of exercise therapy is a nondrug treatment, and it has been applied early abroad [4]. Exercise therapy to treat KOA is mainly based on slowing down the degradation of cartilage tissue, improving the ability of movement control, and exerting analgesic effects [5]. The disease treatment programs customized for different individuals mainly include aerobic exercise, muscle strength training, edema exercise, and some other exercise methods [6]. Moreover, these therapies are effective, safe, inexpensive, and easy to operate. More importantly, it is highly accepted by patients and is recommended by many guidelines as the first-line treatment for KOA [7]. In terms of detection, DR, CT, and MRI are currently the commonly used detection methods [8]. Although CT has a certain effect in the detection of joint cavity effusion, meniscus degeneration, and synovial degeneration,

it is limited in the detection of other tissues [9], so it is unable to assist physicians to make a relatively accurate diagnosis of the condition. Therefore, the CT image technology optimized by the reconstruction algorithm was adopted in this research, there were a variety of image reconstruction algorithms for CT, and the results obtained by optimizing different algorithms were also different [10]. For example, after the 3D reconstruction algorithm was optimized, the reconstruction speed was greatly improved. After the iterative reconstruction algorithm was optimized, the speed was significantly accelerated and the radiation amount was reduced when sparse angle scanning was used. After the compressed sensing (CS) reconstruction algorithm was optimized, both the speed and image quality were improved [11].

The imaging analysis and evaluation of the rehabilitation effect of exercise therapy in the treatment of KOA were made in the research by using the optimized CT compression sensing reconstruction algorithm. This research aimed to provide a favorable basis for the comprehensive treatment of KOA so that exercise therapy can be more widely used in clinical practice in the future.

2. Methods

2.1. Research Objects. 60 patients with osteoarthritis admitted in our hospital from September 2018 to March 2020 were randomly selected as the research objects. According to the different treatment methods, 60 patients with osteoarthritis admitted were divided into two groups, and patients in both groups needed to be tested before and after treatment. One group of patients treated with routine treatment was the routine group. The other group of patients implemented targeted exercise therapy based on routine treatment methods was the exercise group. The number of patients in both groups was 30. The 60 patients ranged in age from 56 to 70 years, with an average age of 69 ± 0.9 years: 24 male and 36 female patients. According to the analysis of the disease, all the 60 patients met the requirements of using exercise therapy for treatment. All family members of the patients signed an informed consent form voluntarily and this experiment had been approved by the hospital's ethics committee. There was no significant difference in the general information of patients ($P > 0.05$), so it had a certain degree of comparability.

Inclusion criteria were as follows: (i) 60 patients as the research object who were diagnosed according to the diagnostic criteria of the Guidelines for the Diagnosis and Treatment of Osteoarthritis (2010 Edition) [12] and met the criteria; (ii) patients not older than 75 years; (iii) patients manifested as lesion of one limb; (iv) the diagnosed patients treated with exercise therapy; (v) patients with normal cognitive function and able to follow the medical treatment; and (vi) patients and family members who had signed the informed consent.

Exclusion criteria were as follows: (i) patients accompanied by serious cardiovascular and cerebrovascular diseases, as well as respiratory, mental, and circulatory system diseases and malignant tumors; (ii) patients with other knee

joint dysfunctions; and (iii) patients with incomplete follow-up data.

2.2. Research Methods

2.2.1. Inspection Methods of Routine CT Images. The specific operation method was shown in Figure 1. All patients were examined using the same instrument, and all patients were examined and reconstructed by the same skilled and experienced radiologist. The results were then interpreted by two senior doctors.

2.2.2. CT Image Reconstruction Based on Optimized Compressed Sensing Algorithm. An improved CS reconstruction algorithm was proposed in the research, which achieved very good reconstructed image quality with a very small amount of projection. The traditional CS algorithm was improved in the model. Finite difference transformation (FDT) was taken as the sparse transformation, and the norm z^1 of FDT, that is, total variation (TV), was optimized as the objective function. The TV in the two-dimensional space can be expressed as in the following equation:

$$TV(T) = \int_{\alpha} \sqrt{|\Delta T|^2} dx dy = \int_{\alpha} \sqrt{\left| \frac{\beta T}{\beta x} \right|^2 + \left| \frac{\beta T}{\beta y} \right|^2} dx dy, \quad (1)$$

where x and y are the point targets on the two-dimensional plane, T is the target image, ΔT represents the inverse of function T , and β is the Dirac parameter.

However, the function was nonconvex and non-differentiable. The solution speed of the function and the stability in the process of finding the result were relatively poor, so the above form can be transformed into the following:

$$TV(T) = \int_{\alpha} \sqrt{|\Delta T|^2} dx dy = \int_{\alpha} \sqrt{\left| \frac{\beta T}{\beta x} \right|^2} dx dy + \int_{\alpha} \sqrt{\left| \frac{\beta T}{\beta y} \right|^2} dx dy. \quad (2)$$

Then, for two-dimensional images, FDT can be expressed as follows:

$$TV(T) = \sum_{i,j} \left(\sqrt{(t_{i,j} - t_{i-1,j})^2} + \sqrt{(t_{i,j} - t_{i,j-1})^2} \right), \quad (3)$$

where i is the number of rays in the graph, j is the number of photons emitted, and t is the target function.

Then, the optimization of the problem was carried out by means of solving, and reconstruction image T can be expressed as

$$\begin{aligned} & \min TV(T), \\ & \text{s.t. } P = AT, \quad T \geq 0. \end{aligned} \quad (4)$$

In the above equation, P represented the transmission projection image, A represented the observation matrix, and T represented the reconstructed image.

FIGURE 1: The specific operation method of CT image inspection.

The calculation process of the algorithm can be divided into two steps. One referred to the MLEM process under constraints, and the other referred to the solution overrun of the total variation minimization (TVM).

Step 1 : projection on convex set (POCS) process with constraint $P = AF$

- (a) The image to be reconstructed was initialized. m in the following equation represented the total number of iterations:

$$T_M^0(m=0) = 0. \quad (5)$$

- (b) The image was iterated using MLEM's algorithm, as shown in (6): the total number of iterations was represented by m . The evaluation value of iteration m was indicated by t_l^m , the projection value of the n th ray was represented by p_n . $a_{n,l}$ represents the probability that the target object pixel n can be detected by the l -th unit of the detector after it is emitted:

$$t_l^{(m+1)} = t_l^m \frac{1}{\sum_n a_{n,l}} \sum_n a_{n,l} \frac{p_n}{\sum_o a_{n,o} t_o^{(m)}}. \quad (6)$$

- (c) The value of (7) was calculated using nonnegative constraints:

$$T_M(m) = \begin{cases} T_M^N(m), & T_M^N(m) \geq 0, \\ 0, & T_M^N(m) < 0. \end{cases} \quad (7)$$

Step 2 : the solution process of TVM.

- (a) The TVM image was initialized, as shown in the following equation:

$$T_{TVM}^0(m) = T_{pocs}(m). \quad (8)$$

- (b) The increment factor was calculated, as shown in the following equation:

$$d(m) = \|X_M^0(m)X_{pocs}(m)\|. \quad (9)$$

- (c) The gradient and direction of the TV were calculated, as shown in (10). Here, z ($1 < z < \infty$) referred to the sequence number of the iteration:

$$\vec{H}^{z-1}(m) = \frac{\partial \|T\|_{TV}}{\partial f_{n,l}} \Big|_{T=T_{TVM}^{z-1}(m)}, \quad (10)$$

$$\vec{H}^{z-1} \frac{\vec{H}^{z-1}(m)}{|\vec{H}^{z-1}(m)|}$$

- (d) The image was repaired from the negative direction of the gradient, as shown in (11), and γ presented a regulatory factor:

$$T_{TVM}^z(m) = T_{TVM}^{z-1}(m) - \gamma d_A(m) \vec{H}^{z-1}(m), \quad k = k + 1. \quad (11)$$

- (e) If any value of v was positive in (12), then the algorithm ended:

$$\|T_{pocs}^m(m) < t_{pocs}^{m-1}(m)\| < v. \quad (12)$$

If the above conditions were not met, then start the next round of calculation according to the following equation:

$$T_M^0(m+1) = T_{TVM}^F(m). \quad (13)$$

Figure 2 showed the difference of the image changes of patients' knee joint position in CT image examination based on the optimized CS algorithm. It can be clearly seen that the CT image after the optimized reconstruction algorithm was clearer than that of the routine reconstruction.

2.2.3. Treatment Methods. The routine group adopted routine comprehensive rehabilitation therapy: the patient's condition was fully understood, according to the condition of the patient, and the doctor guided the patient's lifestyle and selected treatment options such as whether to use TCM treatment, physical therapy, and nonsteroidal anti-inflammatory drugs. The patients in exercise group were given reasonable exercise therapy based on routine rehabilitation comprehensive therapy. According to the individual's situation, a specific exercise treatment plan was developed to guide the patient's patella ligament, quadriceps, and knee joint.

FIGURE 2: Difference between CT image based on optimized compressed sensing algorithm and routine CT.

2.3. Observation Indicators

- (I) Visual analogue scale (VAS) was used to compare the knee joint pain of the two groups of patients before and after treatment.
- (II) The Lysholm knee function score [13] was used to compare the knee function of the two groups of patients before and after treatment, as shown in Table 1. The higher the score, the better the treatment effect.
- (III) The results of CT examination before and after treatment of the two groups of patients were observed and compared. The indicators checked included bone hyperplasia, loose bodies, joint space narrowing, cartilage disease, joint cavity effusion, synovial disease, and meniscus degeneration.

2.4. Statistical Methods. SPSS 22.0 software was used for statistics, the count data was expressed by percentage (%), the Y2 test was performed, and the rank-sum test was performed on the grade count data. The measurement data was expressed by the mean $\pm$ standard deviation, and the t -test was performed. $P < 0.05$ indicated that the difference was statistically significant.

3. Results

3.1. Difference of the VAS Scores of the Two Groups of Patients before and after Treatment. Through statistical analysis of the VAS scores of the two groups of patients, it was concluded that the score of the routine group before treatment was 4.73 ± 0.45 , and the score of the exercise group was 4.33 ± 0.42 . The difference of the VAS scores between the two groups of patients before treatment was not statistically significant ($P > 0.05$). VAS scores of the routine group and the exercise group decreased after treatment, which were 3.21 ± 0.33 and 2.41 ± 0.3 , respectively. Through analysis and comparison, the decline of the exercise group was larger than that of the routine group, and the comparison showed obvious difference ($P < 0.05$) (Figure 3).

3.2. Difference of Lysholm Function Scores of Knee Joints before and after Treatment between the Two Groups. Through statistical analysis of the knee Lysholm function scores of the two groups of patients, it was concluded that the difference

between the knee Lysholm function scores of the two groups of patients before treatment was not statistically substantial ($P > 0.05$). After treatment, the Lysholm function scores of the two groups of patients were obviously increased, the increase in the exercise group was significantly higher than that of the routine group, and the difference was statistically significant ($P < 0.05$), as shown in Figure 4.

3.3. Difference of CT Imaging Results of the Two Groups of Patients before Treatment. The positive rates of periarticular osteogenesis, free bodies, articular space narrowing, cartilage lesions, joint cavity effusion, synovial lesions, and meniscus degeneration in CT images before treatment in two groups of patients were observed and compared, and it was found that the difference was not statistically significant ($P > 0.05$). This also suggested that the efficacy comparison between the two groups of patients was feasible. The results were shown in Table 2, and the difference of typical CT images before treatment was shown in Figure 5.

3.4. Difference of CT Imaging Results of the Two Groups after Treatment. The positive rate of CT examination after treatment was compared between the two groups. It was found that the difference of the positive rates of bone hyperplasia, joint space narrowing, cartilage disease, and synovial disease between the two groups of patients was remarkable, and that of exercise group was lower than that of the routine group ($P < 0.05$), as shown in Figure 6. The typical CT image difference between the two groups of patients after treatment was shown in Figure 7.

3.5. Difference of the Change Rate of the Positive Results of CT Images before and after Treatment in the Two Groups. Results of CT images of patients before and after treatment in the routine group were compared, and it was found that the positive change of indicators in CT examination was about 35%. In the exercise group, the positive change rate of CT images before and after treatment was about 55%, but there was no statistically significant difference in the positive rate between the two groups ($P > 0.05$), as shown in Table 3. The difference of CT images of patients in the two groups before and after treatment was shown in Figure 8.

TABLE 1: Lysholm functional score table of the knee joint.

Limping	Nothing	5	Support	No support needed	5
	Lighter/periodic	3		Need a cane/crutch	2
	Heavier/continuous	0		Unbearable	0
Unstable	No soft legs	25	Pain	Nothing	25
	Occasionally appear when tired	20		Severe work occasionally has light pain	20
	Appear at a time of fatigue	15		Severe fatigue and pain are obvious	15
	Occasionally in daily life	10		Walk more than 2 km/significant pain after walking	10
	Common in daily life	5		Walk less than 2 km/significant pain after walking	5
	Every step appears	0		Persistent occurrence	0
Swelling	Nothing	10	Climb stairs	No difficulty	10
	After tired	6		Slightly strenuous	6
	After normal activities	2		With the step	2
	Continued	0		Cannot proceed	0
Interlock	Nothing	15	Squats	No difficulty	5
	Do not feel stuck but not interlock	10		A little difficult	4
	Occasionally appear	6		Not greater than 90°	2
	Often appear	2		Cannot make this action	0
	At the physical examination	0

FIGURE 3: Difference of the VAS scores of the two groups of patients before and after treatment.

4. Discussion

The pathogenic factors of KOA were complex. The deformation of knee joint and the lesions of nerve, muscle, and ligament are caused by age, body shape, strain, and cold [14]. The rehabilitation comprehensive therapy based on exercise therapy is the main method for the treatment of KOA at present, which includes health education, traditional Chinese medicine treatment, physical therapy, and anti-inflammatory treatment of nonsteroidal drugs and other combined therapies [15]. In addition, due to the great differences between individuals in clinical manifestations of KOA, it is necessary to adopt a personalized treatment plan when a treatment plan was formulated for the patient [16, 17]. The knee joint is a type of joint that is frequently used in human daily life. Daily incorrect exercise, use, habits, and posture will have a great impact on the occurrence of KOA and the development of the disease [18]. Exercise

FIGURE 4: Difference of Lysholm function scores of knee joints before and after treatment between the two groups (* indicates remarkable difference, $P < 0.05$).

therapy can not only correct the improper habit of daily use of the knee but also play a preventive role in the occurrence of KOA, which was often used for KOA and had ideal therapeutic effects [19].

The treatment effect of routine KOA treatment and routine therapy combined with exercise therapy for KOA was compared, and digital pain score and Lysholm knee function score were analyzed. It was found that routine combined exercise therapy was more effective in the treatment of KOA than routine therapy alone. Then, CT imaging technology based on optimized CS reconstruction algorithm was used to compare and analyze the treatment effect of KOA. Some experts conducted research on the effect of exercise therapy on ADL in patients with end-stage knee osteoarthritis. The results showed that exercise therapy was very effective in improving patients' ADL even in the end-

TABLE 2: Difference of the positive rate of CT examination indicators between the two groups (%).

Grouping	Bone hyperplasia	Loose body	Cartilage lesions	Joint volume	Synovial disease	Meniscus disease
Routine group	60	67	57	54	34	33
Exercise group	63	65	54	55	32	32

FIGURE 5: Difference of typical CT images of the two groups of patients before treatment. (a) Routine group. (b) Exercise group.

FIGURE 6: Difference of the positive rate of some CT imaging indicators between the two groups of patients after treatment. (H) bone hyperplasia, (N) joint space narrowing, (C) cartilage disease, (S) synovial degeneration (* indicates remarkable difference, $P < 0.05$).

stage KOA, and it was worthy of promotion [20]. Experts also discussed the effect of exercise therapy on knee osteoarthritis and the effect on the VAS score. The conclusion was that exercise therapy was the main treatment for patients with knee osteoarthritis. The curative effect was satisfactory, which can effectively alleviate knee joint pain and improve the quality of life of patients [21]. In comparative study of CT and MRI in imaging diagnosis of KOA, the detection rate of CT for bone hyperplasia and loose bodies in the diseased position was higher than that of MRI. However, MRI had

higher detection of cartilage destruction, meniscus degeneration, synovial changes, and joint cavity effusion in osteoarthritis than CT scan [22]. Both CT and MRI can provide a certain degree of guidance value for the clinical diagnosis of KOA. Some scholars explored the diagnostic value of DR, CT, and MRI for elderly KOA and found that the detection rate of MRI for loose bodies was significantly lower than that of DR and CT. The detection rate of MRI for cartilage destruction, joint cavity effusion, meniscus degeneration, and synovial changes was significantly higher than those of

FIGURE 7: Difference of typical CT images between the two groups of patients after treatment. (a) Routine group. (b) Exercise group.

TABLE 3: Changes of positive indicators of CT examination before and after treatment in the two groups.

	Routine group (%)		Exercise group (%)	
	Before treatment	After treatment	Before treatment	After treatment
Bone hyperplasia	60	41	63	26
Loose body	67	39	65	22
Cartilage lesions	57	39	54	25
Joint effusion	54	40	55	29
Synovial disease	34	25	32	22
Meniscus lesions	33	21	32	17
Rate of change	35		55

FIGURE 8: Difference of CT images of patients in the two groups before and after treatment. (a) Routine group. (b) Exercise group.

DR and CT ($P < 0.05$) [23]. DR, CT, and MRI had high diagnostic value for elderly KOA, whose combination was of great significance for detailed understanding of the pathological changes of the patient's knee joint. Although some differences were suggested between two kinds of treatments, there was no obvious statistical significance ($P > 0.05$). Some applied the optimized CS reconstruction algorithm to the reconstruction of CT images and found that the image reconstruction speed in this case was accelerated, and the image quality was ideal. However, the fundamental problem was not solved; that is, the scans and inspections of certain tissues in the diseased area were restricted.

5. Conclusion

60 patients with KOA who were admitted in our hospital were randomly selected in the research and divided into two groups for different treatment methods, and the CT images based on optimized reconstruction algorithm were used for efficacy analysis. It was found that the positive rates of periarticular osteogeny, articular space narrowing, cartilage lesions, and synovial lesions in the two groups after treatment were lower in the exercise group than in the routine group, and the difference was statistically significant ($P < 0.05$). There was no statistically significant difference in the positive change rate of CT examination indexes between the two groups before and after treatment ($P > 0.05$). In addition, digital pain scoring and Lysholm knee function scoring were performed before and after treatment in both groups of patients, and it was concluded that the effect of combined exercise therapy was significantly better than that of only using rehabilitation therapy.

Therefore, it was concluded that the CT images of the optimized reconstruction algorithm still had certain restrictive factors in the evaluation of the efficacy of KOA in conclusion. However, it was also proved that exercise therapy had good application value in the treatment of KOA through other methods, with a good application prospect. However, the scope of this study is small, the sample size of the study is insufficient, and it does not have a good representative. The CT imaging technology will be further improved in the following research work to give it more important value in clinical application.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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