



Rotator cuff treatment ranking using the COPRAS method

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ABSTRACT

Rotator cuff injury is affecting most people across the world. MRIs, Ultrasounds and X-rays play an important role in determining the treatment options for such patients. Physical therapy, lifestyle modifications, anti-inflammatory drugs, and analgesic medications form the rigid structure of non-operative treatment. Managing rotator cuff tears is contentious regarding whether the treatment undergoing patient is a surgical candidate or not. This paper focuses on rotator cuff tears and a treatment ranking alternative based on current practical evidence by examining patients of different gender and age group based on the expert comments. In the end, the treatment alternatives are ranked using the COPRAS method. Multi-criteria decision analysis (MCDA) solves different decision-making problems through alternative evaluation. MCDA methods are effectively used in every field to define a problem, alternatives and criteria. This research applies the COPRAS method to the physiotherapy aspect of treatment given to rotator cuff injury patients.

Keywords: multi-criteria decision analysis (MCDA), COPRAS, Physiotherapy, Rotator Cuff, treatment

1. INTRODUCTION

The shoulder structure is the most vulnerable body part of undergoing tear in sports medicine due to its complexity. The Rotator Cuff (RC) comprises four different muscles and their tendons, which help to provide strength and stability during the shoulder's motion. They are also known as the SITS muscle (Supraspinatus, Infraspinatus, Teres, and Subscapularis, respectively). A rotator cuff tear is a cut in the SITS muscle and tendons that stabilizes the shoulder motion for arm lifting purposes [1].

The time required to repair the SITS muscle depends on the patient's age, tear type & size, and other factors, which include smoking and diabetes. The surgical treatment practice uses conservative treatment and arthroscopic repair [1].

Shoulder pain is the third most common musculoskeletal complaint. Patient care starts with evaluating non-operative rotator cuff tears, such as the physical examination, imaging modalities, medications, injections, and physical therapy. Therefore, primary care management forms a perspective standpoint for further treatment. The rotator cuff made up of SITS muscles is shown in Fig-1 below [1]. Patients having Rotator cuff injury are examined in OPD sections and referred to take physiotherapy management whereby they are further diagnosed for the type of tear and severity based on visual inspection. Patients with standard alternative treatment options with some underlying criteria are treated under non-operative management.

The decision-making problem comprises multiple choices/criteria and alternatives. Many a time, reaching an ideal solution is complex. To overcome this difficulty, multi-criteria decision-making (MCDM) methods have been designed to successfully evaluate problems with multiple choices/criteria.

The multiple-criteria decision-making field identifies criteria, classifies alternatives, and groups them accordingly to select the most optimal option. Multiple criteria decision-making problems evaluate the measures and alternatives simultaneously. There are many criteria decision-making methods available. In our study, we will use the COPRAS method as multiple criteria decision-making method to rank the best treatment alternative for Rotator cuff injury.

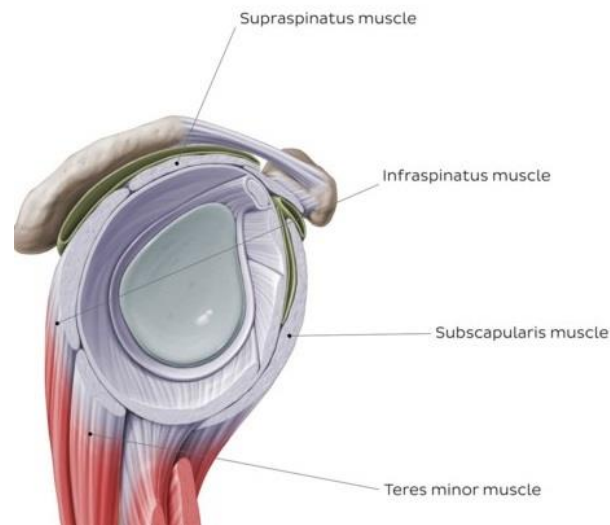


Fig-1: Rotator Cuff Muscles (SITS)

2. RESEARCH METHODOLOGY

Non-operative patients with shoulder pain are examined and shortlisted for treatment related to Rotator cuff injury. Shortlisting involves visual inspection of the shoulder, palpation, range of functional movements, and manual muscle testing. Also, consideration is given to the history linked to shoulder damage of the patient in terms of age/sex/co-morbidities, sports participation, whether contact sports or overhead sports and type of injury [1].

Based on the data, various alternatives & criteria are defined. Here, the alternatives identified are Exercises, Laser, Electro therapy, Exercises+Manual therapy and Exercises+Electro therapy. Criteria defined are Cost/ Session which is non-beneficial having weightage 0.3, Treatment days in time which is non-beneficial having weightage 0.2, Effects on functional movements which is beneficial having weightage 0.3 and pain relief which is beneficial having weightage 0.2. Finally, the COPRAS method is applied to rank the identified alternatives concerning the best possible treatment. Fig-2 below shows the methodology used for this research.

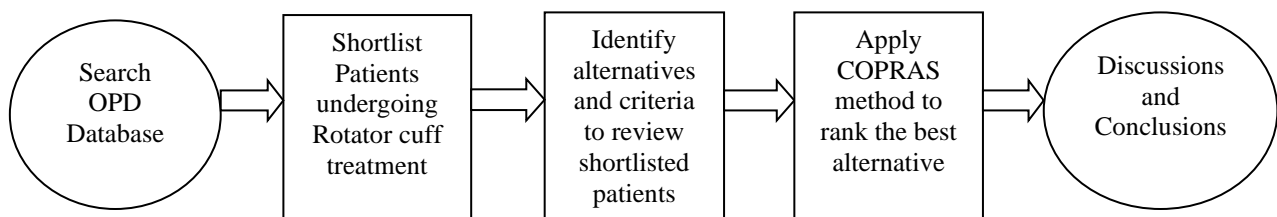


Fig-2: Research Methodology

3. PROBLEM ON HAND

Many people across the globe undergo Rotator cuff injury where the treatment is carried out using different alternatives in different regions of the world. However, the ranking of such options has always been neglected and thus is sometimes uncertain. These alternatives can be ranked by using an MCDM technique.

Simple statistical analysis, including data in the form of numbers, is used chiefly in the medical world of physiotherapy.

Here, the data is taken from several patients undergoing the said treatment for different criteria addressed at a time. But now, opinions are directly taken as linguistic variables from the expert based on past data and the COPRAS method is applied for the same.



4. ANALYSIS

Table-1: Decision Matrix

	Non-Beneficial	Non-Beneficial	Beneficial	Beneficial
Weightage	0.3	0.2	0.3	0.2
	Cost / session	Treatment time in days	Effects on Functional movements	Pain relief
Exercises	400	25	5	7
Laser	350	18	5	5
Electro therapy	300	30	3	5
Exercises + Manual therapy	500	15	7	7
Exercises + Electro therapy	700	12	9	9

Table-2: Normalised Matrix

	Cost / session	Treatment time in days	Effects on Functional movements	Pain relief
Weightage	0.3	0.2	0.3	0.2
Exercises	0.177777778	0.25	0.172413793	0.212121212
Laser	0.155555556	0.18	0.172413793	0.151515152
Electro therapy	0.133333333	0.3	0.103448276	0.151515152
Exercises + Manual therapy	0.222222222	0.15	0.24137931	0.212121212
Exercises + Electro therapy	0.311111111	0.12	0.310344828	0.272727273

Table-3: Weighted Normalised Matrix

	Cost / session	Treatment time in days	Effects on Functional movements	Pain relief
Exercises	0.053333333	0.05	0.051724138	0.042424242
Laser	0.046666667	0.036	0.051724138	0.03030303
Electro therapy	0.04	0.06	0.031034483	0.03030303
Exercises + Manual therapy	0.066666667	0.03	0.072413793	0.042424242
Exercises + Electro therapy	0.093333333	0.024	0.093103448	0.054545455



Table-4: Ranking of Alternatives

	Ci	Bi	min Ci/Ci	qi	Udi	Rank
Exercises	0.1033	0.0941	0.8	0.1897	81.838	4
Laser	0.0827	0.082	1	0.2015	86.913	3
Electro therapy	0.1	0.0613	0.82667	0.1601	69.056	5
Exercises + Manual therapy	0.0967	0.1148	0.85517	0.217	93.606	2
Exercises + Electro therapy	0.1173	0.1476	0.70455	0.2318	100	1
Summation	0.5		4.18638			

5. CONCLUSION

Patients' quality of life is drastically affected by Rotator cuff injury. Millions of people are affected every year across the globe by this type of injury. With the increasing occurrence of rotator cuff injuries, the future poses a unique challenge to orthopedic surgeons and physiotherapists.

Those patients with an excellent initial response showing improvement during primary care should be given non-Operative treatment. However, getting back the structure and strength of the injured rotator cuff to its original form is still challenging. Therefore, further in-depth study of the clinical trials related to rotator cuff injury will significantly promote the future development of this field.

Decision-making in treating rotator cuff injury is always uncertain. Duration of symptoms, weakness, injury & tear size is essential in determining the treatment type for such patients.

This paper's principal objective is to familiarise oneself with the application of MCDM techniques in medical sciences. In this study, alternatives and criteria related to rotator cuff injury treatment are analysed by the COPRAS method and the best suitable treatment is ranked accordingly. In the end, it is accepted that the alternative Exercises+Electro therapy has the best score. Also, we can see that it has the highest cost per session, effects on functional movements, and pain relief. At the same time, it has the lowest number of treatment days. It is also clearly visible that Electro therapy treatment given alone has the lowest performance score.

The authors, along with the expert physiotherapists, have reviewed several case studies for this paper to help researchers explore the future scope of MCDM-based applications and possibilities in the field of medical sciences.

6. REFERENCES

- [1]. Rotator Cuff, accessed 15 Jul. 2022. URL: https://www.physio-pedia.com/Rotator_Cuff.
- [2]. Varatharajulu M, Duraiselvam M, Kumar M, Jayaprakash G, Baskar N. Journal of Magnesium and Alloys 2021.
- [3]. Pandey V, Jaap Willems W. Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology 2015;2.
- [4]. Zamani-Sabzi H, King J, Gard C, Abudu S. Operations Research Perspectives 2016;3.
- [5]. Vakilipour S, Sadeghi-Niaraki A, Ghodousi M, Choi S. Sustainability 2021;13.
- [6]. Clement N, Nie Y, McBirnie J. Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology 2012;4.
- [7]. Triantaphyllou E. Multi-Criteria Decision Making Methods: A Comparative Study. 2000.



- [8]. Mathiasen R, Hogrefe C. *Current Reviews in Musculoskeletal Medicine* 2018;11.
- [9]. Ghaleb A, Kaid H, Alsamhan A, Mian S, Hidri L. *Advances in Materials Science and Engineering* 2020;2020.
- [10]. Lu J, Zhang S, Wu J, Wei Y. *Technological and Economic Development of Economy* 2021;27.
- [11]. Zhang C, Wu J, Li X, Wang Z, Lu W, Wong T. *Frontiers in Bioengineering and Biotechnology* 2021;9.
- [12]. Krishankumar R, Garg H, Arun K, Saha A, Ravichandran K, Kar S. *Complex & Intelligent Systems* 2021;7.
- [13]. Longo U, Risi Ambrogioni L, Candela V, Berton A, Carnevale A, Schena E, Denaro V. *BMC Musculoskeletal Disorders* 2021;22.
- [14]. Sambandam S. *World Journal of Orthopedics* 2015;6.
- [15]. What Is A Rotator Cuff Tear?, accessed 12 Jul. 2022. URL: <https://www.webmd.com/pain-management/rotator-cuff-tear>. Rotator Cuff, accessed 12 Jul. 2022. URL: https://www.physio-pedia.com/Rotator_Cuff.
- [16]. Huisstede B, Koes B, Gebremariam L, Keijsers E, Verhaar J. *Manual Therapy* 2011;16.