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Mini Review

Myogenic Potential and Differentiation of Human

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Abstract

Despite its potential use in the research of myogenesis and its implications for livestock production, the myogenic capacity of bovine foetal MSC (bfMSC) generated from bone marrow (BM) is unclear. The DNA methyltransferase inhibitor 5-Aza-2′-deoxycytidine (5-Aza), the myoblast-secreted factor Galectin-1 (Gal-1), and the myoblast culture medium SkGM-2 BulletKit were utilised in the three in vitro myogenic differentiation methods employed in the current investigation. Foetal BM obtained from foetuses generated from abattoirs included plastic-adherent bfMSC. Propidium iodine (PI)-negative bfMSC were found in 85.6% of samples during post-thaw viability tests. MYF5, MYF6, MYOD, and DES mRNA levels were greater ($P < 0.05$) in bfMSC grown under 100 M of 5-Aza compared to 1 and 10 M of 5-Aza. Treatment of bfMSC with 10 M of 5-Aza led to the up-regulation of MYF6 (Day 7), MYF5, and DES mRNA (Day 21) and the down-regulation of MYOD mRNA (Days 7 to 21). SkGM-2 and Gal-1 Early MRF (MYF5) was sequentially downregulated by BulletKit, whereas intermediate (MYOD) and late MRF (DES) mRNA were sequentially upregulated. Differentiated bfMSC were also MYF5 and DES immunoreactive. As a result of protocols tested in bfMSC, myogenic differentiation progressed to a certain level as shown by alterations in MRF gene expression (Brown et al., 2015).

INTRODUCTION

In pathological processes including muscle atrophy and regeneration as well as damage, myogenic differentiation is crucial. Crotonylation, a brand-new kind of posttranslational alteration, has been implicated in stem cell development and illness. However, it is still unclear how crotonylation affects myogenic differentiation (Onyinyechukwu et al., 2017).

Stem cells are thought to be a significant source of cells that may be utilised to encourage the regeneration of skeletal muscle (SKM), which has been harmed owing to flaws in the organisation of muscle tissue caused by hereditary disorders, trauma, or tumour removal. Mesenchymal stem cells (MSCs), in particular, are an important source of cells for stem cell treatment since they may be harvested using less invasive methods. In the current work, we showed that transplantation of myoblasts and myocytes produced from human T-MSCs facilitates the recovery of muscle function in vivo and that human tonsil-derived MSCs (T-MSCs) may develop into myogenic cells in vitro (Haratym-Maj 2002). The T-MSC-derived spheres were cultured in myogenic induction medium (low-glucose DMEM containing 2% foetal bovine serum (FBS) and 10 ng/ml insulin-like growth factor 1 (IGF1)) for 14 days in order to induce myogenic differentiation. The mediums used for the cultures were Dulbecco's modified Eagle's medium/nutrient mixture F-12 (DMEM/F-12) and nutrient mixture F-12. The development of myotubes in vitro and the enhanced expression of markers associated with skeletal myogenesis, such as -actinin, troponin I type 1 (TNNI1), and myogenin, show that the T-MSCs progressively differentiated into myoblasts and skeletal myocytes. The in situ transplantation of T-MSCs improved muscular function, as shown by gait analysis (footprint analysis), and restored the morphology of SKM without causing teratomas in mice having a partial myectomy of the right gastrocnemius muscle. To efficiently restore SKM after damage, T-MSCs may develop into myogenic cells. The therapeutic potential of T-MSCs to encourage SKM regeneration after damage is shown by these data (Hassan 2010).

The complicated biological process of muscle differentiation includes the control of the cell cycle, the extension of

muscle stem cells, and the fusing of these cells to form multinuclear myotubes. It is generally established that skeletal muscle dysfunction leads to a variety of muscle diseases, from muscular injuries to muscular dystrophies or atrophy. Satellite cell activation and differentiation as well as myofiber remodelling are necessary for muscle regeneration and damage healing. Therefore, a thorough understanding of muscle differentiation might illuminate the causes of muscle illness and possibly recommend fresh treatments (Van et al., 2008).

After protein production, a chemical processing process known as posttranslational modifications (PTMs) takes place. Most PTMs change a protein's characteristics by adding a functional group to one or more amino acid residues. These PTMs change the changed protein's three-dimensional structure, which affects protein-protein interactions and triggers a number of biological processes. Numerous PTMs, including acetylation, phosphorylation, methylation, and ubiquitylation via histone or nonhistone substrates, have been shown to play a significant role in the development of skeletal muscle cells. Propionylation, butyrylation, 2-hydroxyisobutyrylation, succinylation, malonylation, glutarylation, crotonylation, and other new PTMs have recently emerged; propionylation may adversely affect muscle cell differentiation among these PTMs. Further study is needed to determine the functions of other new PTMs in the myogenic differentiation pathway (Hend et al., 2014).

One recently identified acylation alteration is crotonylation. Numerous nonhistone proteins have also been shown to be crotonylated in addition to histones. The histone crotonylation-induced differentiation of neural stem cells or neural progenitor cells and the maintenance of pluripotency by crotonylation in chemically induced pluripotent stem cells (CiPSCs) are two examples of the many key cellular processes involving these crotonylation-modified proteins that are connected to stem cell differentiation and other physiological processes. A "writer" and a "eraser" are needed for crotonylation, much like for the majority of acylation changes. Protein crotonylation levels are regulated by both positive and negative regulators. It has been reported that some "writers" and "erasers" are involved in both crotonylation and other acylation changes. Protein crotonylation is now understood to take place in a number of pathways. It is yet uncertain, nevertheless, whether protein crotonylation contributes to myogenic differentiation or muscle regeneration (Morteza et al., 2013).

We analysed previous studies and divided the proteins involved in crotonylation regulation into four main categories: crotonylation writers, erasers, positive regulators, and negative regulators. This classification allowed us to identify the cause of the drop in crotonylation levels during myogenic differentiation. An investigation of mRNA expression levels found 18 protein regulators of crotonylation during differentiation. A heatmap was created using relative levels, and it was discovered that the amounts of 6 proteins varied considerably between the several groups (Mohamed 2017). The fluctuations in the amounts of the positive regulators ACOX3 and ACADS as well as the rubber HDAC3 were consistent with the change in AKT1 crotonylation given the roles that the proteins perform. Then, we discovered that HDAC3 was elevated at the protein level during the differentiation of myoblasts, indicating that HDAC3 is responsible for the downregulation of crotonylation during the differentiation of myogenesis. Next, we created three siRNAs that specifically target HDAC3, and we discovered that si-HDAC3-1 and si-HDAC3-3 successfully achieved the appropriate level of knockdown. Further investigation revealed that myogenic differentiation was successfully prevented by HDAC3 suppression at the protein level, which was further supported by immunofluorescence labelling. AKT1 and HDAC3 were identified to interact by coimmunoprecipitation studies. AKT1's crotonylation level increased when HDAC3 was knocked down, while its phosphorylation level fell. Theophylline, an HDAC3 activator, and RGFP966, a highly specific HDAC3 inhibitor, were each given to the myogenic differentiation medium on day 1 separately (Nwangwa et al., 2016). AKT1's crotonylation level rose and its phosphorylation level reduced upon detection on day 3 in the presence of RGFP966. Theophylline was added alone, though, and the PTM level remained steady. Western blotting and immunofluorescence labelling further demonstrated that, in contrast to the HDAC3 activator, the inhibition of HDAC3 resulted in a reduction in the production of myogenic factors and hindered myogenic differentiation. Theophylline was then introduced along with sodium crotonate. Theophylline was discovered to be able to partially assist AKT1 in reversing crotonylation, boost AKT1 phosphorylation, and reverse the impairment of myogenic differentiation. In conclusion, these findings showed that HDAC3 is crucial for decrotonylating AKT1 during myogenic differentiation (Obembe et al., 2015).

CONCLUSION

In order to regenerate skeletal muscle and treat skeletal muscle damage, satellite cells must be activated and differentiated. During regeneration and repair, satellite cells, also referred to as muscle stem cells, differentiate and fusion into multinucleated muscle tubes, also referred to as muscle fibres. Muscle atrophy brought on by deficiencies in muscle stem cell proliferation and differentiation results in sarcopenia in clinical settings. The repair and regeneration of skeletal muscle as well as the therapy of sarcopenia depend significantly on alterations in the normal differentiation of muscle stem cells, according to molecular study. A new PTM mechanism related to myogenic differentiation and regeneration is shown by our work. The undifferentiated state of muscle stem cells is maintained by a sufficient quantity of crotonylation. Once muscle differentiation and regeneration begin, AKT1 progressively activates as a result of HDAC3 reducing crotonylation. This implies that methods that stimulate HDAC3 or decrotonylation may be

helpful for fostering muscle regeneration and repair. There are still some issues with our study, though. Our next study will concentrate on developing conditional knockdown/in mice models to better investigate the role of the HDAC3-crotonylation-AKT1 axis in promoting muscle repair and regeneration.

REFERENCES

1. Brown H, Kenanagha B, Onwuli DO (2015). Haemato-pathological effect of dichlorvoson blood picture and liver cells of albino rats. J Toxicol Environ Health Sci. 7: 18-23.

2. Onyinyechukwu AA, Valentine UO, Samuel OE, Samuel O, Benson CA (2017). A study on dichlorvos induced hematology clinical biochemistry and reproductive abnormalities in male albino rats. Journal of Molecular Pathophysiology. 6: 5-11.

3. Haratym-Maj A (2002). Hematological alternations after pyrethroids poisoning in mice. Ann Agric Environ Med. 9: 199-206.

4. Hassan DI, Ogah DM, Yusuf1 ND, Musa MM, Saidu GM (2010). The effect of acute and chronic (short and long term) oral administrations of black pepper (Piper guineense) aqueous extract on the body weight and haematological values of albino-Wistar rat. J Med Plant Res. 4: 122-125.

5. Van Hove CL, Maes T, Joos GF, Tournoy KG (2008). Chronic inflammation in asthma: a contest of persistence vs resolution. Allergy. 63: 1095-1109.

6. Hend MT, Omnia EK, Hekmat MT, Amira A (2014). Potential anti-inflammatory effect of lemon and hotpepper extracts on adjuvant-induced arthritis in mice. The Journal of Basic Applied Zoology.

7. Morteza RT, Alireza B, Afshin S, Maryam NN, Hannan E, et al (2013). Alteration in Liver Enzymes in Aluminum Phosphide Poisoning a Retrospective Study. Iranian Journal of Toxicology. 7:1-4.

8. Mohamed SA (2017). Nephroprotective Effect of Melatonin against Aluminum Phosphide Induced RenalTissue Damage in Rats. Journal of Bioscience and Applied Research. 3: 252-272.

9. Nwangwa JN, Udefa AL, Anyaibe SC, Iragunima AS, Eze NC (2016). Comparative Effect of Chilli Pepper (Capsicum frutescens) Extract and Capsaicin on Some Haematological Parameters and Serum Electrolytes in Albino Wistar Rats. International Blood Research Reviews. 6: 1-8.

10. Obembe AO, Ofutet EO, Okpo-ene AI, Okon VE, Eyong EE (2015). The Effect of Aqueous Extract of Xylopia Aethiopica (Nigro Pepper) On Some Haematological Parameters in Albino Rats. World Journal of Pharmaceutical Research. 4: 2576-2583.